The role of the care-giver in infant immunisation: influences and perspectives on immunisation uptake and pain expression

Hannah Harvey, BSc., MA

A thesis submitted for the Degree of Doctor of Philosophy in the Department of Psychology at Durham University

September 2015

# Thesis abstract

The recent decline in early childhood vaccination has been attributed to negative parental attitudes about immunisation. Vaccinations are a common cause of acute infant pain, although the impact of infant pain expression upon vaccination uptake is not well understood. Theoretical models of infant pain propose that care-giver behaviours may regulate pain expression, although previous findings have been inconclusive. Understanding care-giver beliefs, and the relationship between care-giver and infant behaviours during immunisation, may help to identify effective soothing strategies and develop interventions targeting parental concerns.

This thesis examines a number of factors associated with the role of the care-giver in infant immunisation uptake and pain expression. First, two systematic reviews, summarise evidence regarding the efficacy of uptake interventions and parental beliefs about immunisation. Second, the relationship between infant pain expression, care-giver behaviour and vaccine uptake is explored using a prospective cohort study. Finally, the hierarchical nature of parental viewpoints and their relation to vaccine uptake is examined using Q-methodology.

Whilst care-givers determine immunisation uptake, findings from the thesis suggest that their influence on infant pain expression may be minimal. Instead, the speed at which vaccines are administered, and the offer of a pacifier during injections may reduce pain expression. Whilst parents have complex views about vaccination, the views of immunising parents are dominated by the notion that vaccination provides the best protection from disease. Implications of the findings are discussed in terms of clinical practice, vaccine policy and future interventions promoting confidence in vaccine efficacy to target vaccine-hesitancy.

# Table of contents

List of tables i

List of figures ii

Declaration iii

Statement of copyright iv

Acknowledgements v

Note on publications included in the thesis vii

**Chapter 1: General Introduction..............................................................................1**

1. Overview and aims of the thesis 1

2. Immunisation uptake 4

3. Immunisation pain 10

4. Infant pain and immunisation uptake 25

5. Summary and aims of the thesis 26

**Chapter 2: Parental reminder, recall and educational interventions to improve early childhood immunisation uptake: A systematic review and meta-analysis.. 37**

Abstract 37

1. Introduction 38

2. Material and methods 39

3. Results 43

4. Discussion 64

**Chapter 3: Parents’ views about early childhood immunisation: a systematic review of qualitative studies integrated with trials ..............................................75**

Abstract 75

1. Introduction 77

2. Method 79

3. Results 81

4. Discussion 108

**Chapter 4: Determinants of infant pain expression during immunisation: the role of the care-giver and consequences for uptake over the first year of life..120**

Abstract 120

1. Introduction 121

2. Method 123

3. Results 134

4. Discussion 146

**Chapter 5: A Q-methodology study of parental understandings of infant immunisation: Implications for healthcare advice..............................................158**

Abstract 158

1. Introduction 159

2. Method 161

3. Results 167

4. Discussion 173

**Chapter 6: Parental understandings of infant immunisation and links to vaccine uptake: A Q-methodology study...........................................................................182**

Abstract 182

1. Introduction 183

2. Materials and Methods 185

2.5. Statistical analysis 188

3. Results 191

4. Discussion 197

**Chapter 8: General Discussion..............................................................................207**

1. Summary of findings 207

2. Vaccine uptake 209

3. Infant pain expression 212

4. Implications for clinical practice and vaccine policy 215

5. Limitations 216

6. Future research 221

7. Conclusions 223

**Appendices..............................................................................................................227**

Appendix A: Studies excluded from the systematic review of interventions 227

Appendix B: Risk of bias judgments for studies included in the meta-analysis 228

Appendix C: Studies excluded from the qualitative systematic review 235

Appendix D: CASP judgements for studies included in the qualitative systematic review 236

# List of tables

Table 2.1. OVID search strategy 40

Table 2.2. Study characteristics 46

Table 3.1. Study characteristics 85

Table 3.2. Illustrative quotes to depict themes established from included studies... 102

Table 3.3. Comparison of themes arising from parental viewpoints with interventions evaluated in trials 107

Table 4.1. Coding scheme 130

Table 4.2. Demographic characteristics 136

Table 4.3. Psychosocial factors 137

Table 4.4. Procedural phase durations 138

Table 4.5. Partial correlations between infant pain and care-giver behaviours 140

Table 5.1. By-factor rankings of statements in the Q-set. 168

Table 6.1. By-factor rankings of statements in the Q-set. 193

# List of figures

Figure 2.1. Flow diagram of study selection 44

Figure 2.2. Risk of bias chart for studies included in the meta-analysis (n = 28).. 56

Figure 2.3. Reminder-based interventions 59

Figure 2.4. Educational Interventions 63

Figure 3.1. Flow chart of study selection 82

Figure 4.1. Participant flowchart 135

Figure 4.2. Mean percentage of infant pain-related and care-giver behaviours observed during each procedural phase 139

Figure 4.3. Total infant pain-related expressed across the procedure according to care-giver psychological state 142

Figure 4.4. Variability in mean injection duration across primary care sites 144

Figure 4.5. Association between injection duration and total pain expression 145

Figure 5.1. Quasi-normal fixed response grid.. 165

Figure 6.1. Quasi-normal fixed response grid.. 190

# Declaration

Some of the data included in Chapter 5 has been previously submitted as part of a Masters degree at Durham University. The additional data collection, analysis and interpretation of the complete data set discussed in Chapter 5 have not been previously submitted for a degree in this or any other institution. All other sources and quotations have been appropriately referenced.

# Statement of copyright

The copyright of this thesis rests with the author. No quotation from it should be published without the author's prior written consent and information derived from it should be acknowledged.

# Acknowledgements

First, huge thanks must go to my supervisors, Dr. Nadja Reissland and Jim Good in the Department of Psychology and Prof. James Mason in the School of Medicine, Pharmacy and Health. Without Nadja’s encouragement and belief I would not have come this far, and although I might not say it often, I am extremely grateful for the support she has given me since we have been working together. Thanks go to Jim, for allowing me to learn from his tremendous expertise in Q. Immeasurable thanks must go to James, who has gone the extra mile to support and guide me through the highs and lows of this project – I have thoroughly enjoyed our supervisory meetings and all that you have taught me (as well as the coffee and cake!) – Thank You.

I could not have completed this work without the staff, parents and children who took part. In particular, thanks go to Sue, Trish and Nicky at Yarm Medical Practice for making me feel so welcome and always making me laugh on Tuesday afternoons. Thanks goes to the North East Primary Care Research Network, especially Laura Kirkbride for her help with recruitment, and to all of the practices who allowed me access to their clinics and gave their time to sending letters and talking to parents.

I would also like to acknowledge the Economic and Social Research Council, who provided funding for this project, the work I undertook during my Masters, and the additional funds that meant I could use the support with recruitment offered by the PCRN.

Special thanks also go to Dr. Helen Close for providing her time, expertise and support whilst writing Chapter 3, Dr. Charles Cornford and Maggie Hart for their assistance and support whilst trying to recruit dyads in hard to reach populations, Dr. Adetayo Kasim for helping us wrestle with the statistics presented in Chapter 5, and to Ezra Aydin for travelling many miles from Aberdeen to perform the inter-rater reliability on the videotape data in the same chapter. Thanks also go to all past and present members of Rooms 70 and 43 who, from start to finish, have listened to me ramble on about babies over many a cup of tea.

I would not have got here if it wasn’t for my wonderful friends and family. I couldn’t have asked for better support from my two amazing friends, Beth and Anna. Time spent with them is always some of the best - it’s amazing how wine, chocolate digestives and a laugh with good friends can keep you going. Special thanks also go to Granddad and Wendy for all their help throughout my studies and the Fearn’s and Hosler’s for welcoming me into their families so openly. Particular thanks go to Simon Hosler for all that he has done for my Mum and me, and the many enthusiastic, hand-wavey, debates we have had about my research over the last three years – they’ve been great. Untold thanks must also go to Sam who, as well as providing me with his constant love and support for the last three and a half years, is my best friend and has made me laugh every day.

I would not be the person I am today without my Mum. She is the best Mum a girl could ask for and I couldn’t put the support she has given me, or my thanks for it, into words if I tried. Finally, I would like to dedicate this thesis to my Dad, who taught me never to give up – I hope this would have made you proud.

# Note on publications included in the thesis

At the time this thesis was submitted for examination, Chapters 3 and 5 have been submitted to *Vaccine* and *Pain*, respectively. The following two chapters have been published:

Chapter 2:

Harvey, H., Reissland, N., & Mason, J. (2015). Parental reminder, recall and educational interventions to improve early childhood immunisation uptake: A systematic review and meta-analysis. *Vaccine*, *33*(25), 2862-2880.

Chapter 6:

Harvey, H., Good, J., Mason, J., & Reissland, N. (2013). A Q-methodology study of parental understandings of infant immunisation: implications for health-care advice. *Journal of Health Psychology*, 1359105313513622.

These chapters are presented as they were submitted, although referencing styles have been changed so that they are consistent throughout the thesis and spelling has been changed from American to British English. Unavoidably, there is some repetition in the material covered in the Introduction section of these chapters where common themes have been addressed.

Chapter 1

General Introduction

# 1. Overview and aims of the thesis

Vaccination is essential in the fight against infectious disease [1]. Current estimates suggest that vaccination prevents 2 to 3 million childhood deaths each year [2]; second only to reductions in global mortality afforded by the introduction of clean drinking water [3]. Correspondingly, the World Health Organisation (WHO) recommends that children are universally vaccinated against a number of diseases during the first year of life. The UK immunisation schedule recommends that children are immunised against 11 specific diseases during the first year of life. The primary course of immunisations is administered at 2, 3 and 4 months of age, followed by several ‘booster’ doses between 12 to 13 months [4]. Since vaccinations are routinely performed and their administration is standardised, immunisation procedures provide an ideal research environment for the study of factors that influence aspects of childhood vaccination.

During childhood, vaccine uptake is reliant upon parental decision-making and subsequent appointment attendance [5]. Yet, despite global increases in childhood uptake, rates still remain sub-optimal, meaning that vaccine-preventable diseases continue to pose a public health risk. Moreover, immunisations are typically administered via injection, making vaccination the most common cause of medically induced pain during childhood. Within the context of infant immunisation, the role of the care-giver is paramount. Many studies have examined the influence of the care-giver in relation to vaccine uptake [5, 6] and infant pain expression [7].

During infancy, pain is typically expressed via a series of facial expressions, body movements and cry vocalisations [8-12]. However, factors associated with atypical developmental experience have been found to impact upon infant pain expression. Factors may be associated with the effects of an adverse in utero environment caused by exposure to harmful substances [13-15] and the presence of genetic conditions associated with developmental delay [16, 17]. The presence of these factors may have consequences for the regulation of infant pain. Atypical pain expression may limit the extent to which a care-giver can assess and subsequently respond to infant pain expression, resulting in unrelieved pain [18].

Pre-natal exposure to harmful substances, ‘teratogenic compounds,’ may disturb infant stress reactivity via the alteration of the HPA axis during the fetal period [19]. Previous studies have found that pre-natal exposure to alcohol [13,14] and cocaine [15, 18, 20] is associated with reduced physiological and behavioural responding to painful procedures in infancy. However, studies have not examined the impact of pre-natal opioid-exposure on infant pain expression. Opioids (through the use of heroin and/or methadone) are the most commonly used substances in pregnant drug-using mothers [21]. Opioid use during pregnancy has been associated with medical complications in the new-born period, meaning that these infants may undergo an increased number of painful procedures in the first few months of life [22].

Down syndrome (DS) is a genetic disorder caused by the presence of a third copy of chromosome 21 [23]. DS is associated with a higher prevalence of cardiac, gastrointestinal, immunological, respiratory, sensory, orthopaedic and cognitive impairments across the lifespan [24], meaning that children with DS are more likely to experience a greater number of medical procedures than children without DS [16]. In addition, early impairments in language production mean that children with DS may rely on the behavioural expression of pain longer than their typically developing counterparts [25]. Previous research has found that adults [23] and children [17] with DS have attenuated responses to painful stimuli [69] and have a different pattern of behavioural expression [17] than individuals without DS.

In sum, the experience of an adverse in utero environment and the presence of a genetic disorder may alter infant pain responding. Given the frequency with which these infants may undergo additional medical procedures, understanding the impact of opioid-exposure and DS upon infant pain expression may be beneficial to care-giver and health practitioners seeking to relieve infant pain. Hence, the original aims of this thesis were to explore (1) infant pain expression, (2) care-giver responding, and (3) immunisation uptake during the first year of life in typical dyads, and secondly, to compare these three outcomes to those obtained from care-giver-infant dyads where the infants have (a) been pre-natally exposed to opioids and (b) diagnosed with DS. However, during the process data collection, the recruitment of dyads from these two hard to reach groups became increasingly problematic, impacting on the aims of the thesis.

1.1. The impact of recruitment challenges on the aims of the thesis

Difficulties were experienced in the recruitment of dyads of both the opioid-exposed and DS groups. The chaotic lifestyle of many care-givers in the opioid-exposed group meant that most did not attend schedule appointments. Despite an ethical amendment to increase the number of treatment centres from which dyads could be recruited, unforeseen organisational barriers prevented recruitment. Similarly, in the DS group, recruitment was hampered by a lack of eligible infants at both the original recruitment site and the Portage service contacted in an attempt to improve recruitment.

Failure to recruit dyads from these special groups impacted upon the original aims of the thesis. Only the primary aims of the thesis related to typical dyads were explored; the secondary aims of the thesis were not fulfilled. It was not possible to explore differences in infant pain expression and care-giver responsiveness between the opioid-exposed and DS groups and typical controls. Nor was it possible to explore differences in uptake between these groups. As such, the main body of the thesis focuses on the determinants of *typical* infant pain expression and care-giver responsiveness in response to routine immunisation, and explores the extent to which a range of factors might influence immunisation uptake in these dyads. In the remainder of this chapter, relevant literature and theoretical models relating to typical infant pain expression and the role of the care-giver in the context of immunisation will be introduced and research questions associated with gaps in the current literature will be identified.

# 2. Immunisation uptake

2.1. The influence of the care-giver on immunisation uptake

The success of global vaccination programmes relies on continued vaccine uptake that, during early childhood, is dependent upon parental decision-making and subsequent appointment attendance [5]. Several demographic characteristics have been identified as risk factors for incomplete uptake. Factors include poor access to healthcare, ethnic status, large family size, low educational achievement [26] and a chaotic lifestyle [27, 28]. However, parental attitudes towards vaccination have also been found to affect uptake [29].

At present, the success of vaccination programs is being jeopardised by the recent rise in anti-vaccination movements across the developed world [30]. Messages advocated by these groups about the adverse effects of immunisation have cast doubt on the safety and efficacy of vaccination, leading to increased levels of vaccine-hesitancy amongst parents [5, 30]. Consequentially, a minority of parents are choosing to delay routine immunisation or to reject vaccination altogether [5]. Alarmingly, the impact of recent increased vaccine-hesitancy on community health has already been observed. Increases in vaccine refusal have been directly associated with the current Measles outbreak that threatens the eradication of the disease in several global regions by the end of 2015 [31]. Since parents influence childhood vaccine uptake, it is important to understand factors that shape parental views about vaccination.

2.2. The influence of immunisation attitudes and other barriers to uptake

Many studies have used qualitative methods to examine factors that influence decision-making and vaccine beliefs amongst immunising and non-immunising parents. Findings from these studies suggest that when making uptake decisions, parents perform a risk-benefit analysis, weighing up the advantages and disadvantages of vaccination [32-34]. Correspondingly, results of these studies suggest that there is a dichotomy between the pro-vaccination views of immunising parents and the anti-vaccination views of non-immunisers [29].

Several systematic reviews have summarised parental beliefs about vaccination [6, 29, 35-37]. One review including 15 qualitative studies reported several common barriers to uptake [6]. Factors included concerns about vaccine efficacy and side-effects, immunisation pain, a lack of trust in the medical profession, and access issues.

Results of studies that have explored views about vaccine side-effects have found that concerns were primarily related to long-term side-effects. Specifically, studies reported that parents were concerned about the extent to which vaccines containing multiple antigens would permanently damage their child’s vulnerable immune system [38, 39]. For non-immunisers, the risk of side-effects outweighed the benefits that could be gained from vaccination, prompting them to seek alternative (mostly homeopathic) methods of protection [38, 40]. However, independent of their uptake decision, parents commented on concerns related to the permanent side-effects of vaccination associated with Autism Spectrum Disorder [41-43]. These views were particularly apparent in parents who had participated in studies conducted in the early- to mid-2000s in light of the MMR controversy. Due to the dramatic decline in uptake caused by the MMR controversy, and the associated rise in the incidence of measles that followed, it is unsurprising that parental views about MMR have dominated individual studies (and review articles) conducted in the field. However, given the decline in overall vaccine uptake, it is important to understand parental views about other vaccines to highlight triggers of general vaccine-hesitancy that could be subject to appropriate intervention [31].

In addition to concerns about vaccine side-effects, studies have suggested that immunisation pain may act as a barrier to uptake [32, 40, 44]. Results from these studies suggest that parents anticipated that they would feel guilty and responsible for the pain experienced by infants as a consequence of the injections. However, the majority of studies have not commented upon when parental beliefs about pain influenced uptake decisions; whether concerns about pain influence initial uptake or whether pain experienced during vaccination prevents subsequent attendance.

Other barriers include the level of parental (dis)trust in the medical profession. Findings from studies that have examined this theme point to another dichotomous view; that immunisers trusted and adhered to advice from medical professionals [32, 46], while non-immunisers followed advice from practitioners of ‘alternative’ medicine such as homeopaths or neuropaths [41, 46, 47]. Non-immunisers had come to mistrust medical advice owing to the degree to which vaccine-preventable diseases could be observed in the community. These observations cast doubt on vaccine efficacy and exaggerated parental beliefs that financial incentives offered to GPs were responsible for the medical advocacy of vaccination [41].

In addition to barriers to decision-making, many studies have highlighted barriers related to appointment attendance. Parents may be confused about which vaccines are due and when [40, 44]. As a result, parents may forget to schedule appointments and subsequently fall behind with the recommended schedule [33]. Additionally, parents may believe that children should not be vaccinated if they have a minor illness and so do not attend scheduled appointments, resulting in partial uptake [33, 34, 40].

In sum, many studies have explored parental beliefs about immunisations. Parental views are complex and influenced by a number of factors. Although current studies provide a comprehensive account of factors that promote and discourage immunisation uptake, research has been dominated by views regarding MMR, and thus, vaccination in older infants. There is a paucity of evidence regarding parental beliefs about the vaccines received in the first few months of life, with a focus upon parental viewpoints in anticipation of the procedure. Few studies have examined the impact of the experience of immunisation, particularly of infant pain, on parental attitudes. Understanding the impact of procedural experience on parental beliefs may highlight key views that promote continued attendance that could be targeted in future uptake interventions. Additionally, the hierarchical nature of parental views is poorly understood. Ascertaining which beliefs have the most influence on parental decision-making may highlight specific viewpoints to be targeted in future interventions.

2.3. Interventions to increase uptake

A number of interventions have been formulated to increase childhood immunisation uptake within the health-system [48, 49]. Most have targeted parents [8, 49-51], aiming to increase uptake by: (1) improving schedule awareness; (2), educating parents about the need for vaccination; and/or (3) improving access to healthcare. The efficacy of these strategies have been examined in several meta-analyses [8, 49, 50, 52].

Interventions to improve schedule awareness have focussed on the efficacy of reminder-recall strategies. These strategies inform parents when their child is due for vaccination and prompt them to contact their clinic to schedule an appointment, via postal letter, e-mail, telephone call or audiodialer message. Two meta-analyses [49, 50] have examined the efficacy of reminder-recall interventions. Only one of these focussed on childhood (0 to18 years), but found that reminder-recall strategies were associated with a 1.5 times increase in uptake [50]. Parents participating in qualitative studies reported that they welcomed reminder letters as a helpful prompt to contact their medical practice for immunisations during early childhood [40, 53-56]. However, the overall efficacy of reminder interventions conducted during early childhood has not been specifically examined.

Interventions aiming to provide parents with knowledge about the benefits of vaccination have trialled the efficacy of education via information leaflets, video-tapes and/or face-to-face sessions by trained or untrained (lay) health workers (LHWs). Whilst reminder-recall systems have been linked to a positive effect on uptake, the efficacy of parental education is less convincing. Although individual studies have presented both positive and negative findings, meta-analyses examining the efficacy of leaflets [49] and face-to-face sessions [26] have failed to demonstrate their benefit and report insufficient evidence. Nevertheless, two meta-analyses have found that children (0 to 5 years) were 1.2 times more likely to be immunised if their parents had received education from a LHW [51, 52].

Other interventions have tried to increase uptake by improving access to vaccinations in medical settings or offering them at other settings such as schools, nurseries or at home. Whilst improving access to clinical settings may have some benefit, current evidence for this approach is insufficient to support routinely administering vaccines at school or other child-care settings [49].

In sum, reminder-recall strategies and improved clinic access may improve immunisation uptake in comparison to routine care. While evidence summaries highlight the efficacy of specific interventions across the lifespan, findings are not specific to early childhood (0-5 years). Given the frequency of infant vaccination, it is important to understand which strategies are most effective in promoting uptake. Furthermore, the scope of current interventions appears limited when considering barriers to immunisation expressed by parents and highlighted in qualitative findings [6, 32-34, 40, 41]: the impact of infant pain on parental decision-making is a clear example that remains to be addressed.

# 3. Immunisation pain

Pain has been defined as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage” [57]. As such, pain is a subjective concept that only becomes known through the experience of painful events during infancy and early childhood. During vaccination, acute nociceptive pain is experienced through the activation of peripheral nociceptive pathways when (1) the needle punctures the skin and tissue, and (2) the vaccine solution is injected into the tissue [58]. Hence, vaccines administered during the first year of life provide some of the first experiences of acute pain [58]. Modern definitions of pain acknowledge that “the inability to communicate verbally does not negate the possibility that an individual is experiencing pain and is in need of appropriate pain-relieving treatment” [57]. As such, unrelieved pain during infancy may influence developing pain concepts, and have a lasting consequence on future pain experiences across the lifespan [59] and affect engagement in health-promoting behaviours [58]. Thus, it is important to understand how infants express pain, as well as the efficacy of pain relieving methods.

Infants are able to signal and respond to painful stimuli from birth [60]. However during infancy, immaturities in the pain system, including both sensory and emotional response systems, may lead to an increased pain response in comparison to adults experiencing the same painful event [61]. Moreover, term infants have been found to express a greater response to immunisations experienced at 2 months-old [62, 63] when compared to other vaccinations administered across the first year of life. During infancy, pain cannot be verbalised and so infants must rely on others around them to assess and manage pain [7]. Hence, infant pain experiences are typically measured through physiological responses and/or the behaviours expressed after noxious stimuli such as injections.

3.1. Typical pain expression

Physiological responses to painful events are typically measured by monitoring changes in cardiovascular, respiratory or hormonal systems before, during and after the procedure [64]. However, obtaining reliable physiological data from infants in a clinical setting is difficult [65] as it is often hard to gain adequate saliva samples, samples are easily contaminated, and there are no established norms for levels of stress-indicating hormones such as cortisol [66]. Because of these limitations, and difficulties standardising methods, physiological measures of pain response are more variable and non-specific than behavioural measures [67]; thus behavioural observations of pain expression are preferable when studying pain during infancy [49].

During infancy, behavioural responses to acute pain are consistently expressed by facial expressions of pain, rigid and flailing body movements, and high-pitched cry vocalisations [8-12] Johnston and Strada [8] carried out a seminal study on the behavioural expression of pain in 2 to 4 month-old infants experiencing routine immunisation. During the immunisation, all infants displayed full or partial expressions of pain characterised by a lowering of the brow, drawing in of the vertical furrow between the brows, broadening of the nasal root, tightly shut eyes and a square mouth. In addition, infants expressed high-pitched, phonated cries with a flat melody and most showed rigidity in their arms and torso. In the minute following vaccination, pain expression decreased; body movements returned to baseline levels and cry vocalisations decreased in pitch and became more rhythmical in their phonation. However, infants continued to show facial expressions of pain. The consistency with which infants respond to acute pain events has led to the development of a number of multi- and uni-dimensional pain scales [10, 12, 68, 69] which can be used to measure infant pain expression.

Infant pain expression may be influenced by many factors including individual child factors, procedural factors and those associated with parental behaviour.

3.2. Child factors

Many individual child factors, such as age [70, 71], gender [59, 62] and temperament [72, 73], have been associated with differential pain expression.

In typically developing infants and children, behavioural responses to immunisation have been found to decrease with age [70, 71], as the use of language increases. For example, 2 month-old infants have been found to display the greatest behavioural response to pain [70], with responses decreasing across the first two years of life [70, 71]. With the onset of language, children begin to verbalise their pain experience, leading to a further decrease in the behavioural expression of pain into late adolescence [74]. This developmental trajectory has been attributed to the development of central brain regions associated with sensory discrimination and emotional responding that facilitate a less reflexive response to painful stimuli to a more organised response to unpleasantness and threat that can be measured through self-report [61, 64].

Although studies have not found reliable sex differences in response to immunisation [62, 11], the experience of circumcision without analgesia has been associated with a prolonged behavioural response to immunisation [59]. Findings relating to infant temperament suggest that infants with reportedly ‘more difficult’ temperaments show greater responses to [73], and take longer to regulate pain after immunisation [72] than less temperamental infants.

3.3. Clinical factors

A number of studies have investigated the impact of a range of clinical factors on infant pain expression. Factors include pharmacological interventions as well as techniques associated with vaccine administration [65, 75, 76].

3.3.1. Pharmacological interventions

The effectiveness of pharmacologic interventions in reducing infant pain and distress from medical procedures is well established [77]. Interventions, including topical anaesthetics and sweet tasting (sucrose) solutions, have been found to be analgesic with and without nutritive sucking [78] in infants during the first year of life. A meta-analysis including four trials found sucrose solutions were associated with a 9 second reduction in infant cry duration compared to no intervention or water [76]. The efficacy of topical anaesthetics, such as EMLA cream before or after injection has also been demonstrated [65, 75]. However, despite their effectiveness, pharmacological interventions are rarely requested by parents due to a reported lack of awareness [79].

3.3.2. Vaccine administration

Factors associated with the administration of vaccinations can be more easily adopted into standard clinical practice because they add little time to the injection procedure and do not rely on care-giver awareness [75]. Results of a recent meta-analysis [75] have led to several recommendations being made about injection techniques [65]. The use of less painful vaccine brands (e.g. Priorix over MMR-II); giving the most painful vaccine last (e.g. DTaP/IPV/Hib before Pneumococcal vaccines); stroking the skin before needle injection and the use of rapid injection have all been associated with reduced pain expression. Neither simultaneous injection nor increasing the temperature of vaccines has been found to reduce infant pain [75]. Finally, studies have found that infants lying supine expressed more pain in response to vaccination than those held by a care-giver [75]. Hence, effective practice guidelines recommend that infants are held in a supportive manner during immunisation procedures [65].

3.4. The role of the care-giver

In addition to the functional role related to infant holding, care-givers are typically responsible for assessing and managing infant pain in the context of immunisation. The role of the care-giver has been proposed to be especially important in pre-verbal infants who cannot verbalise or regulate their own distress, and so rely on their care-giver to respond to behavioural signals in a sensitive manner [80] so that their distress is relieved [7]. Some previous studies have proposed that care-givers are important determinants of infant pain. For example, an early study [80] found that maternal behaviours accounted for 53% of the variance of infant pain behaviours expressed during immunisation.

Moreover, care-giver responses to infant pain and distress have been linked to the development of attachment [82] and to strategies related to emotional regulation in the first years of life [60, 83]. Thus, inappropriately managed and unrelieved infant pain has been associated with impaired pain regulation in the later stages of development [83]. Correspondingly, several theoretical models have been proposed to account for the influence of care-giver behaviour upon pain expression during acute pain procedures.

3.4.1. The Social Communication Model of pain

First proposed in the early 1990s, the social communication model (SCM) of pain is one of the most widely tested models of acute paediatric pain [84]. Notably, the model is based on the principle that pain is fundamentally a social experience and so proposes that, in order to understand the determinants of infant pain, the relationship between the child and care-giver must be considered. This assertion acknowledges the increased dependence that infants have upon their care-givers to assess and relieve pain [7]. The SCM proposes that interactions between children and other individuals within the procedure occur over four distinct, but interdependent, phases. The model states that, after a painful event, pain is expressed through a series of non-verbal or verbal behaviours (depending on the developmental age of the child). Once acknowledged by the care-giver, infant pain behaviours are assessed and the care-giver may attempt to alleviate pain through their actions. Correspondingly, care-giver behaviours then influence infant pain and, depending on their efficacy, care-givers may re-assess and update strategies until pain expression has been alleviated.

3.4.2. Care-giver responsiveness and infant pain

A number of studies have examined the influence of the behaviours adopted by parents to alleviate infant pain. Care-givers have been found to use a variety of non-pharmacological strategies during immunisation that can be broadly sub-categorised into three types of behaviour; vocalisations (e.g. speech or sounds), non-verbal behaviours (e.g., touch, rocking) and actions (e.g., the use of a pacifier by breast, bottle or dummy) [60]. Soothing strategies can be used independently or together [80].

Touch has been defined as an important communicative pathway between an infant and their care-giver in the early stages of development [85-87]. During infancy, touch has been associated with soothing, emotional regulation and arousal [88]. Within the context of immunisation, studies have examined the general influence of touch via proximal soothing: the degree to which a care-giver attempts to soothe their infant by touching, kissing, hugging or rocking. These behaviours are thought to provide infants with physical stimulation and proprioceptive feedback that directs attention away from the physical sensation of pain, leading to faster soothing [80]. Although many studies have examined touch, findings have been inconsistent. Whilst some studies have reported an association between proximal soothing and decreased infant pain [80], others have reported no effect [77, 89, 90], and even increased pain responses [42]. In addition, one study reported that touch was only effective at reducing the duration and intensity of infant cry during immunisation when simultaneously performed with vocalisations [83].

Findings related to care-giver vocalisations have been more consistent, indicating that the content of care-giver speech has differential effects on infant pain [80]. For example, whilst care-givers may intend their vocalisations to have a regulatory effect on infant distress [91], several studies (with the exception of one [73]) have found that empathetic (e.g., “I know it hurts”), apologetic (e.g., “I’m sorry”) and reassuring (e.g., “It’s OK”) vocalisations promote infant pain expression during immunisation [90, 91, 92]. This relationship has also been associated with infant distress expressed *before* immunisation in 4, 6 and 12 month-olds [91]. Furthermore, these distress-promoting vocalisations have been found to predict 10% of infant pain-related facial expressions observed after the routine immunisation of 6 to 18 month-old infants [92]. Despite this, distress-promoting vocalisations have been found to be the most common strategy used by parents during immunisation procedures across the first year of life [77]. The mechanisms by which verbal reassurance affects infant pain expression are unknown. However, findings from one study [93] examining the function and tone of care-giver vocalisations during pre-school immunisation have suggested that most reassuring vocalisations were statements and minor phrases spoken with a falling tone. The authors propose that the properties of such vocalisations may be indicative of increased levels of care-giver anxiety. However, a measure of the level of procedural anxiety reported by care-givers was not described.

On the other hand, non-procedural talk has been associated with decreases in infant pain-related distress expressed before and after the procedure [73, 80, 94]. Non-procedural talk has been proposed to promote infant coping via ‘attentional redirection’ [80]; speech un-related to the procedure may direct an infant’s attention away from the painful stimulus and therefore reduce distress. Demonstrating the efficacy of non-procedural talk, one study [73] found that when care-givers were explicitly encouraged to use non-procedural talk during immunisation, 6 month-old infants cried for a significantly shorter duration than infants whose parents were not instructed to change their behaviour during the procedure. Taken together, findings related to care-giver vocalisations suggest that, despite not being able to verbalise themselves, care-giver vocalisations convey an important communicative message that impacts upon infant pain expression [80].

Findings related to the offer of a pacifier (via a dummy, breast or bottle) have also been consistently associated with reduced pain expression [77, 80, 95]. Both nutritive [96] and non-nutritive sucking [95] have been found to have an analgesic quality during infancy and, if performed properly are incompatible with crying [80]. Sucking has been associated with distraction and a mechanism by which infants can self-soothe [96]. Breastfeeding has been defined as a combined intervention, providing skin-to-skin contact, the presence of a comforting other (typically the mother) as well as the opportunity to suck on a sweet-tasting solution (lactose) [75]. However, whilst effective, a recent observational study of care-giver pain management strategies found that pacifiers were rarely used by care-givers after routine immunisation in the first year of life [77].

Finally, the level of infant pain expressed has been found to influence the efficacy of certain pain management strategies. For example, the efficacy of proximal soothing [60], as well as breastfeeding and pacifying [83] have found to be greater when infants expressed lower levels of pain in response to immunisation.

3.4.2.1. Design issues within the infant pain literature

Evidence reported so far has revealed inconsistencies in the extent to which care-givers influence infant pain expression. In part, these inconsistencies may be explained by deficiencies in study design. The majority of the studies have been conducted with small samples, increasing the risk of type II errors associated with insufficient power, whilst testing for multiple outcomes may have led to reporting of chance significant findings. These issues indicate the need for larger, prospectively designed and adequately powered cohort studies from which clear inferences can be drawn.

The issue of sample size have been addressed by several recent studies [77, 90, 91] that have used videotape data collected as part of the OUCH cohort; a cohort of over 750 child-care-giver dyads observed during routine immunisations from the first year of life. These findings may provide a more accurate understanding of the relationship between infant pain and care-giver behaviour during immunisation. In relation to the efficacy of care-giver pain management strategies, three studies have been conducted examining general [77] and specific forms of care-giver-behaviour [90]. Findings from these studies and theoretical implications for the role of the care-giver are discussed below.

3.4.2.2. Larger cohort studies examining infant pain

Lisi, Campbell, Pillai Riddell, Garfield and Greenberg [77] carried out an observational study of the efficacy of pain management techniques used by parents during routine immunisation at 2, 4, 6 and 12 months of age. Care-giver behaviours accounted for between 3% and 13% of the variance in infant pain expressed before and after immunisation, between 2 and 12 months respectively. This suggests that, in very young infants experiencing pain for the first time, care-giver behaviours have little influence on pain expression. Moreover, with the exception of the negative relationship with pacifying at 2 and 6 months, all other care-giver behaviours were associated with small *increases* in infant pain. Authors suggested that these findings could be explained by “cyclical trajectory” (p. 6) between care-giver and infant behaviours; care-giver behaviours do not cause increased infant distress but, greater levels of infant pain evoke an increase in (ineffective) parental soothing.

The efficacy of specific strategies related to proximal soothing [89] and verbal reassurance have also been investigated using OUCH cohort data. Findings related to proximal soothing (defined as rocking and any form of physical comfort) accounted for minimal variance in infant pain reactivity (immediate responses to the needle) and regulation (responses after 2 minutes) across the four vaccinations observed over the first year of life. At 2 months, increased levels of proximal soothing in the 2 minutes post-vaccination were associated with slower pain regulation. Instead, infant distress before and immediately after the injection accounted for the most variance in pain regulation, with higher levels of distress before the needle being associated with increased levels of responding immediately, and 2 minutes after, needle insertion. The negative impact of reassuring vocalisations has similarly been reported in one larger cohort study [91].

Taken together, findings from the larger cohort studies suggest that, across the first year of life care-giver behaviours conducted within the context of immunisation contribute little to infant pain expression. Instead, these findings suggest that prior pain experience both within and between immunisation procedures is a stronger predictor of pain expression. Incorporating these findings, a specific model for acute procedural pain in infancy has been developed in which the deterministic role of the care-giver has been moved to the periphery of infant pain experience [97].

3.4.3. The development of infant acute pain responding (DIAPR) model

The DIAPR model [7, 97] focuses specifically on pain in infancy. Hence, the model seeks to explain how the behaviours of important others (e.g. the care-giver) may change with child development, and the impact that these behaviours may have on infant pain. Proponents of the model assert that, given the steep developmental trajectory of the first few years of life, it is important to understand the developmental context in which an infant is experiencing pain. Thus, the DIAPR model proposes a biopsychosocial model of acute infant pain across the first year of life. The increased specificity of the model may overcome shortcomings associated with previous models of acute paediatric pain (including the Social Communication Model [84]) that failed to account for the developmental age of the child.

Within the model, pain experience is split up into two distinct phases: (1) pain reactivity – the immediate response to pain shaped by biological sensory thresholds and previous pain experience; and (2) pain regulation – the modulation of pain responses influenced by much broader factors (including care-giver behaviour). The DIAPR model suggests that following a painful event, if an infant’s noxious sensory threshold is exceeded, they will immediately and automatically respond through a series of behavioural responses (the model does not try to operationalise non-verbal infant pain experience). After this, infants enter a period of self-regulation, in which pain behaviours are modulated back to baseline levels. Via a feedback loop, the extent to which pain is regulated is incorporated into their sensory threshold and will influence future pain reactivity. Correspondingly, the model proposes that the greatest determinant of infant pain reactivity to an acutely painful event is their previous response to an earlier painful event within the same procedure, or at a previous appointment.

Following pain reactivity, the model proposes that care-givers assess pain and adopt appropriate pain management techniques. However, owing to findings that have indicated that care-giver behaviours are a weak determinant of infant pain (in comparison to individual infant pain behaviours), the direct role of the care-giver is subsumed to the periphery of the model. A care-giver’s pain assessment and management strategies are proposed to be shaped by ‘external systems’ such as the care-giver’s culture and family, clinical factors, as well as the care-giver’s own pain schemas (including their beliefs about pain, vaccination, and their ability to cope with infant pain behaviours). Consequently, the wider social context of pain is assumed to have an *indirect* influence (cf. the SCM model [84]) on infant pain expression that determines pain response through the direct (but weak) influence of the care-giver.

Via a feedback loop, as infant pain becomes regulated and their behavioural response is reduced, care-givers may re-assess and update their pain management strategies accordingly until pain is attenuated. Correspondingly, a care-giver’s evaluation of their pain assessment and management techniques may feed back into their pain schemas. These updated schemas will then contribute to pain assessment and management strategies that will directly influence infant pain in future acute pain episodes.

However, whilst previous studies have found empirical support for the model [77, 89, 90], data regarding young infants were collected during procedures where infants were laid on the examination table to receive their injections [96]. These conditions may have limited the extent to which care-givers could naturally interact with their infant during phases of immediate pain reactivity. In this context, care-givers may have had to rely on vocalisations as their ability to soothe their infant by more proximal methods was restricted. This context may account for failing to observe an effect of non-verbal behaviours, which are consequently reflected in the peripheral role of the care-giver in the DIAPR model [97]. Coupled with findings that suggested infants laid supine expressed more pain than those who were held [75], it could be inferred that when care-givers were able to pick up their infants after the procedure, infant pain reactivity may have been so high that care-giver behaviours were insufficient to regulate pain. Holding infants during the procedure may provide care-givers with a greater capacity to influence immediate pain reactivity and subsequent pain regulation. However, the influence of care-giver behaviours in this context remains to be tested.

3.5. Indirect influences on the care-giver and infant pain expression

Although proposed to have less influence on infant pain than individual infant factors, the DIAPR model suggests that broader social factors can impact on infant pain expression (albeit indirectly via the care-giver). These social factors may include broader systems of social influence such as interaction within the family or between the care-giver-infant dyad itself [97]. Factors associated with care-giver-infant bonding (attachment) and the psychological state of the care-giver may interrupt typical dyadic social interaction outside and within the context of immunisation [98].

Attachment has been defined as “an enduring and affective tie that is reciprocal in nature” (p.3) [99]. Hence, attachment occurs from an infant towards their care-giver and vice versa [100], with differences in infant pain expression associated with infant to care-giver attachment observed by around 12 months [82]. In infancy, care-giver to infant attachment has been found to be associated with the frequency with which a care-giver seeks proximity to their infant, tolerates the responsibilities of care-giving and has a desire to understand and protect their child from harm [100, 101].

Care-giver to infant bonding may also be affected by the presence of other factors, such as the care-giver’s use of illegal substances or atypical infant development. The presence of these factors may impact on a care-giver’s desire to seek proximity to, and their ability to understand and respond to the needs of, their infant [101]. Several studies have found that substance-using mothers share less physical contact with their infants during everyday feeding interactions [102, 103], and have less urgent responses to infant cry vocalisations [104]. These findings suggest that the effects of maternal drug use on infant development continue post-natally and negatively impact on care-giver responsiveness [105]. However, no studies have examined the impact of these factors on care-giver-infant interactions within the context of immunisation.

Findings of an association between infant attachment and care-giver bonding during immunisation are inconsistent. One study [72] found that 12 month-old infants with an avoidant attachment style expressed significantly less distress immediately before immunisation than securely attached infants. However, another study [106] found that care-giver to infant bonding did not predict infant pain expression in response to immunisations administered between 5 and 20 months of age. With only two studies conducted in relation to immunisation using different measures of attachment, additional studies are needed.

Research has also examined the impact of a care-giver’s psychological state, notably depression and anxiety, on infant pain expression during immunisation [11, 81, 107, 108]. One study found that increased levels of parental anxiety were associated with higher reports of infant pain from both parents and nurses [108]. Another study found that infants who expressed higher levels of pain at 4 months were more likely to have had mothers who reported a higher level of depressed mood [107]. These findings are again inconsistent, with two other studies observing no effect of anxiety or depression on infant responses to acute pain [11, 81].

In summary, findings related to the impact of the wider context of care-giver-infant interaction have been inconsistent, with studies subject to the same design criticisms found in studies of care-giver behaviour. Larger and adequately designed studies are needed to increase understanding in the field.

# 4. Infant pain and immunisation uptake

Current research findings do not provide a coherent understanding of infant pain, care-giver behaviour and attributes, and vaccine uptake. Parental concerns about infant pain may act as a barrier to complete immunisation uptake [32, 40, 44]. Parental anxiety associated with infant pain [32, 40, 109, 110] has been linked to partial uptake and vaccine refusal [6, 56, 58]. Negative experiences during vaccination (associated with their child’s response to the procedure and clinic waiting times) are associated with a two-fold increase in the likelihood of non-compliance [111]. Increasing parental awareness about effective pain management strategies may also lead to increased vaccine adherence [58, 111].

Several intervention studies have been conducted to increase parental knowledge and use of effective pain management techniques (including breastfeeding, sucrose solutions, topical anaesthetics and holding). Studies providing parents with an educational pamphlet shortly after birth have not been found to be effective [112]. However, studies in which parents reviewed an educational pamphlet and video on the day of their 2 or 4 month vaccination appointment, were found to use significantly more recommended pain management techniques on the day of education and in subsequent appointments [113]. Whilst these findings suggest that educating parents about the use of effective pain relieving strategies can increase their use across future vaccination appointments, these findings do not directly relate parents’ decisions to return to the clinic to the reduction in infant pain afforded by the use of these strategies.

Returning to the DIAPR model [7, 97], parental anxiety about infant pain may influence pain schemas that have been proposed to directly impact on infant pain via care-giver assessment and management techniques. Thus, infant pain responses following initial immunisation procedures may feed back into care-giver pain schemas and thus influence decisions about uptake [97]. Pain schemas may relate to a care-giver’s vaccination beliefs, expectations before the procedure and their emotional responses to infant pain. Thus, infant pain expression may itself be an additional risk factor for incomplete uptake.

# 5. Summary and aims of the thesis

This chapter has introduced, and described, relevant research regarding the influence of a care-giver over two primary themes associated with infant immunisation – uptake and pain expression. The dissociation between both fields of research highlights how, whilst infant pain has been linked with uptake, uptake interventions have failed to address parental concerns associated with pain and interventions to reduce infant pain have failed to examine their impact on future uptake. In the chapters that follow, several research questions associated with infant pain and its impact on immunisation uptake will be addressed.

Recent research related to childhood immunisation uptake has highlighted the use of many different interventions to increase immunisation uptake. However, recent reviews have not examined the impact of particular interventions on uptake during early childhood. Given the frequency with which children are immunised during the first year of life, understanding and comparing the efficacy of a range of interventions to target uptake may allow the most efficacious strategies to be implemented. Correspondingly, the extent to which intervention studies address the range of barriers highlighted by parents in qualitative studies remains to be examined. Targeted interventions addressing the barriers specified by parents of young children undergoing immunisation may have the greatest impact upon adherence. Chapter 2 provides a systematic review and meta-analysis of parental interventions to increase immunisation uptake. Chapter 3 extends these findings by examining parental views about early childhood immunisations in a systematic review of the qualitative literature, before integrating the findings of both reviews to explore whether current uptake interventions target the barriers cited by parents*.*

Within the infant pain literature, reports are inconsistent concerning the influence of care-giver behaviours during the vaccination procedure, as well as the broader social context of care-giver-infant interaction on infant pain. These inconsistencies may be attributed to design inadequacies. Moreover, studies have not investigated the impact of infant pain on future immunisation uptake. The short time-frame in which the three doses within the primary course are administered provides an ideal setting in which to examine the impact of belief and experience on future vaccine uptake. Hence, Chapter 4 presents an observational exploration of the relationship between care-giver behaviour and infant pain expression, as well as the impact of a range of social and clinical factors. In addition, the impact of infant pain expression on future immunisation uptake during the first year of life is examined. Chapter 5 uses Q-methodology to provide a more in-depth analysis of the impact of immunisation experience on parental views about vaccination. These findings are extended in Chapter 6 by linking parental viewpoints to primary vaccination uptake.

Taken together, these findings address several questions related to the role of the care-giver in infant immunisation; (1) the extent to which care-giver beliefs and the experience of immunisation affect vaccine uptake, (2) the relationship between care-giver and infant behaviours, and (3) the role of broader contextual influences on infant pain expression. Establishing factors that drive uptake decisions and factors that influence infant pain expression may allow new interventions to be formulated.

# References

[1] Andre F, Booy R, Bock H L, Clemens J, Datta SK, John TJ, Lee BW, Lolekha S, Peltola H, Ruff TA, Santosham M, Schmitt, H. J. Vaccination greatly reduces disease, disability, death and inequity worldwide. Bulletin of the World Health Organization. 2008; 86:140-146.

[2] World Health Organisation [Internet],; [cited 10th August 2015]. Available from: http://www.who.int/mediacentre/factsheets/fs378/en/

[3] Plotkin SL, Plotkin SA. A Short History of Vaccination. In: Plotkin SA, Orenstein WA, Offit PA, editors. *Vaccines*. Philadelphia: Sanders, Elsevier; 2008. p. 1-14.

[4] Salisbury D, Ramsay M, Noakes K. The UK Immunisation Schedule. In: Salisbury D, Ramsay M, Noakes K, editors. *Immunisation against infectious disease*. London: The Stationery Office; 2015.

[5] Sadaf A, Richards JL, Glanz J, Salmon DA, Omer SB. A systematic review of interventions for reducing parental vaccine refusal and vaccine hesitancy. Vaccine. 2013;31:4293-304.

[6] Mills E, Jadad AR, Ross C, Wilson K. Systematic review of qualitative studies exploring parental beliefs and attitudes toward childhood vaccination identifies common barriers to vaccination. J clinical epidemiology. 2005;58:1081-88.

[7] Pillai Riddell R, Racine N. Assessing pain in infancy: the caregiver context. Pain Res Manag. 2009;14:27-32.

[8] Johnston CC, Strada ME. Acute pain response in infants: a multidimensional description. Pain. 1986;24:373-382.

[9] Lilley CM, Craig KD, Grunau RE. The expression of pain in infants and toddlers: developmental changes in facial action. Pain. 1997;72:161-170.

[10] Cohen LL, Bernard RS, McClelland CB, MacLaren LE. Assessing Medical Room Behavior During Infants' Painful Procedures: The Measure of Adult and Infant Soothing and Distress (MAISD). Child Health Care. 2005;34:81-94.

[11] Reissland N, Harvey H, Mason J. Effects of maternal parity, depression and stress on two-month-old infant expression of pain. J Reprod and Infant Psychology. 2012;30:363-376.

[12] Taddio A, Nulman I, Koren BS, Stevens B, Koren G. A revised measure of acute pain in infants. J Pain Symptom Manag. 1995;10:456-463.

[13] Oberlander TF, Jacobson SW, Weinberg J, Grunau RE, Molteno CD, Jacobson JL. Prenatal Alcohol Exposure Alters Biobehavioral Reactivity to Pain in Newborns. Alcoholism: Clinical and Experimental Research. 2010;34:681-692.

[14] Ramsay DS, Bendersky MI, Lewis M. Effect of prenatal alcohol and cigarette exposure on two-and six-month-old infants' adrenocortical reactivity to stress. J Pediatr Psychol. 1996;21:833-840.

[15] Roumell N, Wille D, Abramson L, Delaney V. Facial expressivity to acute pain in cocaine-exposed toddlers. Inf Mental Hlth J. 1997;18:274-281.

[16] Gilbert-MacLeod CA, Craig KD, Rocha EM, Mathias MD. Everyday Pain Responses in Children With and Without Developmental Delays. J Pediatr Psychol. 2000;25:301-308.

[17] Mercer K, Glenn S. The expression of pain in infants with developmental delays. Child Care Health Dev. 2004;30:353-360.

[18] Corwin MJ, Kayne H, Lester BM, Sepkoski C, McLaughlin S, Golub HL. Effects of In Utero Cocaine Exposure on Newborn Acoustical Cry Characteristics. Pediatrics. 1992;89:1199-1203.

[19] Egliston KA, McMahon C, Austin MP. Stress in pregnancy and infant HPA axis function: Conceptual and methodological issues relating to the use of salivary cortisol as an outcome measure. Psychoneuroendocrino. 2007;32:1-13.

[20] Magnano CL, Gardner JM, Karmel BZ. Differences in salivary cortisol levels in cocaine‐exposed and noncocaine‐exposed NICU infants. Dev Psychobiol. 1992;25: 93-103.

[21] Hall JL,van Teijlingen ER. A qualitative study of an integrated maternity, drugs and social care service for drug-using women. BMC Pregnancy Childbirth. 2006;6: 19.

[22] Whiteman VE, Salemi JL, Mogos MF, Cain MA, Aliyu MH, Salihu HM. Maternal Opioid Drug Use during Pregnancy and Its Impact on Perinatal Morbidity, Mortality, and the Costs of Medical Care in the United States. J Pregnancy. 2014;8.

[23] Hennequin M, Morin C, Feine JS. Pain expression and stimulus localisation in individuals with Down's syndrome. Lancet. 2000;356:1882-1887.

[24] Bittles AH, Glasson EJ, Clinical, social, and ethical implications of changing life expectancy in Down syndrome. Dev Med Child Neurol. 2004;46:282-286.

[25] Roizen NJ, Patterson D. Down's syndrome. Lancet. 2003;361:281-1289.

[26] Kaufman, J, Synnot A, Ryan R, Hill S, Horey D, Willis N, Lin V, Robinson P. Face to face interventions for informing or educating parents about early childhood vaccination (review). Cochrane Database of Systematic Rev. 2013;5:1-69.

[27] Advisory Council on the Misuse of Drugs. Hidden harm: Responding to the needs of children of problem drug users. London: Home Office; 2003.

[28] Jayasooriya S. The nature and location of primary care services received by the children of people with intravenous substance misuse problems registered at The Primary Care Unit. London: University of London; 2001.

[29] Brown, K.F. Kroll SJ, Hudson MJ, Ramsay M, Green J, Long SJ, Vincent CA, Fraser G, Sevdalis N. Factors underlying parental decisions about combination childhood vaccinations including MMR: a systematic review. Vaccine. 2010;28:4235-4248.

[30] Tafuri S, Gallone MS, Cappelli MG, Martinelli D, Prato R, Germinario C. Addressing the anti-vaccination movement and the role of HCWs. Vaccine. 2014;32:4860-4865.

[31] World Health Organisation. [Internet],; WHO/Europe calls for scaled-up vaccination against measles. [cited 2015 March 25 2015]. Available from: <http://www.euro.who.int/en/media-centre/sections/press->releases/2015/whoeurope-calls-for-scaled-up-vaccination-against-measles.

[32] Austin, H., Parents' perceptions of information on immunisations. J Child Health Care. 2001;5:54-59.

[33] Bond L, Nolan T, Lester R. Vaccine preventable diseases and immunisations: a qualitative study of mothers' perceptions of severity, susceptibility, benefits and barriers. Aust NZ J Publ Heal. 1998;22:441-6.

[34] New SJ, Senior ML.“I don't believe in needles”: Qualitative aspects of a study into the uptake of infant immunisation in two english health authorities. Soc Sci Med. 1991;33:509-518.

[35] Nagaraj A. Does qualitative synthesis of anecdotal evidence with that from scientific research help in understanding public health issues: a review of low MMR uptake. The Eur J Public Health. 2006;16:85-88.

[36] Allan N, Harden J. Parental decision-making in uptake of the MMR vaccination: a systematic review of qualitative literature. J Public Health. 2014:fdu075.

[37] Roberts KA, Dixon-Woods M, Fitzpatrick R, Abrams KR, Jones DR. Factors affecting uptake of childhood immunisation: a Bayesian synthesis of qualitative and quantitative evidence. Lancet. 2002;360:1596-1599.

[38] Hilton S, Petticrew M and Hunt K. ‘Combined vaccines are like a sudden onslaught to the body's immune system’: Parental concerns about vaccine ‘overload’ and ‘immune-vulnerability’. Vaccine. 2006;24:4321-4327.

[39] Hulsey E, Bland T. Immune overload: Parental attitudes toward combination and single antigen vaccines. Vaccine. 2015;33:2546-50.

[40] Tickner S, Leman PJ, Woodcock A.‘It's just the normal thing to do’: Exploring parental decision-making about the ‘five-in-one’ vaccine. Vaccine. 2007;25:7399-7409.

[41] Brown K, Long SJ, Ramsay M, Hudson MJ, Green J, Vincent CA, Kroll JS, Fraser G, Sevdalis N. U.K. parents' decision-making about measles-mumps-rubella (MMR) vaccine 10 years after the MMR-autism controversy: a qualitative analysis. Vaccine. 2012;30:1855-1864.

[42] Luthy KE, Beckstrand RL, Callister LC, Parental hesitation in immunizing children in Utah. Public Health Nurs. 2010;27:25-31.

[43] Tomlinson N, Redwood S. Health beliefs about preschool immunisations: an exploration of the views of Somali women resident in the UK. Diversity & Equality in Health & Care. 2013;10:101-113.

[44] Niederhauser VP, Markowitz M. Barriers to immunizations: multiethnic parents of under- and unimmunized children speak. J Am Acad Nurse Pract. 2007;19:15-23.

[45] Benin AL, Wisler-Scher DJ, Colson E, Shapiro ED, Holmboe ES. Qualitative analysis of mothers' decision-making about vaccines for infants: the importance of trust. Pediatrics. 2006;117:1532-1541.

[46] Brunson EK. How parents make decisions about their children's vaccinations. Vaccine. 2013;31:5466-5470.

[47] Casiday RE. Children's health and the social theory of risk: insights from the British measles, mumps and rubella (MMR) controversy. Soc Sci Med. 2007;65: 1059-1070.

[48] Lagarde M, Haines A, Palmer N. The impact of conditional cash transfers on health outcomes and use of health services in low and middle income countries. Cochrane Database of Systematic Reviews, 2009;4.

[49] Briss PA, Rodewald LE, Hinman AR, Shefer AM, Steikas RA, Bernier RR, Carande-Kulis VG, Yusuf HR, Ndiaye SM, Williams SM. Reviews of evidence regarding interventions to improve vaccination coverage in children, adolescents, and adults. Am J Prev Med. 2000;18:97-140.

[50] Vann Jacobson JC, Szilagyi P. Patient reminder and recall systems to improve immunization rates. The Cochrane Library. 2009;5:1-71.

[51] Lewin S, Munabi‐Babigumira S, Glenton C, Daniels K, Bosch‐Capblanch X, van Wyk BE, Odgaard‐Jense J, et al. Lay health workers in primary and community health care for maternal and child health and the management of infectious diseases. Cochrane Database of Systematic Reviews. 2010.

[52] Glenton C, Scheel IB, Lewin S, Swingler GH. Can lay health workers increase the uptake of childhood immunisation? Systematic review and typology. Trop Med & Int Health. 2011;16:1044-53.

[53] Marshall S, Swerissen H. A qualitative analysis of parental decision-making for childhood immunisation. Aust NZ J Publ Heal. 1999;23:543-5.

[54] Tarrant M, Thomson N. Secrets to success: a qualitative study of perceptions of childhood immunisations in a highly immunised population. J Paediatr Child H. 2008;44:541-7.

[55] Watson PB, Yarwood J, Chenery K. Meningococcal B: Tell me everything you know and everything you don't know. New Zealanders' decision-making regarding an immunisation programme. NZ Med J. 2007.

[56] Wilson T. Factors influencing the immunization status of children in a rural setting. J Paediatr Healthcare. 2000;14:117-121.

[57] IASP Taskfork on Taxomony. Classification of Chronic Pain (2nd edition). Seattle: IASP Press; 2011.

[58] Taddio A, Chambers CT, Halperin SA, Ipp M, Lockett D, Rieder MJ, Shah V. Inadequate pain management during routine childhood immunizations: the nerve of it. Clin Ther. 2009;31:S152-67.

[59] Taddio A, Katz J, Ilersich AL, Koren G. Effect of neonatal circumcision on pain response during subsequent routine vaccination. Lancet. 1997;349:599-603.

[60] Axia G, Bonichini S. Are babies sensitive to the context of acute pain episodes? Infant distress and maternal soothing during immunization routines at 3 and 5 months of age. Infant Child Dev. 2005;14:51-62.

[61] Fitzgerald M, Walker SM. Infant pain management: a developmental neurobiological approach. Nat Clin Pract Neuro. 2009;5:35-50.

[62] Ipp M, Taddio A, Goldbach M, Stevens B, Koren G. Effects of age, gender and holding on pain response during infant immunization. Can J Clin Pharm. 2004;11:e2-7.

[63] Craig K, McMahon RJ, Morison JD, Zaskow C. Developmental changes in infant pain expression during immunization injections. Soc Sci Med. 1984;19:1331-1337.

[64] Fitzgerald M. Central nociceptive pathways and descending modulation. In: McGrath PJ, Stevens BJ, Walker SM, Zempsky WT, editors. *Oxford Textbook of Paediatric Pain.* Oxford: Oxford University Press; 2013, 74-84

[65] Taddio, A, Appleton M, Bortolussi R, Chambers C, Dubey V, Halperin S et al. Reducing the pain of childhood vaccination: an evidence-based clinical practice guideline. Can Med Assoc J, 2010. 182(18): p. E843-E855.

[67] Johnston CC, Stevens B, Craig KD, Grunau RVE. Developmental changes in pain expression in premature, full-term, two- and four-month-old infants. Pain. 1993;52:201-208.

[68] Grunau RV, Craig KD, Pain expression in neonates: facial action and cry. Pain. 1987;28:395-410.

[69] Grunau RV, Johnston CC, Craig KD, Neonatal facial and cry responses to invasive and non-invasive procedures. Pain. 1990;42:295-305.

[70] Ipp M, Taddio A, Goldbach M, Ben DS, Stevens B, Koren G. Efects of age, gender and holding on pain response during infant immunisations. Can J Clin Pharmacol. 2003;11:2-7.

[71] Craig K, McMahon J, Morison D, Zaskow C. Developmental changes in infant pain expression during immunisation injections. Soc Sci Med. 1984;19:1331-1337.

[72] Horton RE, Pillai Riddell R, Flora D, Moran G, Pederson D. Distress Regulation in Infancy: Attachment and Temperament in the Context of Acute Pain. J Dev Behav Pediatr. 2015;36:35-44.

[73] Bustos T, Jaaniste T, Salmon K, Champion GD. Evaluation of a Brief Parent Intervention Teaching Coping-Promoting Behavior for the Infant Immunization Context A Randomized Controlled Trial. Behav Modif, 2008. 32(4): p. 450-467.

[74] Izard CE, Hembree EA, Heubner RR. Infants’ emotional expressions to acute pain: Developmental change and stability of individual differences. Dev Psychol. 1987;23:105-113.

[75] Taddio A, Ilersich AL, Ipp M, Kikuta A, Shah V. Physical interventions and injection techniques for reducing injection pain during routine childhood immunisations: Systematic review of randomized controlled trials and quasi-randomized controlled trials. Clin Ther. 2009:31: S48-S76.

[76] Shah V, Taddio A, Rieder MJ. Effectiveness and tolerability of pharmacologic and combined interventions for reducing injection pain during routine childhood immunizations: systematic review and meta-analyses. Clin Ther. 2009;S104-51.

[77] Lisi D, Campbell L, Pillai Riddell R, Garfield H, Greenberg S. Naturalistic parental pain management during immunizations during the first year of life: Observational norms from the OUCH cohort. Pain. 2013;154:1245-1253.

[78] Stevens B, Yamada J, Lee GY, Ohlsson A. Sucrose for analgesia in newborn infants undergoing painful procedures. Cochrane Database of Systematic Reviews. 2013.

[79] Taddio A, Manley J, Potash L, Ipp M, Sgro M, Shah V. Routine Immunization Practices: Use of Topical Anesthetics and Oral Analgesics. Pediatrics. 2007;120:e637-e643.

[80] Blount RL, Devine KA, Cheng PS, Simons LE, Hayutin L. The impact of adult behaviors and vocalizations on infant distress during immunizations. J Pediatr Psychol. 2008;33:1163-1174.

[81] Frank NC, Blount RL, Smith AJ, Manimala MR, Martin JK. Parent and Staff Behavior, Previous Child Medical Experience, and Maternal Anxiety as They Relate to Child Procedural Distress and Coping. J Pediatr Psychol. 1995;20:277-289.

[82] Ainsworth DS, Salter MC, Waters MC, Wall S. Patterns of Attachment: A Psychological Study of the Strange Situation. Psychology Press; New York; 1978.

[83] Jahromi LB, Putnam SP, Stifter CA. Maternal regulation of infant reactivity from 2 to 6 months. Dev Psychol. 2004;40:477.

[84] Craig K. The social communication model of pain. Can psychol. 2009;50:22-32.

[85] Tronick E.Touch in mother-infant interaction. In: Field TM. *Touch in early development.* Lawrence Erlbaum Associates: New Jersey;1995:53-65.

[86] Hertenstein MJ, Touch: Its communicative functions in infancy. Hum Dev. 2002;45:70-94.

[87] McGlone F, Wessberg J, Olausson H. Discriminative and affective touch: sensing and feeling. Neuron. 2014;82:737-755.

[88] Kisilevsky BS, Stack DM, Muir DW. Newborn Attention: Biological Constraints and the Influence of Experience. In: Wiess M, Zelaza P, editors*. Fetal and infant responses to tactile stimulation*. Ablex: New Jersey; 1991;63-98.

[89] Lewis M, Ramsay DS. Effect of maternal soothing on infant stress response. Child Dev. 1999:11-20.

[90] Campbell L, Pillai Riddell R, Garfield H, Greenberg S. A cross-sectional examination of the relationships between caregiver proximal soothing and infant pain over the first year of life. Pain. 2013;154:813-823.

[91] Racine NM, Pillai Riddell R, Flora D, Garfield H, Greenberg S. A Longitudinal Examination of Verbal Reassurance During Infant Immunization: Occurrence and Examination of Emotional Availability as a Potential Moderator. J Pediatr Psychol. 2012;37:935-944.

[92] Sweet SD, McGrath PJ. Relative importance of mothers' versus medical staffs' behavior in the prediction of infant immunization pain behavior. J Pediatr Psychol. 1998;23:249-256.

[93] McMurtry CM, Meghan C, McGrath PJ, Asp E, Chambers CT. Parental reassurance and pediatric procedural pain: a linguistic description. J Pain. 2007;8:95-101.

[94] Piira T, Champion DG, Bustos T, Donnelly N, Lui K. Factors associated with infant pain response following an immunization injection. Early Hum Dev. 2007;83: 319-326.

[95] Pillai Riddell R, Racine NM, Turcotte K, Uman LS, Horton RE, Osmun LD, Ahola Kohut S, J Hillgrove Stuart, Stevens B, Gerwitz-Stern A. Non-pharmacological management of infant and young child procedural pain. Cochrane Database Systematic Reviews. 2011;10.

[96] Shah PS, Aliwalas LL, Shah VS. Breastfeeding or breast milk for procedural pain in neonates. Cochrane Database Systematic Reviews. 2012;12.

[97] Pillai Riddell R, Racine N, Craig K, Campbell L. Psychological theories and biopsychosocial models in paediatric pain. In: McGrath PJ, Stevens BJ, Walker SM, Zempsky WT, editors. *Oxford Textbook of Paediatric Pain.* Oxford: Oxford University Press; 2013, 85-94.

[98] Murray L, Fiori‐Cowley A, Hooper R, Cooper P. The Impact of Postnatal Depression and Associated Adversity on Early Mother-Infant Interactions and Later Infant Outcome. Child Dev. 1996;67:2512-2526.

[99] Bowlby J. Attachment: Attachment and loss (vol. 1). Hogarth: London; 1969.

[100] Condon JT, Corkindale CJ. The assessment of parent-to-infant attachment: Development of a self-report questionnaire instrument. J Reprod Infant Psych. 1998; 16:57-76.

[101] Condon JT, Corkindale CJ, Boyce P. Assessment of postnatal paternal–infant attachment: Development of a questionnaire instrument. J Reprod Infant Psych. 2008;26:195-210.

[102] Woods NS, Eyler FD, Behnke M, Conlon M. Cocaine use during pregnancy: Maternal depressive symptoms and infant neurobehavior over the first month. Infant Behav Dev. 1993;16:83-98.

[103] Minnes S, Singer LT, Arendt A, Satayathum S. Effects of prenatal cocaine/polydrug use on maternal-infant feeding interactions during the first year of life. J Dev Behav Paediatr. 2005;26:194.

[104] Schuetze P, Zeskind PS, Eiden RD. The perceptions of infant distress signals varying in pitch by cocaine-using mothers. Infancy. 2003;4:65-83.

[105] Landi N, Montoya J, Kober H, Rutherford HJV, Mencl WE, Worhunsky PD, Potenza MN, Mayes LC. Maternal neural responses to infant cries and faces: relationships with substance use. Front Psych. 2011;2:32.

[106] Pillai Riddell RR, Stevens B, Cohen LL, Flora D, Greenberg S. Predicting maternal and behavioral measures of infant pain: the relative contribution of maternal factors. Pain. 2007;133:138-149.

[107] Moscardino U, Axia G, Altoe G. The role of maternal depressed mood and behavioural soothing on infant response to routine vaccination. Acta Paediatr. 2006; 95:1680-1684.

[108] Bernard R, Cohen LL. Parent Anxiety and Infant Pain During Pediatric Immunizations. J Clin Psychol Med S. 2006;13:282-287.

[109] Tarrant M, Gregory D. Exploring childhood immunization uptake with First Nations mothers in north-western Ontario, Canada. J Adv Nurs. 2003;41:63-72.

[110] Tickner S, Leman PJ, Woodcock A. Parents' views about pre-school immunization: an interview study in southern England. Child: Care, Health Dev. 2010;36:190-197.

[111] Stockwell MS, Irigoyen M, Martinez RA, Findley S. How Parents' Negative Experiences at Immunization Visits Affect Child Immunization Status in a Community in New York City. Public Health Rep. 2011;126:24.

[112] Taddio A, Ipp M, Vyas C, Parikh C, Smart S, Thivakaran S, Jamal A, Stephens D, Shah V. Teaching parents to manage pain during infant immunizations: laying the foundation for better pain management practices. Clin J Pain. 2014;30:987-994.

[113] Taddio A, Parikh C, Yoon EW, Sgro M, Singh H, Habtom E, Ilersich AF, Pillai Riddell RR, Shah V.Impact of parent-directed education on parental use of pain treatments during routine infant vaccinations: a cluster randomized trial. Pain. 2015;156:185-191.

**Chapter 2**

**Parental reminder, recall and educational interventions to improve early childhood immunisation uptake: A systematic review and meta-analysis[[1]](#footnote-1)**

Abstract

Vaccination is one of the most effective ways of reducing childhood mortality. Despite global uptake of childhood vaccinations increasing, rates remain sub-optimal, meaning that vaccine-preventable diseases still pose a public health risk. A range of interventions to promote vaccine uptake have been developed, although this range has not specifically been reviewed in early childhood. We conducted a systematic review and meta-analysis of parental interventions to improve early childhood (0-5 years) vaccine uptake. Twenty-eight controlled-studies contributed to six separate meta-analyses evaluating aspects of parental reminders and education. All interventions were to some extent effective, although findings were generally heterogeneous and random effects models were estimated. Receiving both postal and telephone reminders was the most effective reminder-based intervention (RD = 0.11 (95% CI = 0.03 to 0.19). Sub-group analyses suggested that educational interventions were more effective in low-middle income countries (RD = 0.13; 95% CI = 0.05 to 0.22) and when conducted through discussion (RD = 0.12; 95% CI = 0.02 to 0.21). Current evidence most supports the use of postal reminders as part of the standard management of childhood immunisations. Parents at high risk of non-compliance may benefit from recall strategies and/or discussion-based forums, however further research is needed to assess the appropriateness of these strategies.

# 1. Introduction

The reduction in global mortality associated with vaccinations is second only to the introduction of safe drinking water [1]. According to the World Health Organisation, childhood vaccinations prevent an estimated 2 to 3 million deaths per year. Yet despite global increases in childhood vaccine uptake, rates remain sub-optimal (<95%), with vaccine-preventable diseases still posing a public health risk [2]. Neither is this risk limited to low- and middle-income countries (LMICs). Factors such as poor access to healthcare, indigenous or ethnic status, a large family size and low educational achievement are associated with pockets of low coverage in high-income countries (HICs) [3].

Maintaining reductions in mortality from vaccine-preventable disease relies upon continued immunisation uptake that, during childhood, is reliant on parental decision-making and subsequent attendance at vaccine clinics [4]. However, several factors may act as barriers to childhood immunisation. Factors include, parental concerns about vaccine safety, a lack of knowledge about the recommended schedule, pain caused by the injections, distrust of the medical community and difficulty accessing clinics [5]. Therefore, it is important to understand the effectiveness of interventions implemented by primary care settings that are designed to improve childhood immunisation. Interventions to increase childhood immunisation have been targeted at a variety of groups, including healthcare providers, healthcare practices and parents [6]. This review will focus on the effectiveness of interventions targeted at parents. Many strategies have been trialled, including financial incentives [7] and home vaccination [8]. However, as the majority of trials have addressed (a) the lack of schedule awareness using parental reminder systems and/or (b) knowledge about the safety and efficacy of vaccines through educational leaflets or discussion-groups, these interventions will be the primary focus of this review. Systems designed to remind parents that their child was due (reminder) or overdue (recall) their immunisations have been linked to a 1.5 times increase in uptake [9]. The effects of parental education are less clear, with evidence presented both for [10, 11] and against [3] their utility.

Previous reviews have focussed on the efficacy of intervention strategies in isolation and not all have made specific recommendations regarding childhood immunisations. Today, primary health care services are under increasing pressure to meet immunisation expectations at both an organisational and patient-level [12]. In order to facilitate physician judgements about interventions to increase childhood immunisation, and to increase the efficacy of intervention implementation and policy updates, a review comparing the effectiveness of multiple interventions is timely. Therefore, a systematic review and meta-analysis was conducted to evaluate available evidence on parental interventions to improve childhood (birth to 5 years) vaccine uptake.

# 2. Material and methods

2.1. Literature search

A systematic literature search of five databases (MEDLINE, EMBASE, EMBAR, CINAHL and PsychINFO) was conducted in February 2014 using the OVID and EBSCOhost search platforms (with adaptation of terms for EBSCOhost). Search terms were pre-defined to allow a comprehensive search strategy that included text fields within records and Medical Subject Headings (MeSH terms). Terms related to immunisation, immunisation uptake, infants and young children and intervention study design. The OVID search strategy is reported in Table 2.1. This search was conducted as part of a wider review of barriers and facilitators of childhood immunisation and so included both qualitative and quantitative data. The present review refers only to quantitative intervention studies.

Table 2.1. OVID search strategy

|  |  |
| --- | --- |
| Search no. | Search terms (number of records found) |
| 1 | Vaccination/ or vaccin\*.mp. (504709) |
| 2 | Vaccines, Combined ([Roberts et al.](#_ENREF_39)) (15179) |
| 3 | Immunization, Secondary/ or Immunization Schedule/ or immuniz\*.mp. or immunis\*.mp. (259183) |
| 4 | Child, Preschool/ (1015179) |
| 5 | infant\*.mp. or exp Infant/ (1419667) |
| 6 | Intervention Studies/ or intervention\*.mp. (1272614) |
| 7 | Observational Study/ or observational.mp. (186994) |
| 8 | randomized controlled trials as topic/ or epidemiologic research design/ or cross-over studies/ (302583) |
| 9 | comparative study/ or evaluation studies/ or meta-analysis/ (2466746) |
| 10 | Qualitative Research/ or qualitative.mp. (253593) |
| 11 | Attitude to Health/ or attitude\*.mp. (586720) |
| 12 | Decision Making/ or decision\*.mp. (611254) |
| 13 | uptake.mp. (506659) |
| 14 | 1 or 2 or 3 (629636) |
| 15 | 4 or 5 (1921801) |
| 16 | 6 or 7 or 8 or 9 or 10 (4175191) |
| 17 | 11 or 12 or 13 (1636383) |
| 18 | 14 and 15 and 16 and 17 (1432) |

*Note.* Databases searched <dates>: EBM Reviews - Cochrane Database of Systematic Reviews <2005 to December 2013>, EBM Reviews - ACP Journal Club <1991 to January 2014>, EBM Reviews - Database of Abstracts of Reviews of Effects <1st Quarter 2014>, EBM Reviews - Cochrane Central Register of Controlled Trials <January 2014>, EBM Reviews - Cochrane Methodology Register <3rd Quarter 2012>, EBM Reviews - Health Technology Assessment <1st Quarter 2014>, EBM Reviews - NHS Economic Evaluation Database <1st Quarter 2014>, Embase <1996 to 2014 Week 06>, Ovid MEDLINE(R) <1946 to January Week 5 2014>

2.2. Study selection

Database search results were combined and duplicates were removed. Studies were screened for eligibility by the primary author, with uncertain citations discussed with J.M. Full-text reports were gained for all eligible studies. The reference lists of included studies were additionally searched for any relevant articles. A sample of studies was independently assessed for eligibility by J.M to corroborate study selection. Any disagreements were resolved by discussion. Studies were eligible for inclusion in the systematic review if they reported interventions aimed at parents of children (≤ 5 years-old) due or overdue one or more routine immunisations, recommended to be administered by the WHO, with outcomes that measured child immunisation uptake. Because of variations in the reporting of immunisation uptake [3], outcomes that addressed the uptake of individual or a combination of recommended vaccines were included. Studies without a control group and studies that did not provide outcome data in terms of the number of children completely immunised or up-to-date for their age were excluded from the meta-analysis. Interventions that met these criteria but for which only one study was found were also excluded from pooled analyses.

2.3. Data extraction and assessment of methodological quality

Study characteristics were recorded using a pre-defined data extraction sheet. Information was extracted on (a) study design, (b) country of study, (c) intervention (including type, population, setting, details and sample sizes), (d) outcomes (including the number of children completely immunised for their age, received at least one dose of the studies vaccine(s), or were vaccinated on-time), (e) study findings and (f) eligibility for inclusion within meta-analyses.

2.4. Risk of bias in individual studies

Risk of bias was performed by the primary author using the Cochrane Collaboration Risk of Bias Tool [13]. Studies were assessed as being at a high, low or unclear risk of six attributes: sequence allocation, allocation concealment, blinding, incomplete outcome data, selective reporting, and other sources of bias. Studies were assessed as ‘unclear’ when an attribute (e.g., blinding) was not reported, or insufficient evidence to support a judgement was provided. Evidence of quality across studies was determined by the proportion of studies given each judgement for each methodological attribute assessed in the tool. Although assessment of study quality is reported here it was not used to weight review findings.

2.5. Data analysis

Studies that were eligible for inclusion in the meta-analysis were grouped according to intervention type. Separate meta-analyses were conducted for each intervention type. Studies examining multiple interventions could contribute to several analyses. Where trials had a cluster randomised design, reported intra-cluster correlation coefficient (ICC) were sought. If ICCs were not reported, unadjusted values were included in the meta-analyses, accepting that this might overestimate the weight of these studies in the analysis. Risk difference values and 95% confidence intervals were used to calculate both individual and pooled effect sizes for the effect of each intervention on complete childhood immunisation uptake. Potential differences between studies were explored by sub-group analyses including where possible, the effect of the country of study income, time, frequency and method of intervention delivery and focus of intervention content.

Heterogeneity was assessed using Cochrane’s *Q* statistic, with *p* < 10 denoting heterogeneity. Inconsistency across studies was measured using the *I2* statistic, with a value greater than 40% presenting evidence of moderate heterogeneity and signalling the need to use a random effects model [13]. Where heterogeneity was not reduced by sub-group analyses, variability in study method was discussed. Evidence of publication bias was investigated by examining the symmetry of the funnel plot and quantified using the Egger statistic, with *p* < 0.05 denoting evidence of publication bias. All analyses were performed using StatsDirect [14].

# 3. Results

3.1. Selection of studies

The literature search generated 1577 articles. Following the removal of duplicates, 922 of the remaining 1078 articles did not meet the inclusion criteria based on an appraisal of the abstract. This resulted in 86 full-text articles, which were examined in-depth. Forty additional articles were identified from the reference lists of eligible papers and eight systematic reviews identified in the database search [3, 6, 9-11, 15-17]. One hundred and twenty-six full-text reports were examined, and 48 qualitative studies removed for later qualitative analysis. Based on the criteria cited above, 32 intervention studies were ineligible (see Appendix A for details), leaving 46 articles suitable for inclusion in the systematic review. Of these, a further 13 articles were excluded because of inadequate study designs and outcomes measures, and five [8, 18-21] because of a lack of comparable trials, leaving 28 articles suitable for meta-analysis (Figure 2.1).

1577 articles identified through database searching

(1432 OVID; 145 EBSCOhost)

40 additional articles identified through SRs and reference lists

499 duplicates removed

1078 records screened

1040 irrelevant articles excluded

86 full-text articles assessed for eligibility from database search

46 articles included in systematic review

28 articles included in meta-analysis

32 articles excluded using eligibility criteria

18 articles excluded from meta-analysis

Figure 2.1. Flow diagram of study selection

3.2. Characteristics of studies included in the meta-analysis

Table 2.2 summarises the characteristics of studies included in the systematic review and meta-analysis. Of the studies included in the meta-analysis (n = 28), 16 studies were conducted in the United States, five in the UK or Republic of Ireland, two in Pakistan and one each in Australia, Ghana, India and Japan. Twenty-four Randomised Controlled Trials (RCTs), three cluster RCTs and one sequentially allocated control trial, were included. One cluster RCT [22] reported an ICC of zero. Consequently, no adjustment was made for clustering and clustering had no impact upon any findings reported. The studies included a total of 14,936 parent-child dyads whose immunisation uptake was assessed. Eight studies had data on the complete uptake of both DTP and Measles vaccines; 12 on DTP; five on MMR; and one each on DTP and OPV; Hib, HBV and PCV7 and; DTP and HepB.

Each of the studies evaluated some form of parental reminder and/or education. These were grouped into six intervention types (a) postal reminders [23-33]; (b) telephone reminders [25, 26, 29, 32, 34]; (c) combined recall and reminder [25, 26, 32, 35]; (d) education [22, 30, 31, 36-42]; (e) education and reminder [30, 31, 43-45]; and (f) lay health workers (LHWs) [46-49]. Studies that could not be included in the meta-analysis because of a lack of comparable trials investigated a variety of intervention methods. Interventions included home vaccination [8], financial incentives [19], individual case management [21], LHW-led group discussions [18] and being tracked and escorted to the clinic by an LHW [20].

Table 2.2. Study characteristics

|  | **Study design** | **Intervention type** | **Population/ Setting** | **Intervention** | **Outcomes measured** | **Summary of findings** | **Included in meta-analysis? (Yes/ No; reason for exclusion)** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Reminder-based interventions** | | | | | | | |
| Abramson et al. (1995) [35], USA | RCT | Postal and telephone reminder | Infants born at Forsyth Memorial Hospital receiving primary care from 1 of 2 health centres | A: Postcard reminder + telephone follow up (n = 302) Control: Routine care. No reminder (n = 299) Intervention: Postal reminder sent 1 week before appointment and again if appointment missed. Families then telephoned every week until the child had been vaccinated, the family moved health care provider or the infant was > 1 month behind the schedule | Complete age-appropriate immunisation by 2, 4 and 6 months | Postal reminder significantly increased uptake compared to routine care | Yes |
| Alemi et al. (1996) [50], USA | Non-randomised control trial | Telephone reminder | Mothers with infants < 6 months attending Paediatric practice who were seen by 1 of 3 participating paediatricians and practice nurses | A: Computer-reminder (n = 124) Control: Routine care. No reminder (n = 89) Intervention: Computer telephone reminder attempted before scheduled appointment. If appointments were missed, parents reminded to reschedule. | On-time immunisation | Computerised reminders significantly improved on-time immunisation compared to routine care. | No; outcome measure (on-time immunisation) |
| Alto et al. (1994) [51], USA | Prospective cohort study | Postal and telephone reminder | Children between 2 months and 7 years who were behind schedule and enrolled at the family practice residency clinic | A: Postcard followed by telephone reminder after 6 weeks (n = 231) Control: Routine care. No reminder (n = 233) Intervention: Parents sent postcard detailing immunisation schedule and urging them to make an appointment at the clinic. Telephone calls were made up to 3 times over an 8 week period if children remained unimmunised 6 weeks from initial contact | Complete age-appropriate immunisation 8 months after intervention | Postal followed by telephone reminder significantly increases immunisation uptake compared to routine care. | No; study design |
| Atchison et al. (2013) [52], UK | Before and after study | Postal reminder | All children between 0-5 years attending 44 GP practices | A: Standardised call/ recall system (n = 32 practices) Control: No system implemented (n = 12 practices) Intervention: Postal reminders sent to all children who were due or overdue any immunisations. Overdue appointments were sent up to 3 invitations to attend. Third time defaulters were referred to the HV for follow up. | Complete immunisations at: 1. 12 months for 3x DTaP/IPV/Hib 2. 24 months for MMR1, Hib/ MenC booster, PCV booster 3. 5 years for DTaP/IPV/Hib pre-school booster and MMR2 | Post-implementation, uptake was significantly improved following postal reminders. | No; study design |
| Bjornson et al. (1999) [23], Canada | Prospective RCT | Postal reminder cards | 314 parents of children due 12 month MMR or 18 month DTP/IPV/Hib booster | A: Reminder card (MMR n = 153; DTP/IPV/Hib n = 152) Control: No reminder (MMR n = 155; DTP/IPV/Hib n = 154) Intervention: Bright-coloured reminder card posted 4 weeks before appointment reminding parents which immunisations were due and to make an appointment | Infant immunisation status after 2 month follow-up period | Postal reminders did not significantly improve infant immunisation status by 2 years old. | Yes |
| Campbell et al. (1994) [24], USA | RCT | Postal reminder | Parents of new-borns enrolled in Paediatric clinic who did not receive care from the primary author | A: Letter reminder (n = 87) B: Post-card reminder (n = 96) Control: Routine care. No reminder (n = 105) Intervention: Reminders sent 1 week before appointment and specified its date and time. Letters included information on the benefits of immunisation in accordance with the HBM. | Complete uptake of 3x DTP by 7 months of age | Postcard and letter reminders did not significantly improve immunisation uptake in comparison to the control group. | Yes |
| Dini et al. (2000) [25], USA | RCT | Telephone and postal reminder | 1227 children 60-90 days-old who had received the first dose of DTP and Polio registered at 1 of 4 public health practices | A: Telephone reminder followed by letter  B: Telephone reminder only C: Letter reminder only Control: Routine care. No reminder  Intervention: Telephone messages sent 1 week before appointment and repeated every of schedule and the importance of immunisations. After the 5th telephone attempt, letters posted 2 days after the 1st missed appointment in group C and every week in group A. | Complete uptake by 24 months | Children in all intervention groups had significantly improved immunisation rates compared to children in the control group. There was no difference in immunisation rates between the three intervention groups | Yes |
| Goldstein et al. (1999) [53], USA | Cohort study | Door-to-door recall and reminder | 510 families with 1075 children <6 years living in inner city public housing | Paediatric Immunisation Program (PIP) outreach workers carried out door-to-door to ascertain child immunisation status from records. Record form provided to caregiver detailing current uptake and vaccines due in the future. | Final child immunisation status based on records categorised as receiving all, none or some of: DTP, PCV, Hib, MMR | Visits by an out-reach workers significantly improved immunisation rates from baseline measures. | No; study design |
| Hicks et al. (2007) [54], USA | Before and after cohort study | Postal reminder | All children <35 months not up-to-date registered at a non-profit community health centre | Intervention: Up to 3 language-appropriate postal reminder cards sent to families. Postcards listed the type and number of vaccines the child needed and invited parents to attend the clinic. Postcards served as a physician order to the nurse to administer the vaccine (n = 240 at baseline; 263 after intervention). | Number (%) children completely immunised and up-to-date for their age pre- and post-intervention | Reminder cards significantly increased immunisation uptake | No; study design |
| Irigoyen et al. (2000)  [26], USA | Non-randomised control trial | Postal and telephone reminder | Parents of children between 4-18 months attending hospital- Paediatric clinic in a low-income population | A: Postcard reminder (n = 314) B: Telephone reminder (n = 307) C: Postcard + telephone reminder (n = 306)  Control: Routine care. No reminder (n = 346) Intervention: Postcards were sent 1 week before appointments. A bilingual clerk telephoned parents up to 3 times on the weekday evening before the appointment. | Complete uptake of 4x DTP, 3x Polio, 1 x MMR. | No significant difference in uptake was found between intervention and control groups. Reminders significantly increased uptake for a subgroup of children who were not up-to-date at baseline. | Yes |
| Irigoyen et al. (2006) [27], USA | RCT | Postal reminder | Children aged 6-15 weeks attending 1 of 5 community-based Paediatric practices in an inner city community | A: Continuous postal reminder (n = 549) B: Limited postal (max. 3 letters) reminder (n = 552) Control: Routine care. No reminder (n = 561) Intervention: Bilingual (English/ Spanish) reminder cards posted to parents who needed a repeat reminder for a previously missed dose or a reminder for a new dose. | Complete uptake of 4x DTP, 3x Polio and 1x MMR. | Postal reminders did not significantly increase uptake compared to routine care. | Yes |
| LeBaron et al. (2004) [34], USA | RCT | Reminder recall by audiodialer and LHW outreach | 3050 parent-child pairs born between July 1995-August 1996 | A: Audiodialer only (n = 764) B: Outreach only (n = 760) C: Audiodialer + Outreach (n = 763) Control: Routine care (n = 763) Intervention: Audiodialer message left 1 week before appointment and followed up with postcard if no contact made. If child remained unvaccinated 6 days after due date the message repeated every 6 days before another postcard was sent. | Complete uptake of 4x DTP, 3x Polio, 1x MMR, 3x Hib by 24 months | Children in the audiodialer only group were significantly more likely to have completed the recommended course of immunisations by 24 months. | Yes |
| Lieu et al. (1997) [28], USA | RCT | Postal reminder | Parents of 20 month-old children who had not received MMR | A: Postal reminder (n = 153) Control: Routine care. Nor reminder (n = 136) Intervention: Personalised computer-generated letter reminding parents their child was overdue for immunisation and requesting them to schedule an appointment | MMR uptake by 24 months | Significantly more children received MMR by 24 months in the intervention than control group. Postal reminders significantly improved immunisation uptake by 19%. | Yes |
| Lieu et al. (1998) [55], USA | Randomised trial | Postal and telephone reminder | 752 unimmunised 20 month-olds registered with a HMO | A: Automated telephone message (n = 188) B: Letter (n = 188) C: Automated telephone message + letter after 1 week (n = 188) D: Letter + automated telephone message after 1 week (n = 188) Intervention. Letters were personalised, language-appropriate and stated the child was overdue recommended vaccines and detailing the location of the nearest HMO. Telephone messages were read in a language chosen by the listener. | The receipt of any needed childhood immunisation(s) by 24 months | Receipt of a combined reminder strategy resulted in significantly greater uptake of needed immunisations than receipt of a letter or telephone message alone. | No; study design |
| Morgan & Evans (1998) [29], UK | RCT | Postal reminder or telephone inquiry to HV | Children born between 1994-1995 who were behind schedule at 9 months or who had not received MMR by 21 months | A: Telephone call to HV (n = 153) B: Postal reminder + questionnaire (n = 159) Control: Routine care. No intervention (n = 139) Intervention: A) Telephone calls were made to HVs to confirm the child details and immunisation status. B) Parents were sent a reminder letter and questionnaire asking about the child's immunisation status and reasons for non-compliance | Complete uptake of the primary immunisation schedule by 12 months or receipt of MMR by 24 months | Neither telephone calls to HVs or reminder letters had an effect on primary immunisation or MMR uptake compared to routine care. | Yes |
| Stehr-Green et al. (1993) [56], USA | RCT | Telephone reminder | Parents of 2 year-old children attending 1 of 2 public health centres due DTP, OPV or MMR during the 6 week study period | A: Telephone reminder (n = 112) Control: Routine care. No reminder (n = 110) Intervention: Computer-generated telephone reminder message notifying parents of necessary immunisations and to make an appointment. Messages were made for 5 days starting the day before a child became due for immunisation. Calls were attempted a maximum of 9 times. | Frequency of on-time immunisation for DTP, OPV 1, 2 or 3 and/or MMR within 1 month of becoming due for immunisation | Telephone reminders significantly increased immunisation uptake by 2.8% compared to routine care. | No; outcome measure (on-time immunisation) |
| Vivier et al. (2000) [32], USA | RCT | Telephone and/or postal reminder | 264 under immunised children <6 years enrolled in Medicaid or uninsured with a family income <250% of federal poverty line | A: Telephone reminder (n = 60) B: Mail reminder (n = 63) C: Sequential mail + telephone reminder (n = 70) Control: Routine care (n = 71) Intervention: Up to 3 telephone calls (group A) or a letter (group B) reminding parents their child’s vaccines were overdue and to schedule appointment. Parents in group C sent letter and telephoned after 1 week if an appointment remained unscheduled. | Immunisations received during 10 month follow-up Immunisation status at the end of the follow up | Reminder programs significantly improved uptake of any immunisations and being up-to-date. There was no difference in uptake rates between the three reminder groups. | Yes |
| Vora et al. (2009) [57], USA | Non-randomised control trial | Postnatal health education and reminder | 400 infants enrolled in Medicaid. | A: Hep B + immunisation education at birth + reminder until uptake complete or infant 35 months (n = 400). Control: Citywide school entrants who completed kindergarten in 2001 and 2002 from the same zip code as intervention population (n = 67, 376). | Up-to date immunisations at 7, 13, 19 and 24 months of age  Completeness defined for 7 and 13 months as: ≥ 2 HBV, ≥ 3 DTaP, ≥ 3 Hib, ≥ 2 IPV; and ≥ 3 HBV, ≥ 4 DTaP, ≥ 3 Hib, ≥ 3 IPV for 19 and 24 months. | Education from outreach-workers significantly improved immunisation uptake in high-risk children compared to controls. | No; study design |
| Yokley & Glenwick (1984) [58], USA | RCT | Postal reminder and/or increased access and/or incentive | 1133 under immunised children <5 years | A: Prompt giving general vaccine information (n = 195) B: Specific prompt naming child and vaccines (n = 190)  C: Increased access (2x out-of-hours clinics) + specific prompt (n = 185) D: Monetary incentive (lottery entry upon visit) + specific prompt (n = 183) E: Contact control: telephone call detailing uptake (n = 189) F: No contact control: Routine care (n = 191) | Number of children receiving 1 or more immunisations at the clinic Total number of immunisations received by target children | All interventions except the general prompt significantly increased uptake. The monetary incentive had the largest effect followed by increased access, specific prompts. | No; outcome measure (1 or more immunisations) |
| Young et al. (1980) [33], USA | RCT | Postal reminder | Children at risk of being overdue based on ≤ 1 parent not educated past high school, or 1 parent with a college education and ≥ 4 children | A: Postal reminder (n = 253) Control: Routine care. No reminder (n = 254) Intervention: Letter posted to parents of high-risk children who were 6 months of age during the intervention period. The letter was intended to reduce immunisation dropouts and was intended to act as a 'motivation' to return to the health centre. | Children who received at least one vaccine Children bought up-to-date with the recommended schedule (3x DTP, 2x OPV) | Significantly more children received a vaccination following a motivational letter. More children were bought up-to-date in the postal reminder group but this did not reach significance. | Yes |
| **Education-based interventions** | | | | | | | |
| Bolam et al. (1998) [36], Nepal | RCT | Postnatal health education | Mothers living in 2 communities served by a government funded hospital | A: Education at birth in hospital + 3 months at home (n = 135) B: Education at birth in hospital (n = 135) C: Education at 3 months at home (n = 135) Control: No education (n = 135) Intervention: 20 minute one-one health education discussion facilitated by questions posed to mother | Complete age appropriate immunisation (1x BCG, at least 2x DTP, 2x OPV) after 3 and 6 month follow ups | Maternal education at birth did not significantly increase immunisation uptake of Nepalese children. | Yes |
| Owais et al. (2011) [37], India | RCT | Postnatal health education | 366 mother-infant pairs <6 weeks living in one of 5 low income sites | A: Pictorial information cards (n = 183) Control: Verbal message about general health promotion (n = 183) Intervention: 5 minute session with CHW using pictorial cards. Cards depicted information regarding the benefits of vaccines, logistics surrounding clinics and the need to retain immunisation records for school admission | Immunisation status of DTP-3/ HBV at 4 months after enrolment | Receipt of pictorial information cards significantly improved uptake compared to routine care. | Yes |
| Porter-Jones et al. (2009) [38], UK | RCT | Informative teddy bear | 974 children due their 1st dose of MMR being seen by the HV for routine 8 month check | A: Teddy bear + routine care (n = 542) Control: Routine care (n = 432) Intervention: Children given teddy bear wearing a T-shirt that showed a website address that directed parents to an NHS portal for MMR information and the number of a telephone helpline | Uptake of the 1st dose of MMR | Receiving a teddy bear with MMR information sources did not increase uptake of the 1st dose compared to routine care. | Yes |
| Quinlivan et al. (2003) [39], Australia | RCT | Educational home visits | 136 mothers attending antenatal appointment at teenage pregnancy clinic | A: Home visits + routine post-natal support (n = 65) Control: Routine post-natal support (n = 71) Intervention: 6 structured home visits provided by a midwife conducted at 1 week, 2 weeks, and then bimonthly. Visits lasted 1-4 hours and covered issues surrounding breastfeeding, contraception and immunisation. | Complete uptake of all recommended immunisations at 6 months | Home visits did not increase immunisation uptake compared to routine care. | Yes |
| Saitoh et al. (2013) [40], Japan | RCT | Perinatal health education | Mothers attending 1 of 3 Obstetrics hospitals | A: Prenatal education at 34-36 weeks gestation (n = 34).  B: Postnatal education 3-6 days post-delivery (n = 36). Control: Routine check up (36).  Intervention: One-to-one interactive educational information on immunisation, including: vaccine types, effectiveness, side effects and scheduling. | Complete uptake by 3 months. | Immunisation uptake was significantly higher in the educational intervention groups compared to the control group. There were no significant differences in uptake between the pre and postnatal education groups. | Yes |
| Shourie et al. (2013) [22], UK | Cluster RCT | Decision aid for MMR | Parents with children between 3-12 months registered at 1 of 50 GP practices | A: MMR decision aid + routine care (n = 50) B: 'MMR your questions answered' leaflet + routine care (n = 93) Control: Routine care (n = 77) Intervention: MMR decision aid contained detailed information about the risks and benefits of having and not having MMR and encouraged parents to evaluate the information in accordance with their values. | First dose MMR uptake by 15 months  (ICC estimated as zero, no adjustment for clustering) | Both interventions were successful in reducing decisional conflict but neither significantly improved uptake compared to routine care. | Yes |
| Stille et al. (2001) [41], USA | RCT | Education | 323 infants born at participating hospital who presented to 1 of 3 participating primary care sites <28 days old | A: Parental education + routine care (n = 156) Control: Routine care (n = 159) Intervention: Parents provided with a graphic card written in accordance with the HBM depicting the primary immunisation schedules, and leaving space to document child uptake along with general information. Providers also explained the card and answered any questions. | Complete age-appropriate immunisation by 7 months | Parental education did not increase uptake by 7 months compared to routine care. | Yes |
| Williams et al. (2013) [42], USA | Cluster randomised trial (2 sites) | Education | Vaccine hesitant parents attending 2 Paediatric practices for 2 week well-child visits | A: Parental education (n = 55) B: Routine care (n = 67) Intervention: Parental education constructed using the HBM containing an 8 minute video describing common concerns amongst vaccine hesitant parents, and two leaflets about vaccine concerns and how to find accurate medical information on the Internet. | On-time receipt of all recommended vaccinations by 2 months  ICC not reported, no adjustment for clustering | Receiving a brief educational session significantly improved uptake compared to routine care. | Yes |
| Wroe et al. (2005) [59], New Zealand | Non-randomised control trial | Antenatal decision aid | 100 women attending hospital antenatal classes | A: Decision aid (n = 50) Control: Standard immunisation leaflet (n = 50) Intervention: 20 page booklet containing detailed information regarding the benefits/ risks of vaccines, the role of emotions (e.g., omission bias) and the golden rule to encourage decision-making from child’s perspective. | Number (%) of children immunised on-time, late or unimmunised by 3 months | A significantly higher proportion of infants who received the decision aid were immunised on time compared to control group infants. | No; outcome measure (on-time immunisation) |
| **Education and reminder based interventions** | | | | | | | |
| Hawe et al. (1998) [43], Australia | RCT | Educational postal reminder | Parents of children born 1987-1988 | A: HBM reminder card (n = 124) Control: Usual vaccination reminder card (n = 135) Intervention: Reminder cards worded in accordance to the HBM. Cards worded to prompt immunisation by stating (1) the severity of measles, (2) the susceptibility of children <2 years and (3) the risks of the disease outweigh those of the procedure. | Percentage of children vaccinated against measles/mumps in the 5 weeks following postal reminder. | A significantly greater proportion of children were immunised following receipt of the HBM card compared to the usual reminder card. | Yes |
| Mason & Donnelly (2000) [45], UK | RCT | Postal reminder and information | Children living in a health authority born between Nov 1996-April 1997 who had not received MMR by 21 months | A: Postal reminder + informational leaflet (n = 255) Control: Routine care. No reminder (n= 256) Intervention: Personal reminder letter sent to parents, GP and HV of child due for immunisation. Parents also sent the leaflet *MMR: the facts.* | MMR uptake between 21-24 months-old | Personal reminder letters including an informational leaflet did not increase MMR uptake compared to routine care. | Yes |
| Oeffinger et al. (1992) [44], USA | RCT | Education and reminder | 238 mother-infant pairs delivered by family practice residents | A: Educational discussion + postal reminder (n = 116)  Control: Routine care (n = 122)  Intervention: 10-15 minute discussion on the 1st day postpartum with a nurse or physician about the risks and benefits of immunisation. Mothers also given 1-page hand-out summarising points made in the discussion and were sent a reminder letter 2 months post-delivery. | Complete uptake of first 3 doses of DTP/OPV by 1 year. | Postnatal education and reminder did not significantly improve uptake compared with routine care. | Yes |
| Usman et al (2009) [30], Pakistan | RCT | Immunisation card and centre-based education | 1500 mother-child dyads attending 5 urban EPI centres | A: Redesigned card (n = 375) B: Centre-based education (n = 375) C: Redesigned card + centre-based education (n = 375) Control: Routine care (n = 375) Intervention: Parents were given a redesigned reminder card detailing date and location of their appointment and instructed to place the card in a visible location and/or received a 2-3 minute education session emphasising the importance of immunisation at the EPI centre. | Complete uptake of 2nd and 3rd doses of DTP at the end of 90 day follow up | Immunisation uptake was significantly improved in all intervention groups. Reminder cards and centre-based parental education significantly increased uptake. | Yes |
| Usman et al. (2011) [31], Pakistan | RCT | Immunisation card and centre-based education | 1506 mother-child dyads attending 6 rural EPI centres | A: Redesigned card (n = 378) B: Centre-based education (n = 374) C: Redesigned card + centre-based education (n = 376) Control: Routine care (n = 378) Intervention: Parents were given a redesigned reminder card detailing date and location of their appointment and instructed to place the card in a visible location and/or received a 2-3 minute education session emphasising the importance of immunisation at the EPI centre. | Complete uptake of 2nd and 3rd doses of DTP at the end of 90 day follow up | Immunisation uptake was significantly improved in all intervention groups. Reminder cards and centre-based parental education significantly increased uptake. | Yes |
| **Lay Health Workers** | | | | | | | |
| Barnes et al. (1999) [46], USA | Before and after RCT | Education by LHWs | 434 parent-child pairs at 1 of 2 Paediatric centres who were < 2 years-old and behind schedule | A: LHW home visits (n = 218) Control: Reminder at enrolment visit (n = 216) Intervention: LHW home visits provided immunisation education and clinic referral, followed by 6 month reminder period | Complete age-appropriate immunisation after 6 month follow-up period | LHW home visits significantly improved immunisation uptake in the intervention group compared to routine care. | Yes |
| Brugha & Kevany (1996) [47], Ghana | Cluster RCT | Home visits by LHW | 60 clusters containing 36-39 residences containing children 12-18 months-old | A: Survey + clinic referral and home follow-up (n = 200) Control: Survey only (n = 219) Intervention: Child immunisation status established by interview and clinic referral made. Advice targeted to parents of incompletely immunised children. Nurse followed up non-attendance up to 3 times in 6 months. | Immunisation coverage at completion of home visit intervention based on health record and mother's history. No ICC reported to adjust for clustering | Mean immunisation significantly higher in the 30 intervention clusters (clinic referral and home follow-up) than the control group clusters. | Yes |
| Johnson et al. (1993) [48], Ireland | RCT | Education by LHWs | 262 first time mothers living in a deprived area | A: Home visits from 'Community mother' + Routine care (n = 141) Control: Routine care (n = 121) Intervention: Monthly visits from the community mother providing information and guidance on child health and development, including immunisations. | Complete uptake of primary immunisation schedule by 12 months | Infants whose mothers received home vests were significantly more likely to have completed their primary course of immunisations by 1 year | Yes |
| Norr et al. (2003) [49], USA | RCT | Home visits by LHW | 588 mother-infant pairs attending one of 2 prenatal clinics living in a low income area | A: Home visits + routine care (n = 258; A-A = 182; M-A = 26) Control: Routine care (n = 219; A-A = 141; M-A = 78) Intervention: Monthly home visits by the nurse and/or LHW 2 weeks after hospital discharge to discuss child health and development. Home visits were replaced by telephone calls after 2 months if mother-infant pairs were doing well. | Complete uptake by 12 months documented by maternal report and medical records | Immunisation uptake not significantly improved by home visits compared to routine care. Immunisation rates were significantly higher in M-A compared to A-A children. | Yes |
| **Studies not included in the meta-analysis** | | | | | | | |
| Andersson et al. (2009) [18], Pakistan | Cluster RCT | LHW lead group discussion | In each of the 32 enumeration areas, 100 children < 60 months | A: Community discussion + health education program (18 clusters) Control: Health education program (14 clusters) Intervention: Three-phase community based discussion based on 1) the prevalence of childhood diseases, 2) costs and benefits to immunisation and 3) Community specific barriers and challenges to uptake | Uptake of measles and 3x DTP between 12-23 months | Immunisation uptake was significantly higher for children in the community discussion clusters than clusters that received health education alone. | No; not comparable with other studies |
| Banerjee et al. (2010) [19], UK | Cluster RCT | Incentive | 30 households containing children aged 0-5 years randomly selected from 134 villages | A: Immunisation camp (30 villages, 379 children) B: Immunisation camp + incentive (30 villages, 382 children) Control: No camp or incentive (74 villages, 860 children) Intervention: Monthly 'immunisation camp' offering regular immunisation services. Additional incentive offered to group B consisting of 1kg raw lentils per immunisation administered and a set of metal plates upon completion of full schedule. | Complete or partial uptake of 1x BCG, 3x DTP, 3x OPV, 1x measles | Small incentives to immunise had a greater positive impact (RR = 6.7) on uptake compared to improving services alone (RR = 2.2). | No; not comparable with other studies |
| Bond et al. (1998) [8], Australia | RCT | Home vaccination | Children 90 days late for 3rd dose DTP/OPV/Hib or 120 days late for MMR living in one of 10 council areas | A: Home vaccination service (n = 81) Control: Routine care (n = 88) Intervention: Home vaccination at a time convenient to parents. | Complete uptake of DTP/OPV/Hib or MMR | Home vaccination significantly increased immunisation uptake compared to routine care. | No; not comparable with other studies |
| Bond et al. (2002) [60], Australia | Cross-sectional before and after | Incentive | Children <3 years attending a registered child care centre | Governmental parent incentive scheme. To receive childcare benefits and Maternity Allowance parents must demonstrate complete immunisation of child. | Proportion of children between 1997 and 2000 who were:  1. Fully immunised; 3 milestones complete (1. 3x DTP, 3x Hib, 3x OPV; 2. MMR; 3. DTP/ Hib).  2. Age appropriately immunised | Significantly more children were fully immunised in 2000 following the introduction of the governmental incentive compared to 1997 before it was introduced. | No; study design |
| Crittenden & Rao (1994) [61], UK | Before and after study | General encouragement | Parents of non-attending children | Intervention: Reasons for non-compliance discussed with GP and HV before postal contact made. If necessary a home visit was made to discuss vaccination or administration scheduled for a hospital visit (n = 93) | Complete uptake of primary vaccines or preschool booster | Significantly more children were immunised as a result of the intervention. The greatest effect was for the pre-school booster. | No; study design |
| Ferson et al. (1995) [62], Australia | Randomised trial (no control) | School-nurse | 239 incompletely immunised 5 year olds attending one of 28 primary schools | A: Written material in appropriate language (n = 119) B: Written materials + phone call 1-2 months after information (n = 120) Intervention: Written material to encourage immunisation uptake. Telephone call established uptake or encouraged uptake in cases where child remained unimmunised. | Uptake of measles and/or booster immunisations classified as complete, some or none | Significantly more children were immunised following a telephone call compared to the provision of written materials alone. | No; study design |
| Rodewald et al. (1999) [20], USA | RCT | Tracking with outreach LHW and provider prompting | 3015 infants attending one of 9 primary care practices born between 01/03/1993 and 28/02/1994 | A: Tracking/ outreach + prompting (n = 732) B: Tracking/ outreach only (n = 715) C: Prompting only (n = 801) Control: Routine care (n = 767) Intervention: Tracking/ outreach was provided by LHWs who worked with parents of under immunised infants to bring them to the primary care office using postcards, telephone calls and home visits. Prompting was provided by the primary care office that used reduced missed opportunities by immunising necessary children regardless of visit type. | Immunisation status on the last day of the intervention classed as complete uptake for age-appropriate schedule | Tracking/ outreach and prompting significantly increased immunisation uptake by 20% and reduced the delay in immunisation by 63 days. | No; not comparable with other studies |
| Wood et al. (1998) [21], USA | RCT | Case management | 419 mother-infant dyads living in one if 10 enrolment zip codes | A: Case management + Health Passport (n = 209) Control: Health Passport only (n = 210) Intervention: In-depth assessment at home when infant < 6 weeks and subsequent visits 2 weeks before scheduled appointment by case manager. Managers provided information about immunisation and sought to overcome barriers such as lack of insurance and transport. | Complete immunisation by 12 months defined as the receipt of 3x DTP, 2x OPV, 3x Hib | Immunisation uptake was significantly improved by 13.2% in the case management group compared to routine care. | No; not comparable with other studies |

*Note.* DTP = Diphtheria, Tetanus, Pertussis; DTaP = Diphtheria, Tetanus, acellular Pertussis; IPV = inactivated Polio vaccine; OPV = oral Polio vaccine; Hib = *Haemophilus influenzae* type b; Hib/ MenC = *Haemophilus influenzae* type b and meningitis C; MMR = Measles, Mumps and Rubella; HBV = Hepatitis B vaccine; PCV = Pneumococcal vaccine; BCG = Tuberculosis vaccine; M-A = Mexican-American; A-A = African-American; HBM = Health Belief Model; HV = Health Visitor; HMO = Health Maintenance Organisation; EPI-Centre = Extended Programme on Immunisation.

3.3. Risk of bias for individual studies

Using the risk of bias tool, 12 studies (43%) were judged to have an overall high risk of bias, four (14%) as low risk, and 12 studies (43%) as unclear risk. Risk of bias judgements for studies included in the meta-analysis are shown in Figure 2.2. Nine studies were judged to be at a high risk of selection bias, describing a non-random component in the sequence generation process [38, 41], inappropriate allocation concealment [37, 42], or both [26, 30, 31, 44]. The blinding of parents and/or health professionals was not possible where interventions were provided face-to-face. Only six studies included a blind outcome assessor. In the majority of studies, blinding was unclear or judged to be of high risk because those administering the intervention also assessed outcomes [22, 30, 31, 36-38, 40, 44, 48]. In the majority of studies, insufficient information was reported to provide a judgement regarding blinding. Approximately 10% of studies [36, 38, 46] were judged to be at high risk of attrition bias owing to high rates of exclusion and loss to follow up. Only three studies [22, 40, 42] referred to protocols, so for the majority of studies it was unclear whether selected reporting had been an issue. Risk of bias judgements for each study included in the meta-analysis are presented in Appendix B. No evidence of publication bias was found for included studies: for each pooled analysis, funnel plots were symmetrical, with studies published in each quarter of the plot. The associated Egger statistics were non-significant in each case.

Figure 2.2. Risk of bias chart for studies included in the meta-analysis (n = 28). Numbers at the end of each bar show the number of studies within each judgement for each attribute of the tool.

3.4. Effectiveness of reminder-based interventions

Thirteen studies evaluated the impact of one or more methods of parental reminder. Pooled risk differences were calculated for the effect of postal and telephone reminders, as well as studies that utilised both methods in one study arm.

3.4.1. Postal

Eleven studies (1 sequentially allocated control trial, 10 RCTs) examined the effectiveness of postal reminders [23-33]. In all studies, parents were sent a letter or postcard reminding them that their child’s immunisations were due or overdue. Intervention groups within one study [24] examining personal and non-personal reminders were pooled to summarise the overall effect of intervention. The pooled fixed effect showed that postal reminders significantly improved immunisation uptake by 10.6% (RD = 0.106; 95% CI = 0 .080 to 0.131; *p <* .001; Figure 2.3a). However, individual studies reported a range of findings (from a 1.8% decrease to a 27.2% increase) and substantial heterogeneity (*I2*= 76.3%), indicating that the fixed effect model is unreliable. Using the random effects model, the positive effect of postal reminders remained significant (RD = 0.099; 95% CI = 0.045 to 0.152, *p* < .001).

Sub-group analyses were performed according to the personalisation and focus of postal reminders to explore the heterogeneity between studies. Sub-group findings also displayed heterogeneity and hence, random effects models are reported. Results suggest that the specificity of postal reminders did not influence efficacy, as all results were similarly positive. Both personal [23, 24, 26-28, 30, 31] (including the child’s name, immunisations due and/or appointment detail; n = 7; RD = 0.112; 95% CI = 0.037 to 0.187, *p* = .004), and non-personal reminders [24, 25, 29, 32, 33] (RD = 0.075; 95% CI = 0.024 to 0.125, *p* = .004) were associated with a significant increase in uptake. Likewise, letters that were targeted (recall) to children overdue their scheduled vaccines or those at a high-risk of non-compliance [27-29, 32, 33] (RD = 0.091; 95% CI = 0.030 to 0.153, *p* < .001), and those that were not [23-26, 30, 31] (reminder; RD = 0.10; 95% CI = 0.020 to 0.190 *p* < .001) had a positive effect on uptake.

3.4.2. Telephone

Five studies (1 sequentially allocated control trial, 4 RCTs) examined the efficacy of telephone reminders [25, 26, 29, 32, 34]. Telephone calls were made and/or messages were left with parents to remind them that their child’s immunisations were due or overdue. As heterogeneity was minimal, a fixed effects model was used. Receiving a telephone reminder (Figure 2.3b) was associated with a significant 4% increase in immunisation uptake (RD = 0.040; 95% CI = 0.006 to 0.073, *p* = .019). One large study [34] dominated the analysis. Heterogeneity of findings was low and thus a random effects model produced similar findings.

3.4.3. Combined postal and telephone (recall and reminder)

Four studies (1 sequentially allocated control trial, 3 RCTs) assessed the impact of receiving a postal reminder letter and telephone prompt on childhood immunisation uptake [25, 26, 32, 35]. The fixed effect model found that the receipt of both postal and telephone reminders (Figure 2.3c) was associated with a significant 10.6% improvement in immunisation uptake compared with controls (RD = 0.106; 95% CI = 0.070 to 0.143, *p* < .001). Substantial heterogeneity was found between the studies, with individual study findings ranging from a 3.2% to 18.9% increase in uptake, meaning the size of the effect cannot be accurately determined. Nevertheless, use of combined reminders remained significant using a random effects model (RD = 0.113; 95% CI = 0.033 to 0.193, *p* < .006).

One study [26] was methodologically different from others in the group because it used a combination of postal and telephone reminders to inform parents of their child’s appointment before they were due, whereas the remaining studies used one method to inform parents of their child’s appointment details (recall), and only used another method if children remained unimmunised after one week (reminder). Excluding this trial reduced heterogeneity (I2 = 31.6%), while the overall effect remained similar (RD = 0.147; 95% CI = 0.10 to 0.195, *p* < .001).

Figure 2.3. Reminder-based interventions

3.5. Effectiveness of education-based interventions

Seventeen studies evaluated the impact of parental education. Pooled risk differences were calculated for the effect of educational interventions, education and reminder and the support of a Lay Health Worker (LHW).

3.5.1. Immunisation education

Ten studies (2 cluster RCTs; 8 RCTs) examined the effect of providing parents with immunisation-based education [22, 30, 31, 36-42]. Parents were advised about immunisation or general child health before their child’s immunisation appointment. Education was facilitated by a discussion with a trained professional, or by written information in picture card or leaflet format. One study provided parents with the details of how to access several written educational sources [38]. Two studies included intervention groups who received education at different time points; intervention groups are pooled for these trials [36, 39]. The overall fixed effect suggests that parental education significantly improved immunisation uptake by 8.3% (Figure 2.4a; RD = 0.083; 95% CI = .056 to 0.110, *p* < .001). However, findings from individual studies ranged from a 1.6% decrease to 26% increase in immunisation uptake and substantial heterogeneity was found in the data. A random effects model reported a similar average effect of intervention (RD = 0.078; 95% CI = 0.013 to 0.142, *p* = .018).

Heterogeneity was explored by sub-group analyses performed according to study country income, intervention timing, frequency and method. Similar levels of heterogeneity were found, thus random effects models are reported. The overall effects of studies offering parental education at birth [36, 40-42] (infants < 1 month) and post-natally [22, 30, 31, 36-38] (infants > 1 month) were similar. Results suggested that the efficacy of educational interventions varied between low- and high-income countries, and the method of education used. LMIC studies [30, 31, 36, 37] found education to be significantly more effective than routine care, improving uptake by 13% (RD = 0.13; 95% CI = 0.05 to 0.22, *p* = .002), while those in HICs [22, 38-42, 63] were not found to be consistently effective. Discussion-based interventions [30, 31, 36, 39, 40] significantly improved uptake by 12% compared to routine care (RD = 0.12; 95% CI = 0.02 to 0.21, *p* = .014). Interventions providing parents with written educational information [22, 37, 38, 41, 42] were not found to be effective. Study numbers were too small to explore interactions between country income and intervention methods.

3.5.2. Immunisation education and postal reminders

Five RCTs examined the efficacy of interventions that provided parents with some form of immunisation education in addition to a postal reminder [30, 31, 43-45]. The fixed effect model found parental education and postal reminders (Figure 2.4b) led to a 16% increase in uptake (RD = 0.16; 95% CI = 0.12 to 0.19, *p* < .001), although with substantial heterogeneity. Individual study findings ranged from 1% to 26% improvements, with the two largest studies reporting the greatest effect, being conducted in Pakistan [30, 31]. A positive effect of education and postal reminders remained, using a random effects model (RD = 0.13; 95% CI = 0.01 to 0.25, *p* = .04).

3.5.3. Support from Lay Health Workers (LHWs)

Four studies (1 cluster RCT, 3 RCTs) examined the impact of parental education about immunisation and advice from a LHW [46-49]. For the purposes of this review, LHWs were defined as a health worker providing education about immunisation, but who had not received any formal healthcare training. LHWs comprised of volunteer mothers, O-level graduates and community workers. A significant effect of LHWs (Figure 2.4c) was found using the fixed effects model (RD = 0.10; 95% CI = 0.05 to 0.15, *p* < .001). However, individual study findings were mixed (ranging from a decrease of 3% to an increase of 20%) and substantial heterogeneity was found. A random effects model did not reach statistical significance (RD = 0.11; 95% CI = -0.02 to 0.25, *p* = .09). Sub-group analyses accounting for the specificity of LHW advice found that specific immunisation advice [46, 47] was associated with a significant 17% increase in immunisation uptake (RD = 0.17; 95% CI = 0.10 to 0.24, *p* < .001).

Figure 2.4. Educational Interventions

# 4. Discussion

There is evidence to support the efficacy of postal and/or telephone reminders, parental education, and parental education with postal reminders for improving child immunisation uptake.

Reminder-based interventions were significantly more effective than routine care independent of their method of delivery. This finding is comparable to that of a previous Cochrane review that found that reminder systems were efficacious for immunisation uptake across the lifespan [9]. The present review however, conducted separate meta-analyses for individual reminder strategies specific to childhood immunisations and found that postal reminders were more effective than telephone reminders. Hence postal reminders are recommended for use in primary care to improve childhood vaccine uptake. Moreover, postal and telephone reminders had an additive impact on uptake; their combined use was associated with a greater increase in immunisation uptake than the use of each strategy alone. However, this effect could be an artefact of the more intensive recall-reminder strategies used in these trials and suggests that recall strategies may be particularly effective in parents whose children may be at risk of non-attendance. There is a need for future research to explore the efficacy of this intervention in trials comparing children at high and low risk of non-compliance.

The overall group analysis suggested that educational interventions significantly increased childhood immunisation uptake. However, sub-group analyses suggested that this effect was driven by two factors: (a) the study occurring in an LMIC and (b) parents having a discussion with a professional expert, rather than receiving information in written form. Analysis did not suggest that the timing or intensity of education impacted upon its effectiveness. The baseline education levels of the participants enrolled in included studies may explain the increased efficacy of interventions conducted in LMICs. Approximately 50% of mothers enrolled in studies within this comparison were illiterate or had no education. Secondary levels of maternal education have been associated with a two-fold increase in childhood immunisation compared to mothers with no education [63]. Interventions that raise the basic level of parental knowledge are therefore more effective in areas where understanding is low compared to countries where it is comparatively higher and educational barriers to immunisation may be more subtle and linked to vaccine belief [2, 4]. Contrary to a previous meta-analysis [11, 64], the overall effectiveness of LHWs could not be recommended following the application of a random effects model [20, 34, 46-49]. Sub-group analyses did suggest that parents who received specific vaccine support from an LHW might be more effective than general support that did not extend beyond topics covered by health visitors in routine care, suggesting an avenue for future research.

Keys to the efficacy of discussion-based educational interventions may come from qualitative findings that suggest that discussion with a trusted medical practitioner may facilitate immunisation compliance owing to the depth and clarity of understanding gained compared to the reported overwhelming nature of written information leaflets [65-67]. These findings suggest that providing parents with the opportunity to discuss immunisations in detail with a healthcare professional may further facilitate immunisation rates. However, due to the additional human resources needed to incorporate practitioner-lead discussion within primary care settings, policy planners may be mindful to reserve these strategies for vaccine-hesitant parents.

The overall utility of educational strategies within standard practice may be further questioned when examined alongside the results of trials that provided parents with both immunisation education and appointment reminders. Using the same methods in both rural and urban settings, the two Usman et al., trials [30, 31] examined education and reminder strategies in separate and combined study arms. In both communities, improvements of uptake in groups who received the combined intervention were minimal in comparison to postal reminders alone. This finding has implications for policy as it suggests that reminder systems may be sufficient facilitators of childhood immunisation in the majority of cases, and that discussion-based strategies may be most effective in families with children at high-risk of non-compliance. Such strategies may increase compliance because they acknowledge parental concerns about vaccination. Addressing these concerns in a discussion with a medical professional regarding the risks and benefits of vaccination may change the parental attitudes, knowledge and beliefs about vaccination. Changes in attitude may facilitate behaviour change; facilitating a pro-vaccination decision and subsequent vaccine uptake. However, the effectiveness of such strategies must be tested in future trials.

4.1. Strengths and limitations

Whilst the findings of this review help to summarise the large body of literature on parental interventions for childhood immunisation uptake, several limitations were apparent. First, substantial heterogeneity was evident in all of the comparisons except telephone reminders. Although random effects models were utilised to investigate the mean distribution of underlying intervention effects, such models do not identify reasons for variation. Unexplained heterogeneity suggests there may be some differences in study method and/or services provided that explain why interventions were effective in some cases but not in others. Although there were too few studies within the published research sampled to explore this formally, the effect of differences in study context can be illustrated by the two Usman et al., studies [30, 31]. These studies utilised the same method of allocation, intervention strategy and outcome measure but were conducted in urban and rural areas of Pakistan respectively. However, they found a 12.8% difference in immunisation uptake of parents who received postal reminders in favour of rural communities, suggesting factors not reported such as access to, and interaction with, healthcare services may contribute to the success of interventions.

Variation between studies may also explain the discrepancy between the results of the present study and two previous reviews on LHWs [11, 65]. The present review examined the effects of education provided by LHWs and therefore did not include two [20, 34] out of four studies [20, 34, 46, 48] previously analysed. Instead, two additional studies [47, 49] were included. This difference and the high levels of heterogeneity found between studies in each review may explain this disagreement and further exaggerates the limited conclusions that can be made by presently available studies in the field.

Second, many of the strategies used in reminder-based interventions may not be relevant to the parents of today. Mobile phones are owned by large majorities of people living in major countries around the world, 75% of whom use their mobile phones for texting [68]. For example, 96% of mobile phone owners in Indonesia, a country where less than 50% of children do not receive the 3 doses of DTP [2], use their mobile phones to text. The increasing commonality of access to technology including mobile phones and text messaging may offer increased effectiveness in terms of outcome and cost. Several small-scale studies have linked text message reminders to improvements in both adolescent [69, 70], and childhood [71] immunisations. However, larger RCTs are necessary to make firmer conclusions about the efficacy of such interventions.

4.2. Conclusions

The findings of this review suggest that several interventions, particularly postal reminders, combined recall and reminder strategies and discussion-based education, can increase childhood immunisation uptake. The precise effectiveness of these interventions is likely to be influenced by numerous factors such as country of intervention and levels of parental vaccine hesitancy that need to be explored by future trials. This review highlights the potential benefits to childhood vaccine uptake of incorporating parental interventions, particularly postal reminders into the standard management of childhood immunisations, and the use of recall strategies and/or discussion-based forums with parents whose children are at high risk of non-compliance.

References

[1] Plotkin SL, Plotkin SA. A Short History of Vaccination. In: Plotkin SA, Orenstein WA, Offit PA, editors. Vaccines. Philadelphia: Sanders, Elsevier; 2008. p. 1-14.

[2] World Health Organisation, UNICEF, World Bank. State of the world’s vaccines and immunization. 3rd ed. Geneva: World Health organisation; 2009.

[3] Kaufman, J, Synnot A, Ryan R, Hill S, Horey D, Willis N, Lin V, Robinson P. Face to face interventions for informing or educating parents about early childhood vaccination (review). Cochrane Database of Systematic Rev. 2013;5:1-69.

[4] Sadaf A, Richards JL, Glanz J, Salmon DA, Omer SB. A systematic review of interventions for reducing parental vaccine refusal and vaccine hesitancy. Vaccine. 2013;31:4293-304.

[5] Mills E, Jadad AR, Ross C, Wilson K. Systematic review of qualitative studies exploring parental beliefs and attitudes toward childhood vaccination identifies common barriers to vaccination. J clinical epidemiology. 2005;58:1081-88.

[6] Briss PA, Rodewald LE, Hinman AR, Shefer AM, Steikas RA, Bernier RR, Carande-Kulis VG, Yusuf HR, Ndiaye SM, Williams SM. Reviews of evidence regarding interventions to improve vaccination coverage in children, adolescents, and adults. Am J Prev Med. 2000;18:97-140.

[7] Fairbrother G, [Hanson](http://www.ncbi.nlm.nih.gov/pubmed/?term=Hanson%20KL%5Bauth%5D) KL,  [Friedman](http://www.ncbi.nlm.nih.gov/pubmed/?term=Friedman%20S%5Bauth%5D) S, and [Butts](http://www.ncbi.nlm.nih.gov/pubmed/?term=Butts%20GC%5Bauth%5D) GC. The impact of physician bonuses, enhanced fees, and feedback on childhood immunization coverage rates. Am J Public Health 1999; 89: 171-5.

[8] Bond L Nolan T, Lester R. Home vaccination for children behind in their immunisation schedule: a randomised controlled trial. Med J Australia. 1998;168:487-90.

[9] Vann Jacobson JC, Szilagyi P. Patient reminder and recall systems to improve immunization rates. The Cochrane Library. 2009;5:1-71.

[10] Kendrick D, Hewitt M., Dewey M., Elkan R., Blair M., Robinson J, Williams J, Brummell, K. The effect of home visiting programmes on uptake of childhood immunization: a systematic review and meta-analysis. J Public Health Med. 2000;22:90-8.

[11] Glenton C, Scheel IB, Lewin S, Swingler GH. Can lay health workers increase the uptake of childhood immunisation? Systematic review and typology. Trop Med & Int Health. 2011;16:1044-53.

[12] World Health Organisation. The World Health Report 2008 – Primary Health Care (Now More Than Ever). Geneva: World Health organisation: 2008.

[13] Higgins JPT, Green SE. Cochrane handbook for systematic reviews of interventions Version 5.1.0 [Updated March 2011]. The Cochrane Collaboration: 2011. Available from [www.cochrane-handbook.org](http://www.cochrane-handbook.org/).

[14] Stats Direct Ltd. StatsDirect statistical software. [http://www.statsdirect.com](http://www.statsdirect.com/). England: StatsDirect Ltd. 2013.

[15] Oyo-Ita A, Nawchukwu CE, Oringanje C, Meremikwu MM. Interventions for improving coverage of child immunization in low- and middle-income countries. Cochrane Database of Systematic Reviews. 2011;7:1-36.

[16] Whittaker K. Lay workers for improving the uptake of childhood immunization. Br J Community Nurs 2002;7:474-9.

[17] Williams N, Woodward H, Majeed A, Saxena S. Primary care strategies to improve childhood immunisation uptake in developed countries: systematic review. JRSM Short reports. 2011;2:1-21.

[18] Andersson N, Cockcroft A, Ansari NM, Omer K, Baloch M, Foster AH, Shea B, Wells GA, Soberanis JL. Evidence-based discussion increases childhood vaccination uptake: a randomised cluster controlled trial of knowledge translation in Pakistan. BMC Int Health and Human Rights. 2009;9(S1):S1-8.

[19] Banerjee AV, Duflo E, Jameel AL, Glennerster R, Kothari D. Improving immunisation coverage in rural India: clustered randomised controlled evaluation of immunisation campaigns with and without incentives. BMJ. 2010;340;1-9.

[20] Rodewald LE, Szilagyi PG, Humiston SG, Barth R, Kraus R, Raubertas RF. A randomized study of tracking with outreach and provider prompting to improve immunization coverage and primary care. Pediatrics. 1999;103:31-8.

[21] Wood D, Halfon N, Donald-Sherbourne C, Mazel RM, Schuster M, Hamlin SJ, Pereyra M, Camp P, Grabowsky M, Duan N. Increasing immunization rates among inner-city, african american children: A randomized trial of case management. JAMA. 1998;279:29-34.

[22] Shourie S, Jackson C, Cheater FM, Bekker HL, Edlin R, Tubeuf S, Harrison W et al, A cluster randomised controlled trial of a web based decision aid to support parents' decisions about their child's Measles Mumps and Rubella (MMR) vaccination. Vaccine 2013;31:6003-10.

[23] Bjornson GL, Scheifele DW, LaJeunesse C, Bell A. Effect of reminder notices on the timeliness of early childhood immunizations. Paediatr & Child Health. 1999;4:400-5.

[24] Campbell JR, Szilagyi PG, Rodewald LE, Doane C, Roghmann KJ. Patient-Specific Reminder Letters and Pediatric Well-Child-Care Show Rates. Clinical Pediatr. 1994;33:268-72.

[25] Dini EF, Linkins RF, Sigafoos J. The impact of computer-generated messages on childhood immunization coverage. Am J Prev Med. 2000;18:132-9.

[26] Irigoyen MM, Findley S, Earle B, Stambaugh K, Vaughn R. Impact of Appointment Reminders on Vaccination Coverage at an Urban Clinic. Pediatrics. 2000;106(S3):919-23.

[27] Irigoyen MM, Findley S, Wang D, Chen S, Chimkin F, Pena O, Mendonca E. Challenges and Successes of Immunization Registry Reminders at Inner-City Practices. Ambul Pediatr. 2006;6:100-4.

[28] Lieu TA, Black SB, Ray P, Schwalbe JA, Lewis EM, Lavetter A, Morozumi PA, Shinefiel HR. Computer-generated recall letters for underimmunized children: how cost-effective? J Pediatr Infect Disease. 1997;16:28-33.

[29] Morgan MZ, Evans M. Initiatives to improve childhood immunisation uptake: a randomised controlled trial. BMJ. 1998;316:1570-71.

[30]Usman HR, Akhtar S, Habib F, Jehan I. Redesigned immunization card and center-based education to reduce childhood immunization dropouts in urban Pakistan: A randomized controlled trial. Vaccine 2009; 27:467-72.

[31] Usman HR, Rahbar MH, Kristensen S, Vermund SH, Kirby RS, Habib F, Chamot E. Randomized controlled trial to improve childhood immunization adherence in rural Pakistan: redesigned immunization card and maternal education. Trop Med & Int Health. 2011;16:334-42.

[32] Vivier PM, Alario AJ, O'Haire C, Dansereau LM, Jakum EB, Peter G. The impact of outreach efforts in reaching underimmunized children in a medicaid managed care practice. Arch Pediat Adol Med. 2000;154:1243-7.

[33] Young SA, Halpin TJ, Johnson DA, Irvin JJ, Marks JS. Effectiveness of a mailed reminder on the immunization levels of infants at high risk of failure to complete immunizations Am J Public Health. 1980;70:422-4.

[34] LeBaron CW, Starnes DM, Rask. KJ. The impact of reminder-recall interventions on low vaccination coverage in an inner-city population. Arch Pediat Adol Med. 2004;158:255-61.

[35] Abramson JS, O’Shea TM, Ratledge DL, Lawless MR, Givner LB. Development of a vaccine tracking system to improve the rate of age-appropriate primary immunization in children of lower socioeconomic status. J Pediat 1995;126:583-6.

[36] Bolam A, Manandhar DS, Shrestha P, Ellis M, de L Costello AM. The effects of postnatal health education for mothers on infant care and family planning practices in Nepal: a randomised controlled trial. BMJ. 1998;316:805-11.

[37] Owais A, Hani B, Siddiqui AR, Agha A, Zaidi AKM. Does improving maternal knowledge of vaccines impact infant immunization rates? A community-based randomized-controlled trial in Karachi, Pakistan. BMC Public Health. 2011;11:1-8.

[38] Porter-Jones G, Williams S, Powell C, Pusey L, Roberts J. Impact of a novel way to communicate information about MMR on uptake of MMR vaccine: A randomized controlled trial. Public Health. 2009;123:78-80.

[39] Quinlivan JA Box H, Evans SF, Postnatal home visits in teenage mothers: a randomised controlled trial. Lancet. 2003;361:893-900.

[40] Saitoh A, et al. Perinatal immunization education improves immunization rates and knowledge: A randomized controlled trial. Prev Med. 2013;56:398-405.

[41] Stille CJ, Chritison-Lagay J, Bernstein BA, Dworkin PH. A Simple Provider-Based Educational Intervention to Boost Infant Immunization Rates: A Controlled Trial. Clinical Pediatr. 2001;40:365-73.

[42] Williams SE, Rothman ERL, Offit PA, Schaffner W, Sullivan M, Edwards, KM. A Randomized Trial to Increase Acceptance of Childhood Vaccines by Vaccine-Hesitant Parents: A Pilot Study. Acad Pediatr. 2013;13:475-80.

[43] Hawe P, McKenzie N, Scurry R. Randomised controlled trial of the use of a modified postal reminder card on the uptake of measles vaccination. Arch Dis Child. 1998;79:136-40.

[44] Oeffinger KC, Roaten SP, Hitchcock MA, Oeffinger P. The effect of patient education on pediatric immunization rates. J Fam Practice. 1992;35:288-93.

[45] Mason B, Donnelly P. Targeted mailing of information to improve uptake of measles, mumps, and rubella vaccine: a randomised controlled trial. Comm Dis Public Health. 2000; 3:67-8.

[46] Barnes K, Friedman SM, Brickner Namerow P, Honig J. Impact of community volunteers on immunization rates of children younger than 2 years. Arch Pediat Adol Med. 1999;153:518-24.

[47] Brugha RF, Kevany JP. Maximizing immunization coverage through home visits: a controlled trial in an urban area of Ghana. B World Health Organ. 1996;74:517-24.

[48] Johnson Z, Howell F, Molloy B. Community mothers' programme: randomised controlled trial of non-professional intervention in parenting. BMJ. 1993;306:1449-53.

[49] Norr KF, Crittenden KS, Lehrer EL, Reyes O, Boyd CB, Nacion KW, Watanabe K. Maternal and Infant Outcomes at One Year for a Nurse-Health Advocate Home Visiting Program Serving African Americans and Mexican Americans. Public Health Nurs. 2003;20:190-203.

[50] Alemi F, Alemagno SA, Goldhagen J, Ash L, Finkelstein B, Lavin A, Butts J, Ghadiri A. Computer Reminders Improve On-Time Immunization Rates. Med Care. 1996;34:OS45-51.

[51] Alto WA, Fury D, Cndo A, Doran M, Aduddell M. Improving The Immunization Coverage Of Children Less Than 7 Years Old In A Family Practice Residency. J Am Board Fam Practice. 1994;7:472-7.

[52] Atchison C, Zvoc M, Balakrishnan R. The evaluation of a standardized call/recall system for childhood immunizations in Wandsworth, England. J Comm Health. 2013;38:581-7.

[53] Goldstein KP, Lauderdale DS, Glushak C, Walter J, Daum RS. Immunization outreach in an inner-city housing development: reminder-recall on foot. Pediatrics.1999;104:69-75.

[54] Hicks P, Tarr GAM, Hicks XP. Reminder Cards and Immunization Rates Among Latinos and the Rural Poor in Northeast Colorado. J Am Board Fam Med. 2007. 20(6): p. 581-586.

[55] Lieu TA, Capra AM, Makol J, Black SB, Shinefield HR. Effectiveness and Cost-effectiveness of Letters, Automated Telephone Messages, or Both for Underimmunized Children in a Health Maintenance Organization. Pediatrics.1998;101:e3.

[56] Stehr-Green PA, Dini EF, Lindegren ML, Patriarca PA. Evaluation of telephoned computer-generated reminders to improve immunization coverage at inner-city clinics. Public Health Rep. 1993;108:426-31.

[57] Vora S, Verber L, Potts S, Dozier T, Daum RS. Effect of a novel birth intervention and reminder-recall on on-time immunization compliance in high-risk children. Human Vaccines. 2009;5:395-402.

[58] Yokley JM Glenwick DS. Increasing The Immunization Of Preschool Children; An Evaluation Of Applied Community Interventions. J App Behav Anal. 1984;17:313-25.

[59] Wroe AL, Turner N, Owens RG. Evaluation of a decision-making aid for parents regarding childhood immunizations. Health Psychol. 2005;24:539-47.

[60] Bond L, Davie G, Carlin JB, Lester R, Nolan T. Increases in vaccination coverage for children in child care, 1997 to 2000: an evaluation of the impact of government incentives and initiatives. Aust NZ J Publ Heal. 2002;26:58-64.

[61] Crittenden P, Rao M. The immunisation coordinator: improving uptake of childhood immunisation. CommDis Rep CDR Rev. 1994;4:79-81.

[62] Ferson MJ, Fitzsimmons G, Christie D, Woollett H. School health nurse interventions to increase immunisation uptake in school entrants. Public Health. 1995;109:25-9.

[63] Save the Children. Finding the Final Fifth: Inequalities in immunisation. London: The Save the Children Fund: 2012.

[64] Lewin S, Munabi‐Babigumira S, Glenton C, Daniels K, Bosch‐Capblanch X, van Wyk BE, Odgaard‐Jense J, et al. Lay health workers in primary and community health care for maternal and child health and the management of infectious diseases. Cochrane Database of Systematic Reviews. 2010.

[65] Benin AL, Wisler-Scher DJ, Shapiro ED, Holmboe ES. Qualitative analysis of mothers' decision-making about vaccines for infants: the importance of trust. Pediatrics. 2006;117:1532-41.

[66] Evans M, Stoddart H, Condon L, Freeman E, Grizzell M, Mullen R. Parents' perspectives on the MMR immunisation: a focus group study. Brit J Gen Pract. 2001;51:904-10.

[67] Gardner B, Davies A, McActeer J, Michie S. Beliefs underlying UK parents' views towards MMR promotion interventions: a qualitative study. Psychol Health Med. 2010;15:220-30.

[68] Kohut A, Horowitz JM, Simmons K, Poushter J, Barker C, Bell J, Gross EM. Global digital communication: Texting, social networking popular worldwide. Washington: Pew Research Center: 2011.

[69] Stockwell MS et al.Text4Health: impact of text message reminder–recalls for pediatric and adolescent immunizations. Am J Public Health. 2012;102:e15-e21.

[70] Kharbanda EO, Stockwell MS, Fox HW, Andres R, Lara M, Rickert VI.Text message reminders to promote human papillomavirus vaccination.Vaccine. 2011;29:2537-41.

[71] Ahlers-Schmidt CR, Chesser AK, Nguyen T, Brannon J, Hart TA, Williams KS, Wittler RR. Feasibility of a randomized controlled trial to evaluate Text Reminders for Immunization Compliance in Kids (TRICKs).Vaccine. 2012;30:5305-09.

**Chapter 3**

Parents’ views about early childhood immunisation: a systematic review of qualitative studies integrated with trials

Abstract

Despite the success of global vaccination programmes, there has been a recent decline in early childhood immunisation uptake. This decline has been directly attributed to increases in parents’ negative attitudes towards vaccination. To understand the impact of parental attitudes on decision-making and subsequent appointment attendance, we conducted a systematic review of qualitative studies using thematic synthesis. Findings of a systematic review of parental interventions to promote vaccination uptake [1] were then interpreted using the qualitative review findings, to assess the appropriateness of current strategies and inform future trials. Thirty-eight qualitative studies (including 1522 parents) were included in the thematic synthesis. Nine main themes emerged related to parental beliefs about: the process of decision-making; decisional control; interpretation of information; vaccine efficacy; vaccine safety; societal pressure; access; the vaccine schedule; and pain. Eight recommendations for intervention were derived from these themes. Comparison of these recommendations with the efficacy of trials included in the quantitative systematic review indicated that interventions involving reminders or discussions about vaccine concerns are appropriate methods for increasing vaccine uptake. However, few clinical trials have investigated the effect of balanced, timely and evidence-based information. This is the first known study to synthesise qualitative and quantitative evidence on vaccination. Findings demonstrate the complex informational needs of parents. Vaccine-hesitant parents may benefit from more balanced information when deciding whether or not to vaccinate their children, however further research is needed to assess the efficacy of these strategies.

# 1. Introduction

Childhood vaccinations prevent an estimated 2 to 3 million deaths each year [2]. Yet despite global improvements, rates remain below the threshold for herd immunity, meaning vaccine-preventable diseases still pose a public health risk [3]. During childhood, vaccine uptake is reliant upon parental decision-making and subsequent appointment attendance [4]. The outcome of these decisions affects both child and community health. For example, the current measles outbreak threatens the World Health Organisation’s aim to eradicate the disease in several international regions by the end of 2015 [5, 6]. The outbreak has been directly attributed to the recent rise in the number of parents deciding against early childhood vaccination [6, 7]. However, relatively little is known about factors that might promote vaccine decision-making and appointment attendance.

A number of systematic reviews have examined interventions to improve vaccine uptake in early childhood (0-5 years) [1, 8-12]. Whilst the results of individual trials are encouraging, reviews report heterogeneous findings for a range of interventions, meaning that the precise value and determinants of intervention efficacy are not understood [13]. The extent to which qualitative literature can illuminate viewpoints regarding the barriers and facilitators of a phenomenon, and factors that contribute to intervention efficacy, is increasingly recognised [14-17]. However, the degree to which qualitative evidence has been reviewed is limited, with only one study identified (dominated by the views of vaccinating parents) that has systematically examined beliefs about childhood vaccination [7]. With recent increases in non-compliance [6], an update is timely.

The value of synthesising quantitative and qualitative review findings has also been highlighted [14, 18, 19]. The results of such syntheses can be used to make policy recommendations relating to current and future interventions that would not be apparent by examining each evidence base independently [14]. Several studies have conducted an evidence synthesis about childhood vaccination [17, 20, 21]. However, the methods of analysis used in two recent reviews [20, 21] limit the utility of their conclusions. Both reviews reduced the results of quantitative studies to a qualitative form, thereby assuming equality between studies that have been designed for different purposes. This arguably gives more weight to qualitative findings [22]. To ensure a balance between both evidence types, it is important to review both types of evidence according to their respective review standards [18].

Despite the fact that current interventions are not vaccine-specific, previous reviews [20, 21, 23] have focussed on MMR uptake. To cope with increasing organisational pressure to offer cost-effective increases in vaccine uptake [24], future interventions must be applicable across the childhood vaccine schedule. This study provides the first known thematic synthesis of qualitative research to examine parental views of early childhood (0-5 years) immunisation, decision-making processes and factors that influence appointment attendance. To provide insight into the effectiveness of current and future interventions [25], the study also integrates these findings with those from a recent systematic review and meta-analysis conducted by the study team of parental interventions to improve uptake [1].

# 2. Method

2.1. Literature search

The literature search was conducted as part of a wider review examining factors that promoted and/or discouraged childhood vaccine uptake. Primary research articles that examined these factors using parental intervention or qualitative methods were included. A comprehensive search of the literature from five electronic databases (MEDLINE, EMBASE, EMBAR, CINAHL and PsychINFO) was conducted with no lower date limit using OVID (1946 to January week 5 2014) and EBSCOhost (1980 to January week 5 2014) search platforms (terms were adapted for EBSCOhost). Pre-defined search terms related to immunisation, immunisation uptake, infants and young children and study design. Evidence from qualitative and intervention studies were analysed separately. The overall search strategy and results relating to intervention studies have been reported elsewhere [1] (Chapter 2; Table 2.1).

2.2. Study selection, quality assessment and data extraction

English language studies were included that examined parental views about early childhood vaccines (0-5 years) using qualitative methods of data collection (particularly interview and focus groups) and textual analysis. Studies that statistically analysed qualitative findings were excluded. Studies that used standardised surveys to establish immunisation attitudes were not included; results were not presented in a manner that facilitated thematic synthesis and therefore did not allow the process of decision-making to be explored in-depth.

Studies were screened for eligibility by the primary author. J.M independently assessed 10% of studies to corroborate study selection. Disagreements were resolved by discussion. An additional reference was sought from reference lists of included studies [26]. Details of relevant study characteristics (study sample, methods of data collection and analysis and study findings) were recorded using a pre-defined form. Study quality was assessed using the Critical Appraisal Skills Program checklist [27]. Studies were scored from 0 to 10, with one point awarded for each satisfied criteria. Although study quality is reported, studies were not excluded or weighted on this basis.

2.3. Qualitative data analysis

Eligible studies were analysed using thematic synthesis; a derivation of thematic analysis that can be used to integrate original qualitative research findings within a systematic review [14]. In line with established guidelines [14], all text under the ‘results’ or ‘findings’ sections were copied verbatim into NVivo [28]. The primary author conducted the qualitative analysis. At all stages, emerging themes were discussed with the study team.

In the initial stages of analysis, findings across studies were summarised using methods of theme generation and organisation associated with thematic analysis. First, studies were coded line-by-line to generate initial themes. Second, similarities and differences between initial codes both within and across studies were compared and organised into a hierarchical tree structure. New descriptive themes were created to capture the overall meaning of the groups of initial codes. The final stage of the analysis is the distinguishing feature of thematic synthesis, where conceptual inferences that extend the conclusions of the synthesis beyond those of original research are made. Analytical themes related to the barriers and facilitators of childhood immunisation were inferred from descriptive themes. Analytical themes were reviewed until a comprehensive account of all themes was provided. The implications of these themes were then considered in terms of current and future interventions.

2.4. Synthesis of findings from the thematic synthesis and meta-analysis

Following established guidelines for evidence synthesis [29] the secondary aim of this review was to integrate the conclusions of the thematic synthesis with those of a recent systematic review and meta-analysis [1]. Recommendations inferred from the qualitative studies were compared with appropriate trials from the quantitative systematic review to establish whether current interventions addressed barriers highlighted by parents in the qualitative studies.

# 3. Results

3.1. Summary of studies included in the thematic synthesis

One hundred and twenty six full-text reports were examined following the appraisal of studies against the eligibility criteria. Of these, 48 were qualitative studies, from which 10 were excluded because of the study design [30-34] or focus [35-39] (Appendix C). This left 38 articles suitable for thematic synthesis (Figure 3.1).

1577 articles identified through database searching

(1432 OVID; 145 EBSCOhost)

499 duplicates removed

1078 records screened

992 irrelevant articles excluded

40 additional articles identified through SRs and reference lists

86 full-text articles assessed for eligibility from database search

32 quantitative articles excluded

10 qualitative articles excluded

28 articles included in meta-analysis

46 articles included in quantitative synthesis

18 articles excluded from meta-analysis

38 articles included in qualitative synthesis

Figure 3.1. Flow chart of study selection

3.2. Characteristics and quality of included studies

Table 3.1 summarises the characteristics of included studies. These studies included the perceptions of 1522 parents. Studies included the views of first-time parents as well as those with more than one-child, although numbers in each group were not routinely provided. Of the 38 studies, 31 reported the actual or intended immunisation status of included children [26, 38, 40-66]: 497 were fully immunised, 177 unimmunised or undecided and 315 were partially immunised or vaccinated using single vaccines. Nine studies [67-74], including 527 children did not provide exact immunisation details. Five studies included parents residing in areas with reportedly low immunisation uptake [70-74]; and the remaining four included parents with a range of views [67-69, 75].

The majority of studies (n = 37) utilised semi-structured interviews (n = 22) [40-46, 50, 54-56, 58-66, 73, 75], focus groups (n = 13) [26, 38, 49, 51, 52, 57, 67-72, 74] or both (n = 2) [47, 48]. The remaining study used open-ended questionnaires [53]. Studies were published between 1991 and 2013. Of these, the majority were conducted in the UK (n = 14) [26, 45, 47-49, 51, 52, 56, 58, 59, 63, 64, 68, 73], USA (n = 10) [42, 46, 50, 53, 57, 66, 69-72] and Australia (n = 4) [38, 43, 44, 54]. The remainder were conducted in Canada [55, 60, 61], China [62], Norway [41], New Zealand [65, 75], Turkey [74] and Uganda [67]. Childhood vaccination is not compulsory in the UK, Australia, Canada, China, Norway, New Zealand or Uganda. In the USA parents are required to vaccinate their children by state law unless a medical, religious or philosophical exception has been granted, and in Turkey, vaccination is regulated by legislation.

On average, studies fulfilled 7.7/10 of the CASP criteria. Thirty-four studies [26, 38, 40-44, 46-53, 55-57, 59, 61-66, 68, 69, 71-75] were judged to be appropriate in terms study aims, design and ethics as well as methods of recruitment and data collection. The remaining four [54, 58, 60, 70] only met five criteria, and were judged to be insufficient because details of data collection, analysis and ethical approval were not cited in depth. Only five studies [44, 45, 57, 71, 72] provided adequate consideration of the researcher-participant relationship, and fewer than half (n = 18) [26, 41, 42, 45, 46, 49, 52, 57, 61, 63-67, 69, 72-74] reported methods of data analysis in sufficient detail (in particular, where thematic analysis was used). CASP judgements for individual studies are presented in Appendix D.

Table 3.1. Study characteristics

| **Reference** | **Population** | ***n*** | **Data collection** | **Conceptual approach** | **Analysis** | **Summary of findings** | **Study quality (CASP rating/ 10)** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Austin (2001) [40], Unclear | Parents of children between 7, 9 and 18 months | 13  (11 mothers, 2 couples) | Semi-structured interview. Parents were asked open-ended questions about any information received before vaccination, any recommended changes they would make to it, and influences on their decision-making process | Phenomenology | Thematic analysis | Parents experienced feelings associated with risk, worry, fear and responsibility; expressed the need for health professionals to understand patients' beliefs and felt a lack of control surrounding the decision-making process. | 8 |
| Austvoll-Dahlgren & Helseth (2010) [41], Norway | Parents who had attended a counselling session at a health centre who had a pre-school aged child that had been immunised in the last 3 months | 10 | 45-90 minute semi-structured interview. Parents were asked about their decision-making experiences, what informed their decision and barriers and facilitators to their search for information | Grounded theory | Constant-comparative method, member checking | Positive views of immunisation, already being decided, doubts about understanding and a limited capacity to store information were perceived as barriers to information seeking. Parents felt less confident in their decisions if they felt less informed. Parents expressed uncertainty regarding the responsibility for immunisation decisions and their consequences. | 9 |
| Benin et al. (2006) [42], USA | Mothers of newborn infants | 33 | Phase 1: face-to -face interview 1-3 days postpartum (n = 33). Open-ended questions about immunisation attitudes, concerns and information seeking habits. Closed-ended questions used to establish plans for vaccination and vaccination knowledge. Phase 2: telephone interview after 3-6 months (n = 19). Open-ended questions used to reassess knowledge, attitudes and information sources. Interview focussed on vaccination-related experiences and interactions with medical system. | Grounded theory | Constant-comparative method. Independent coding by 2 researchers, recoding to check validity | Trust was central to mothers' decision-making. Trust central concept in 3 domains identified:  1) sources of information  2) promoters of vaccine acceptance, e.g. trusting paediatrician, desire to maintain cultural norm  3) inhibitors of vaccine acceptance, e.g. lack of trust in medical profession/ belief in homeopathy, concerns about side-effects, seriousness of vaccine-preventable diseases etc. | 9 |
| Bond et al. (1998) [43], Australia | Parents with children between 3-30 months | 45  (6 fathers) | 45-90 minute semi-structured interview. Parents were asked open-ended questions about how they kept their child healthy, experiences and concerns about vaccine-preventable diseases, influences on risk perception and how these influences related to vaccination decisions. | Unclear | Unclear | Decisions were underpinned by perceptions of risk.  Complete immunisers believed that the risk of disease was less than that of the immunisation, whereas incomplete immunisers perceived vaccines to be less effective. Non-immunisers were concerned about the long-term side effects of immunisation and believed that in situations where vaccinations did not prevent disease that immunisation was not desirable. Generally, vaccinations were seen to place vulnerable infant immune systems under pressure. Other barriers included a lack of detailed information and minor illness. | 7 |
| Bond et al. (2011) [44], Australia | Parents with children between 3-30 months | 45  (6 fathers) | 45-90 minute semi-structured interview. Parents were asked open-ended questions about how they kept their child healthy, experiences and concerns about vaccine-preventable diseases, influences on risk perception and how these influences related to vaccination decisions. | Unclear | Thematic analysis | Immunisers dreaded unfamiliar diseases, felt vaccinations were safe and effective, that side effects were rare and trusted their health care provider. Non-immunisers felt diseases did not pose a risk as long as the child had a healthy immune system, dreaded unknown long-term side effects from vaccines, and felt vaccines were actively dangerous and ineffective. | 9 |
| Braka et al. (2012) [67], Uganda | Care-givers living in a rural or urban district with a child <5 years who reported they were somewhat or very concerned about vaccine side-effects | 136 | Approx. 1 hour focus group discussion | Unclear | Content analysis; descriptive summaries and quotes | 4 key themes were identified:  1) Lack of information from medical professionals. Caregivers relied on authoritative local community leaders  2) Benefits of immunisation. Caregivers were aware of reductions in child mortality and disability 3) Concerns about immunisation. Caregivers raised concerns about the management, storage of vaccines and experiences of adverse effects 4) Misconceptions. Caregivers believed that vaccines did not contain any vaccine, were intended to kill Africans or have other negative side effects, e.g. HIV/ infertility. | 9 |
| Brown et al. (2012) [45], UK | Parents of children between 11 and 36 months who had received MMR1 on-time, late, were not immunised or had obtained ≥1 single doses | 24 | Semi-structured interview. Parents were interviewed at home or at work in person or on the telephone. Interviews followed a guide that asked parents about their planned MMR1 behaviour and key factors in their decision-making process. | Modified Grounded theory approach | Constant comparative method, thematic analysis, duplicate analysis, member checking | 5 key themes were identified:  1) MMR controversy.  2) Social and personal decisional consequences. 3) Health professionals and policy. 4) Severity of measles, mumps and rubella. 5) MMR information and alternatives. | 9 |
| Brunson (2013) [46], USA | US-born parents of a child <18 months-old | 15 mothers, 3 couples | Open-ended and Semi-structured interview. Phase 1: open-ended questions focussing on how parents reached their vaccination decisions. Phase 2 (conducted after formation of initial codes from P1): interviews asked about the steps parents took to reach their immunisation decision, sources of information considered and feelings about their current and future vaccination decisions and plans. | Grounded theory (as described by Charmaz, 2006) | Constant-comparative method, theoretical coding, member checking | A five-stage decision-making process was identified using grounded theory:  1) Pre-decision-making factors. Parents not blind to decision, personal qualities influence its outcome. 2) Awareness. Parents become aware that immunisation directly affects their child(ren) – the start of decision-making. 3) Assessing. The examination of issues surrounding vaccination. There are 3 main groups acceptors (minimal searching due to unquestioning acceptance of immunisation), relies (active assessment of verbal information that follows the social norm of their peers) and searchers active and involved searching of written information which can be critically evaluated).  4) Choosing. Decision outcome can apply generally to all vaccines or be vaccine-specific. 5) Stasis. Reassessment and on-going assessment. Decision may remain static, parents may reassess their decision if new information comes to light or they may constantly reassess their decision by gathering additional information. | 8 |
| Casiday (2007) [47], UK | Parents of pre-school aged children | 87 | Semi-structured interviews and focus groups. Questions asked parents to describe their experiences during the decision-making process. | Unclear | Thematic analysis | During their decision-making process surrounding the MMR vaccine, parents balanced risk concerns surrounding the risk of disease and autism in particular. Parents felt pressure to make the 'right' decision in the midst of uncertainty and contradictory information from private and public sources, and felt that the outcome of their decision would reflect their ability to be a 'good parent.' | 7 |
| Condon (2002) [48], UK | Mothers of children aged 16 months to 3 years of Pakistani, Somali and Afro-Caribbean ethnicity | 21 | Semi-structured interviews and focus groups. Mothers were interviewed at home or as part of one of 3 different focus groups conducted in their first language. A question framework was used to ascertain maternal attitudes in both instances. | Unclear | Thematic analysis | All mothers were pro-immunisation, viewing vaccines as the best method of protection against dangerous diseases. The different ethnic groups had different exposure to the media, linked to their grasp of the English language. Health professionals were the most trusted source of information for all women. Somali and Afro-Caribbean women wished for more information from medical professionals that was specific to Black families and which had been translated to their first language. | 7 |
| Evans et al. (2001) [68], UK | Parents who had accepted or refused MMR for their youngest child, aged 14 months to 3 years | 48  (5 fathers) | 6 focus groups of approximately 1-2 hours. Discussion facilitated by a moderator asking open-ended questions about child health, immunisation attitudes, the effects of the media and other influences on decision-making. | Grounded theory | Constant comparative method, coding index developed and applied to transcripts, member checking | 4 key themes were identified: 1) Beliefs about the risks and benefits of immunisations compared with contacting MMR 2) Responses to information from the media and other sources about vaccine safety 3) Confidence, trust and compliance with the advice given by medical professionals 4) Views on the importance of choice within government policy on immunisation | 8 |
| Gardner et al. (2010) [49], UK | Parents of children < 16 years with varying immunisation statuses | 28 parents reporting on 49 children | 5 focus groups of approximately 45-90 minutes.  A moderator facilitated discussions using a booklet that described 6 potential MMR interventions (3 motivational and 3 organisational). Parents were asked to describe their responses to each intervention, detailing intervention usefulness, feasibility, implementation and awareness of similar interventions. | Realist epistemology | Thematic analysis | 5 themes were identified: 1) Parents' information needs regarding the risks and benefits of MMR 2) Distrust of government sources and associated sources (research, medical professionals) 3) Trust of other parents 4) Attentional bias towards risk information over immunisation benefits information 5) Problems of achieving balance within MMR information | 8 |
| Glanz et al. (2013) [69], USA | Parents of children <4 years-old enrolled in a health plan who had delayed or refused childhood immunisations for personal or non-medical reasons | 24  (11 delayed) | 7 focus groups (3 delayed) containing ~ 3-5 participants and lasting for approximately 60-90 minutes. A moderator facilitated discussions using a focus group guide. Questions focussed on parents' decision-making and immunisation processes. | Team-based inductive approach using Grounded theory | Constant comparative method, group discussion | 5 main themes were identified: 1) Decision timing during pregnancy or whilst planning birth 2) Continuous assessment of decision 3) Multiple sources of information sought 4) Discrepancy between levels of overall and vaccine-specific trust in paediatricians 5) Confidence in the perceived to be biased, vaccine information given by physicians | 8 |
| Gullion et al. (2008) [50], USA | Parents who had children or were pregnant and had made a conscious decision to refuse or delay vaccination | 25 | In-depth semi-structured interviews conducted face-to-face in the participant's environment. Discussions were facilitated through the use of an interview guide. Questions invited parents to discuss issues related to their decision-making. | Popular epidemiology | Thematic analysis | 2 main themes were identified: 1) Information seeking using sophisticated search strategies reliant upon scientific evidence 2) Distrust in the medical community as an information source | 7 |
| Hilton et al. (2006) [26], UK | Diverse range of parents of children < 2 years. | 72  (8 fathers) | 18 focus groups (2 ASD; 2 immuno-comprimised) of about 3-5 people.  Discussions based around topic guide to include beliefs about childhood immunisation, the current vaccine schedule, experience of childhood infectious disease and factors affecting vaccine decision-making | Unclear | Constant comparative method | Parents base their immunisation decision on 3 key risks: 1) Risk of disease 2) Risk of vaccines  3) Ability of child's immune system to 'cope' with combined vaccines | 9 |
| Hilton et al. (2007a) [51], UK | Diverse range of parents of children < 2 years. | 72  (8 fathers) | 18 focus groups (2 ASD; 2 immuno-comprimised). Discussions based on topic guide including beliefs about vaccines, previous experience of infectious disease, and knowledge of symptoms and severity of these diseases. | Unclear | Constant comparative method | There were gaps in parental knowledge regarding the 5 in 1 vaccine that influenced parental perceptions of the need for vaccination. Polio and Diphtheria were no longer seen as a threat to child health in the UK, with mumps and rubella only seen as a threat to boys and girls respectively. | 8 |
| Hilton et al. (2007b)[52], UK | Diverse range of parents of children < 2 years. | 72  (8 fathers) | 18 focus groups (2 ASD; 2 immuno-comprimised) of about 3-5 people lasting between 1-2 hours. Discussions based around topic guide to include parental understandings of the safety of MMR, perceptions of the role of the media, politicians and health professionals in the MMR controversy | Unclear | Thematic analysis following principles of constant comparative method and rigorous analysis | Following the MMR controversy, parents found it hard to know who to trust to find balanced and accurate information. Politicians were viewed as untrustworthy about health decisions, with healthcare providers seen as having a vested interest in immunisations owing to financial incentives. Dr. Wakefield was seen as an important whistle blower. | 9 |
| Keane et al. (1993) [70], USA | Parents/ guardians of infants aged 18-24 months living in inner city, low income areas | 40 parents | 3 focus groups of 2 hours lead by a trained moderator and assisted by a facilitator. Discussions were based on word associations and direct questioning about conceptualisations of illness, vaccine efficacy and parental challenges. | Unclear | Unclear | Vaccines were not seen as effective/ necessary by all parents, with many citing chickenpox as an example. Side effects of fever were seen as an illness caused by vaccination. Immunisation was not considered a high priority for parents. | 5 |
| Lannon et al. (1995) [71], USA | Mothers who were uninsured or using Medicaid | 50 | 11 focus groups of 1 hour lead by 2 female moderators. Mothers were asked about their understanding of well-child care, the purpose of immunisations and their perceptions of administrative and organisational barriers to vaccination. | Unclear | Thematic analysis validated by (1) the summary focus group to members, (2) comparison of barriers between researchers and (3) discussion of results with health dept. staff. | Socially disadvantaged mothers identified 3 barriers:  1) Organisational barriers. Including difficulty making appointments and long waiting times. 2) Personal barriers. Including lack of transport, chaotic lifestyles and taking time out of employment 3) Health knowledge and beliefs. Including a lack of schedule awareness and misconceptions about vaccine safety. | 8 |
| Leask et al. (2006) [38], Australia | Mothers | 37 | 6 focus groups of between 4-8 participants moderated by the primary author.  Discussions were facilitated by prompts relating to mothers' spontaneous thoughts about immunisation, and videos showing positive and negative support for vaccination. One to two days after the focus groups, parents were interviewed and debriefed by telephone. | Unclear | Thematic analysis | Mothers were initially concerned about vaccine risks highlighted to them in the videos presented but quickly returned to positive immunisation beliefs due to trust in medical community, judgements about non-immunisers, and notions of anticipated regret and social responsibility to immunise. | 7 |
| Luthy et al. (2010) [53], USA | Parents whose children were overdue ≥1 vaccine by 6 months. | 86 | Vaccine-hesitant parents were asked to fill in an open-ended questionnaire regarding their concerns about immunisation and any advice they would give to a family member or friend about immunisation. | Unclear | Content analysis | 2 main themes were identified suggesting that hesitant parents have concerns regarding:  1) vaccine safety 2) the perceived need for having their children immunised | 7 |
| Marshall & Swerissen (1999) [54], Australia | Mothers with ≥1 pre-school child. | 20 | Semi-structured interviews of 1 hour conducted in participants home or other private setting. Parents were asked to relate their child's immunisation history, their decision-making processes, perceptions and reactions to the vaccination procedure. Non-vaccinating parents were asked to recall the issues related to this decision. | Thematic analysis (Berg, et al. and Walker). | Thematic analysis | Parental decision-making processes were dynamic and dependent on many changing factors. At each decision point, parents made a risk-benefit analysis to guide their decision. Decision outcomes were consolidated. | 5 |
| McCormick et al. (1997) [72], USA | Parents of children < 5 years from a range of ethnicities and residential locations | 69 | Twelve focus groups facilitated by a moderator using a question guide in English and Spanish.  Discussions explored parental knowledge, attitudes, beliefs and behaviour related to childhood immunisations. | Unclear | Deductive and Inductive themes included in codes and analysed using Ethnographic software | Parents indicated that time off work, access to well-child clinics, lack of schedule knowledge and cost were all barriers to child immunisation uptake. | 10 |
| Miller et al. (2008) [55], Canada | Mothers of children < 2 years with varying immunisation statuses | 11 | Semi structured interviews of 1 hour using an interview guide. Interviews explored what information contributed to parental decisions, what types of information were needed, which sources were helpful trusted and parental recommendations for improvements in how information could be conveyed. | Unclear | Content analysis; descriptive themes and concepts | 5 main themes were identified:  1) Factors influencing decision-making. A variety of sources is necessary 2) Concerns surrounding decision. Pressure to make the 'right' decision and have its outcome respected 3) Perception of 'good' information. Unbiased, understandable, official but easy to relate to 4) Information needs. Varied presentation, quantity needed individualised, pre-natal timing, cover concerns 5Recommendations. Need for open environment for discussion to meet individual needs. | 8 |
| New and Senior (1991) [56], UK | Mothers of children with varying immunisation statuses | 253 | Questionnaire. Open-ended questions included as part of broader questionnaire completed regarding vaccine attendance, reasons for non-attendance if applicable, the type of advice received by parents and their knowledge and attitudes towards immunisation. | Unclear | Unclear | Barriers related to transport and time constraints did not differentiate between immunisers and non-immunisers. Groups were distinguished by their different beliefs, attitudes and experiences surrounding infant immunisation. | 7 |
| Niederhauser & Markowitz (2007) [57], USA islands | Parents whose children were not immunised at 2 years | 64 | 13 Focus groups of 1-8 parents lasting approximately 1 hour. Twelve open-ended questions were asked in the same order in each group. The report refers to 2 questions: "Tell me about why parents cannot come to get their shots" and "tell me about what gets in the way of parents getting their children their shots on time according to the recommended schedule." | Content analysis according to Krippendorff's guidelines | Content analysis; open coding, collapsed categories to reveal emergent themes | 5 core barriers emerged: 1) Parental issues related to decision-making, schedule awareness, beliefs and fears 2) Organisational issues related to access, clinic policy 3) Transportation issues related to clinic access 4) Financial issues relating to cost of immunisation 5) Child issues related to additional children in the family, child illness | 10 |
| Raithatha et al. (2003) [58], UK | Parents who had immunised their children | 15 | In-depth interviews. Researchers asked parents about their perception of vaccine risks. | Interpretive phenomenological analysis | ‘Coding down' from interview questions and 'coding up' from the data to develop over-arching framework; data triangulation; respondent validation | 4 over-arching frameworks were identified: 1) Perception of vaccine risk 2) Attitude to immunisation process 3) Lack of trust 4) Consequences of decision | 5 |
| Sporton & Francis (2001) [59], UK | Parents of unimmunised children aged between 18 months and 20 years | 13 | Semi-structured interviews completed with the parent who felt most strongly about immunisation at home or at work. | Unclear | Thematic analysis; sample of transcripts coded and discussed with 2nd researcher | For non-immunising parents, the risk of immunisation side effects outweighed that of the disease. Parent’s described 3 responses to decision-making; a routine response, an emotional response and a delayed response. Parents reflected on their decision, recognising the consequences of their decision. Parents did not see health professionals as providing a balanced source of information about immunisation | 6 |
| Tarrant & Gregory (2001) [60], Canada | Mothers of young children | 28 | Person-centred, semi-structured interviews with mothers. Interviews were facilitated by a topic guide, asking questions about their views on child health, immunisation, the advantages and disadvantages of vaccination and stories about immunisation from other community members | Unclear | Content analysis | 4 key themes were identified:  1) Knowledge barriers. Lack of knowledge of immunisations and diseases protected against  2) Influence of others. Negative accounts from peers impact on uptake 3) Vaccine barriers. Procedural consequences e.g. side effects, pain etc. impact on uptake 4) Missed opportunities. Children not vaccinated when they presented at clinic/ delayed due to illness | 5 |
| Tarrant & Gregory (2003) [61], Canada | Parents with ≥1 child <5 years | 28 mothers | Semi-structured interviews were conducted with mothers at a location convenient to them Interviews were facilitated using a guide. Questions referred to perceptions about immunisations, its pros and cons, vaccine-preventable diseases, community stories etc. | Unclear | Content analysis | 6 key themes were identified: 1) The fear of disease. Motivating factor for uptake  2) Efficacy of immunisations. Mixed views on whether vaccines prevented or caused illness 3) The immunisation experience. Not enjoyable, particularly if other children present 4) Consequences of immunisation. Side-effects and community stories reinforcing negative consequences 5) Interactions with health professionals. Useful information sources  6) Barriers to immunisation. Time constraints; child illness | 9 |
| Tarrant & Thomson (2008) [62], China | Parents with at ≥1 child between 6 months to 3 years | 15 parents  (1 father) | In-depth interviews conducted with parents at a time and location convenient to them. An interview guide developed within the context of the Health Belief Model guided interviews. 6 interviews were conducted in Cantonese using a translator, 5 in English with a translator where necessary and 4 in English without a translator. | Content analysis according to Morse and Field (1995) | Content analysis; descriptive themes; secondary review of themes for validation | 3 levels of influence on immunisation uptake were identified (3 themes): 1) Individual factors. Low level of knowledge; vaccines provide protection from disease; risk benefit analysis 2) Family and social factors. Parental responsibility; little advice from peers; overcrowding increases vulnerability, herd immunity 3) System factors. Public health programs; trust in medicine and government; mandatory vaccination; barriers | 7 |
| Tickner et al. (2007) [63], UK | Diverse range of parents with a range of immunisation beliefs whose children were due to receive the first 5-in-1 vaccine | 22 parents  (1 father) | Semi-structured interview conducted with 1 parent at home at a time convenient to them. Interviews were facilitated by a flexible schedule that comprised questions covering the diseases in the 5-in-1, parental understanding of how vaccines work, sources of information, views about the schedule and factors that contributed to decision-making. | Modified Grounded theory approach due to the researcher's familiarity with the surrounding literature | Line-by-line coding; constant comparative method; theme identification (sub-set independently coded). | Whilst parents had concerns about immunisations, the majority of the m complied with the schedule rather than making an informed decision. Other themes related to the perceived importance of immunisations, beliefs about how immunisations work, trust, perceptions of vulnerability; feelings of guilt and responsibility and procedural practicalities. | 8 |
| Tickner et al. (2010) [64], UK | Parents of children aged 2-5 years | 19 mothers (2 partners contributed to their partners interview) | Semi-structured interviews conducted at the parents' homes.  Interviews were facilitated by an open-ended interview schedule which covered topics such as knowledge of the MMR and DTaP/IPV, risks and benefits, information sources, factors facilitating or preventing attendance. Later interviews were altered to include questions to clarify themes. | Modified Grounded theory approach due to the researcher's familiarity with the surrounding literature | Line-by-line coding; axial coding for sub-categories; theoretical coding for relationships between categories; memo-writing; validation by independent review of a sub-set of transcripts by 2 authors | Whilst most parents understood the importance of pre-school immunisations and intended to immunise their children, some parents questioned whether additional protection was necessary following the primary course of injections. Parents’ comments that they received little information compared to the primary injections and that further barriers to immunisation included minor childhood illnesses, parental apprehension and work commitments. | 7 |
| Tomlinson & Redwood (2013) [73], UK | Mothers born in Somalia but resident in the UK with at least 1 child < 5 years-old | 23 mothers | Semi-structured interviews conducted at community centres and lasting between 20-30 minutes.  Interviews were conducted in English with lay interpreters provided where necessary. Interviews were facilitated by an interview topic guide which covered topics related to mothers' understanding, beliefs about preschool immunisation and its safety as well as personal practices. | Thematic analysis (Braun & Clarke, 2006) | Thematic analysis | Although parental attitudes were generally positive, parents were concerned about the link between MMR and Autism. Societal interpretations of Islam, personal experience of vaccination and perceptions of their child’s vulnerability to disease influenced parents’ attitudes. | 9 |
| Topuzoglu et al. (2007) [74], Turkey | Mothers who had children < 5 years-old living in a slum area of Istanbul | 70 mothers | 8 focus groups consisting of 8-12 mothers and lasting between ~ 40-80 minutes. A topic guide that explored parental attitudes to immunisation, the decision-making process and barriers and facilitators of immunisation was used to structure interviews. | Unclear | Thematic analysis. Key themes identified from interview transcripts to develop a coding frame for use with subsequent transcripts. | Whilst mothers understood the importance of vaccination, their sub-ordinate role in Turkish society made accessing clinics difficult. Mothers relied on social networks to gain access to immunisation services. Access was also prevented by financial constraints and the inability to access services independently. Uptake was further prevented by poor communication between medical professionals and mothers. | 8 |
| Watson et al. (2007) [65], New Zealand | Caregivers with ≥1 child between 6 weeks and 15 years who had decided whether or not to immunise their child against MeNZB. | 21 parents  (2 both parents, 1 father) | Semi-structured interviews conducted at parents' convenience and lasting between 45-60 minutes.  Interviews focussed on parents' descriptions of their decision-making process. | Unclear | Thematic analysis using methods of constant comparison. | Parents were influenced by similar factors despite differences in decision outcomes. Most parents felt a gut reaction regarding their decision outcome regarding Men B. A trigger from a source within the community or media generated this reaction. Parents then sought information from a variety of sources before conducting a risk/ benefit analysis, which shaped their decision outcome. Following this, many parents felt a degree of uncertainty about their decision. | 9 |
| White & Thomson (1995) [75], New Zealand | Parents attending local childcare or child health sessions with ≥1 pre-school child. | 67  (3 fathers) | 7 focus groups and 21 individual interviews. Discussions were based around a standard question set that asked parents about their knowledge and concerns about childhood diseases and their associated immunisations. | Unclear | Thematic analysis | Themes were divided into 4 categories:  1) Knowledge and experience. Parents were unfamiliar with common diseases and their associated vaccines. 2) How immunisations work. Majority of parents mentioned protection but most were unaware of mechanisms. Some were concerned about side-effects and overloading the immune system. 3) Concerns. Parents had mixed emotions about injections, 1st time parents were especially anxious, parents felt a responsibility to remember the schedule and for any side-effects.  4) Service Delivery. Mostly positive but issues raised over lack of information, the pressure to immunise and schedule awareness. Parents were grateful for reminders. | 6 |
| Wilson (2000) [66], USA | Parents who had chosen not to immunise at least one of their children | 12 mothers | Semi-structured interviews focussing on mothers' feelings and experiences getting their child(ren) vaccinated. | Grounded theory (Strauss, 1987) | Constant comparative method; independent coding discussed with principal investigator to define themes. | 4 key themes were identified:  1) Although parents saw immunisation as a benefit, many had misconceptions about immunisation 2) Past experiences of adverse reactions to immunisation acted as a barrier to uptake 3) Competing tasks acted as a barrier to uptake 4) Transportation difficulties acted as a barrier to uptake | 9 |

*Note.* DTP = DTaP/IPV = Diphtheria, Tetanus, acellular Pertussis, Polio; MenC = Meningitis C; MMR = Measles, Mumps and Rubella; ASD = Autism Spectrum Disorder.

3.3. Theme development

Parents described a range of themes related to early childhood vaccination uptake. Themes related to influences on decision outcomes and appointment attendance. Eighty-eight initial codes generated from line-by-line coding were organised into nine descriptive themes relating to: (a) the process of decision-making, (b) influences on decision-making and (c) influences on appointment attendance. To illustrate the descriptions that follow, representative quotations from participants and study texts are provided in Table 3.2.

3.3.1. The process of decision-making

When making vaccine decisions, all parents performed a risk-benefit analysis that influenced decision outcomes [38, 40, 43, 44, 47-50, 53, 54, 56, 59, 62, 63, 65-70, 72, 73]. The conflict between perceived risks associated with diseases and immunisations (e.g. creating illness by overloading the immune system) were weighed up against the perceived protective benefits of vaccination [38, 40, 43, 49, 56, 58, 59, 62, 65, 73]. Many immunisers sought protection from the risk posed by unfamiliar disease [49, 62, 65]. However, many non-immunisers believed common diseases were natural and their infection was beyond parental control [38, 56, 59]. Consequently, they were not prepared to commit the potentially harmful act of vaccination (omission bias) [38, 56, 59, 69] that many associated with permanent side-effects (e.g. brain damage) [26, 40, 42, 44, 57-59, 73].

3.3.2. Influences on decision-making

3.3.2.1. Decisional control

For those residing in countries where immunisation was not compulsory, most parents were aware of their legal right to decide whether or not to immunise their child(ren) [40, 41, 43, 45, 46, 48, 49, 54, 59, 63-66, 68, 69, 73, 74]. Many felt a responsibility to make the ‘correct’ choice for their child(ren) [40-43, 47, 54-56, 58-60, 62-64, 67-69, 71-73, 75] and reported that they would feel guilty should their child experience any negative consequences as a result of their decision [38, 45, 47, 63, 73]. However, some parents believed that they had a diminished responsibility: immunisers because they could share the responsibility with medical professionals [42, 45], and non-immunisers because the contraction of disease was beyond their control [59, 73].

The degree to which parents felt in control of their decision influenced their emotional response to its outcome. Parents who reported feeling in control of their decision expressed confidence about its outcome: immunisers because they believed they had secured protection for their child [44, 46, 65], and non-immunisers because they perceived they had not put their child at risk of vaccination harm, and/or because they felt suitable care for vaccine-preventable diseases was available [59]. Conversely, other parents felt uncertain, in many cases due to a perceived lack of decisional control [45, 54, 55, 65, 68, 69]. In particular, many first-time parents felt overwhelmed by the demands of new parenthood and thus unable to complete a satisfactory risk-benefit analysis. Anxious to make the ‘right’ decision, these parents followed medical advice for primary vaccinations before reassessing their decision for pre-school vaccinations [40, 54, 59, 63, 64, 66].

Parents also evaluated others’ decisions. For example, some immunisers felt non-immunisers put their own fears about vaccination before their child’s health [38, 45, 46, 63, 68]; whereas some non-immunisers felt immunisers renege on their duty to protect their child by taking the ‘easy’ vaccination option [45].

3.3.2.2. Interpretation of information

Most parents reported using a variety of information sources [38, 44-50, 54, 55, 59, 63-65, 68-70, 72-74]. The extent to which parents felt they trusted the source and quality of information influenced decision outcomes [40-42, 44-46, 50, 55-57, 59, 63, 65, 73]. Information judged to be of ‘poor’ quality was seen as a barrier to effective decision-making and prohibitive of informed choice. Parental evaluations about information quality were influenced by views about the time at which information was received and the nature of its content. Many parents felt vaccine information was poorly timed [42, 43, 45, 46, 50, 55, 62-64, 68] and overwhelming [41, 45, 49, 50, 55, 62, 73]. For primary immunisations (typically administered between 2 to 4 months), some parents felt that receiving information during pregnancy would facilitate informed decision-making [42, 55, 62]. However, parents from all groups expressed frustration at the extent to which medical information was biased towards the benefits of vaccination and omitted details about vaccine risks [38, 40, 41, 44, 45, 48-51, 55, 59, 63, 65, 68, 69]. Some immunisers felt this bias prevented informed choice [38, 40, 44, 45, 49, 55, 63, 68], whilst others were concerned that acknowledging these risks might lead to further non-compliance [49, 51]. For example, many non-immunisers valued information from medical professionals that had spoken out against vaccination. These individuals (including Andrew Wakefield) were seen as important whistle-blowers of deliberately withheld information about vaccine risks [43, 51]. Correspondingly, some parents felt that standard medical advice could be improved by the inclusion of more scientific evidence [40, 42, 45, 47, 49, 51, 59, 65, 68]. However, they noted that such information would need to be communicated in a more accessible manner to facilitate its evaluation and contribution to risk-benefit analyses [41, 44, 55, 68].

The majority of immunising parents trusted medical professionals and followed their advice [38, 40-48, 50, 51, 55, 56, 58, 60-65, 68, 69, 72, 73]. In comparison, many non-immunisers were influenced by the advice from a practitioner in alternative medicine or homeopathy who was perceived as more informed than their medical counterparts [38, 42, 45-47, 49, 50, 55, 57, 59-61, 63]. For many parents, medical information was often viewed in contradiction to previous experiences and anecdotal evidence from peers about adverse reactions, and rates of vaccine-preventable disease in the community (e.g. chickenpox) [26, 38, 41, 42, 44-51, 55, 56, 58-64, 68, 72, 73]. This perceived disparity reduced parental trust in the medical profession. In addition, mistrust was highly influential for some non-immunisers because of beliefs about financial incentives offered to GPs who reach uptake targets [45, 49-51, 53, 56, 58, 59, 62, 63, 68] and the Industry’s perceived use of fear-based marketing strategies [45, 47, 48, 68]. Some vaccine-hesitant parents reported their mistrust had been overcome by openly discussing vaccine concerns with their GP. Studies that included parents who experienced this level of interaction found it had positively influenced their vaccine beliefs, perceived levels of decisional control and appointment attendance [38, 40, 42-44, 47, 49, 55, 68, 73].

3.3.2.3. Vaccine efficacy

Whilst the majority of parents recognised that vaccines provided protection from disease [38, 40-44, 48, 49, 53, 56, 58, 60-64, 66, 67, 72, 74], many were reported to have limited knowledge [45, 60, 61, 63, 64, 66, 72, 74] and diverse views about the severity of vaccine-preventable diseases. Most immunising parents feared the unknown threat from disease, and sought the necessary protection [38, 43-45, 47-50]. Both immunisers and non-immunisers were aware of individual children who had caught diseases (e.g. measles and chickenpox) after immunisation and so questioned the reported severity of such diseases [26, 42-44, 56, 59, 68] and the efficacy of their associated vaccinations [43-45, 52, 60-65, 68, 70, 73]. For some parents, this observation prevented initial uptake or resulted in partial immunisation against only the most ‘threatening’ illnesses (e.g. meningitis) [44, 46, 50].

Parents in all groups recognised the importance of herd immunity but had different views about their responsibility to maintain it. Some immunisers believed they had a social contract to immunise their child to ensure the protection of others [38, 40, 42, 43, 45-47, 57, 58, 62-64], whilst for others maintaining herd immunity was simply a by-product of their decision to protect *their* child [47, 63, 68]. Within non-immunisers, some relied on herd immunity to protect their own child (known as free-riding) [42, 64], other parents attempted to contribute to herd immunity through alternative methods of protection such as low-level exposure to pathogens [26, 43, 45, 53, 66, 68], natural or homeopathic remedies [26, 45, 63, 65] and/or breast milk [63, 65, 68]. Few did not consider the consequences of their decision on the community [43].

3.3.2.4. Vaccine safety

Parents had different views about vaccine safety. These views were strongly related to the trust placed in information sources. Consequently, many immunisers believed that vaccines were safe [49, 62-64], whereas many non-immunisers were concerned about the perceived toxicity of vaccine ingredients [44, 45, 57, 65, 68, 73]. Concerns about vaccine safety resulted in the partial immunisation of some children [53, 56]. In these cases, parents chose not to immunise their children with ‘unsafe’ vaccines or, particularly in the case of MMR, opted for single vaccinations [26, 45, 49, 62, 63, 68]. However, only a minority of parents voiced concerns about other multiple antigens (e.g. the 5 in 1 vaccine; DTaP/IPV/Hib) [47, 64]; most recognised their benefits in terms of the reduction of painful injections and clinic visits needed to ensure protection [63, 64].

Independent of vaccine safety, most parents commented on the side effects of vaccination. Most immunising parents received medical advice about short-term side effects. Viewed as minor in comparison to the diseases vaccinated against, they did not influence decision-making [38, 40, 43, 45, 60-62, 67, 70, 75]. Opinions about long-term side-effects however, strongly influenced decision outcomes [43, 45, 47, 53, 56, 59-61, 65, 67, 68, 73]. These views were shaped by perceptions of their child’s vulnerability and the impact vaccination would have on the child’s immune system. A proportion of parents in each group were concerned that the large number of vaccines recommended would overload or cause permanent damage to their child’s vulnerable immune system [26, 38, 43-45, 47, 53, 55, 57, 58, 63, 67, 68, 73]. However, some immunising parents were encouraged to vaccinate *because* of this vulnerability [62-64, 73]. Beliefs regarding the increased risk of permanent side-effects of vaccination [26, 42-44, 49, 52, 56, 58, 59, 68, 73] such as asthma, brain damage and, especially Autism Spectrum Disorder (ASD) in light of the MMR controversy [26, 42, 45, 47, 49, 51, 53, 62, 68], complicated the decision-making process for all parents. The fear associated with these side-effects was cited as the primary reason for non-vaccination in many cases.

3.3.2.5. Societal pressure

Many parents experienced pressure to make a particular immunisation decision from their society and/or culture [38, 41, 42, 46, 49, 52, 55, 57-59, 62, 63, 73-75]. Most parents were aware of the social norm surrounding vaccination. For immunisers, these norms were generally accepted and related to the view that immunisation was the act of a ‘good’ parent [38, 41, 42, 45, 46, 49, 59, 62-64, 73]. However, others felt pressured to immunise from healthcare professionals [42, 43, 45, 51, 68] and/or to avoid negative judgement from other parents [63, 65, 73]. The perceived disparity between these pressures and notions of decisional choice facilitated non-compliance in some non-immunisers.

Religious doctrines had a varying influence on uptake. Some non-immunising parents citied the prohibition of certain (particularly pork-based) vaccine ingredients and believed their God would protect children from harm [57, 59, 66, 73], whilst others vaccinated because they believed that their Scripture encouraged the protection of family and health [73].

3.3.3. Influences on appointment attendance

3.3.3.1. Access

Many parents that intended to immunise cited difficulties accessing clinics [43, 44, 56, 57, 66, 67, 71, 72, 74]. Parents reported that access was prevented by transport difficulties [56, 57, 66, 72, 74], having additional children [56, 66] and/or work commitments [56, 57, 59, 61-64, 66, 72, 74]. Unseen costs associated with these factors compounded non-attendance in a few parents [72]. For example, some parents who had returned to work found it difficult to leave during the day and wanted to save their annual leave for when their child was unwell. In light of these barriers, many parents stated that extending clinic hours into evenings and weekends, in addition to home vaccination would facilitate uptake [56, 72]. For other working parents, service dissatisfaction lessened the likelihood of attendance as long waiting times from late running clinics increased the amount of time off work [56, 57, 60-62, 64, 66, 72].

Children being ill around the time of vaccination resulted in partial uptake and acted as a barrier to complete immunisation for some [26, 43, 54, 56, 57, 61, 63-65, 74]. Being declined vaccination for this reason contributed to additional service dissatisfaction and inhibited future attendance in a few parents [66, 72].

3.3.3.2. The vaccine schedule

Many parents were reported to have little knowledge about the vaccine schedule [43, 63, 64, 66, 71-75], when vaccines were due [43, 57, 72] or why adherence was important [53, 57]. As a result, some parents forgot to schedule appointments [43, 54, 57]. Parents reported that the tendency to miss appointments increased as parents returned to work and children became older [54]. Most parents stated that reminder letters were a welcome prompt to attend appointments [54, 62-66, 75]. However, others had negative views, stating that letters placed undue pressure on parents to vaccinate [48, 73]. Some found the content patronising and felt prescribed appointments removed parental choice; these parents wanted respect from the medical profession to schedule their own appointment depending on the outcome of their informed choice [45, 63, 64].

3.3.3.3. Pain

The majority of parents felt their child would experience pain as a result of the immunisation [40, 57, 70, 71, 75]. Many parents, but especially those who believed their children were vulnerable, reported feelings of guilt and responsibility about the pain caused [40, 63], leading to anxiety about the procedure [40, 60, 63, 64]. Many parents were unsure of what to expect from the procedure and were concerned about their child’s ability to communicate pain, particularly during first immunisations [63, 75]. For others, this concern was greater for pre-school children who had a greater awareness of the procedure and might blame their parents for the pain caused by the injections [63, 64]. For some of these parents, procedural anxiety outweighed the risk of disease and resulted in partial immunisation [66].

Table 3.2. Illustrative quotes to depict themes established from included studies. Participant quotes are indicated in *italics*.

| **Theme** | **Included studies** | **Illustrative text** |
| --- | --- | --- |
| **The process of decision-making** | | |
| Risk-benefit analysis | [38, 40, 43, 44, 47-50, 52-56, 59, 62, 63, 65-70, 72, 73] | Participants’ decision to immunise their children was often the result of weighing the beneﬁts against the risks [62]  *If its going to happen [vaccine damage] it will do-not that I want it to happen, but I think its better they’re protected against* (Immuniser)[56]  They did note that there can be beneﬁts to vaccines, but for now, they felt the risks outweighed those beneﬁts [50] |
| Conflict between preventing and creating illness | [38, 40, 43, 49, 56, 58, 59, 62, 65, 73] | *Not that you’re actually preventing your child from being really ill, you actually think what could happen by giving them the immunisation in the first place, so you don’t actually think I’m doing some good here by stopping him getting ill, you’re thinking, oh no, I could be making him really ill* (Immuniser) [40]  To be healthy, prevention of serious disease was desirable but while vaccination prevents serious disease, it was also associated with the belief that it weakened the immune system. These representations or models caused these mothers to perceive a conflict in their decisions and in their actions to protect their children, especially in terms of susceptibility to disease and vaccine side effects. [43] |
| Omission bias | [38, 56, 59, 69] | *If anything happened as a result of vaccination, I would always blame myself* (Non-immuniser) [56]  *That’s a real fear that I’ve lived with in making this decision. Oh my gosh, if she contracts something, then it’s my fault for not vaccinating her* (Non-immuniser)[69] |
| **Influences on decision-making** | | |
| Decisional control | [40, 41, 44, 46, 48, 49, 54, 59, 61, 63-66, 68, 69, 73, 74] | *As long as it’s going to be one of those hot topics that’s out there, there’s going to be huge differing opinions. I mean, it’s—every person should just be educated on both sides, to make their own decision* [69]  Parents themselves reported that they found it hard to balance the concept of free choice with what was perceived as the health system’s or the public health nurse’s ‘strong voice’ about what was the right choice to make [41]  *It’s a nerve-wracking decision all round, just making the decision about vaccination and I did at times feel like you’re damned if you do and damned if you don’t with this* (Non-immuniser)[65]  *‘Cos I was a ﬁrst-time mother, it was different...I think I just kind of believed what the health professionals were doing...* [64] |
| Responsibility for decision outcome | [38, 40-43, 46, 47, 54-56, 58-60, 62-64, 68, 69, 71-73, 75] | Across decision groups, parents expected and feared guilt if their chosen course of action resulted in a negative outcome for their child [45]  *I’m not fully happy with not immunizing, because I would hate my children to get an awful disease, on the other hand, I think for me, it’s the lesser of two evils* (Immuniser) [59]  *Who do you love more than your children? You want to know am I putting him at unnecessary risk? So that’s the other thing that makes it hard, is that you’re not just deciding it for yourself, you’re deciding it, with your best intentions for somebody else* (immuniser) [47]  *He’s too young to make that decision. So when it comes to injections. When he’s older then that’s different. But when he’s young and he’s my responsibility* (Immuniser) [45]  The anticipation of regret at their unvaccinated child acquiring a vaccine-preventable disease arose repeatedly [38]  Other parents were judged also on whether they had taken responsibility for their child’s wellbeing, or absolved themselves of it [45] |
| Quality of information | [38, 40-45, 47-51, 55-59, 62-66, 68-75] | *I want someone to look at him as an individual and I don’t feel that they are the medical community....I don’t want people making the decisions for me....I want that information available so that I can make an informed choice* (Non- immuniser)[44]  *I can’t believe that in this day and age they can’t get the information across to the parents* (Immuniser) [68]  *You know…nobody really explains anything easily, you know? ...all these big words…* [55]  *But all the information is pro-vaccination and it doesn‘t tell you everything. It doesn’t tell you about the side effects* (Partial immuniser)[43]  *They [the government] are making decisions for what they see as society as a whole and we’re making decisions for our individual children so we are polarised to start with* (Non-immuniser)[68]  *My experience is that they give you the [information] papers when they want you to get the shot. So, here’s a stack of ten papers, but here’s the nurse standing there with the needle* (Immuniser) [50]  Some felt that the quantity of information available surrounding their child’s health made it difficult to isolate, and assess the quality and relevance of, MMR-speciﬁc information [49]  *I guess statistics would be what I would be looking for…how many years have they been giving this and the kids that have been followed along and they had no problems….* [55] |
| Trusted sources of information | [26, 38, 40-51, 55-66, 68, 69, 72-74] | *I think it is all in being told from someone that you trust then you are much better off in giving your child the vaccine* (Incomplete immuniser) [43]  There was confusion about why information given by public health nurses did not reﬂect the reality they experienced through media reports or stories from family and friends, most importantly when it came to harms associated with vaccination [41]  *I don’t know enough about how [vaccines] are put together and tested to have a conﬁdence level about that. But that’s where the doctors come and you have to trust them* [42]  For non-vaccinators, the preferred, trusted sources of information were the homeopath or naturopath [42]  Parents empathised with and trusted other parents, who were seen to offer honest and unbiased advice unavailable from official sources [49]  *I just don't think enough research has been done really, one way or the other, to say whether it is completely safe* [51]  *[If] she happened to get measles, well I’m not that worried...because I had it and it was fine* (Immuniser) [44] |
| Protection from disease | [26, 38, 40-44, 46-50, 52, 53, 55-57, 59-64, 66-70, 72-75] | In general, parents exhibited no understanding of the nature of the diseases immunizations protect against [72]  *I think the world of her and I thought if [I] can prevent her getting any of these diseases I will* (Complete immuniser) [44]  Moreover, non-vaccinators expressed a belief that vaccine-preventable diseases are non-existent, are not serious, and are easily treatable [42]  *Even if they are immunized, there are some that catch it. Like they’re asking why their children get whooping cough even though they had been immunized for it* [61]  *If it’s a disease like measles, mumps, chicken pox, things like that you can let them get through fine, then if you got into meningitis, polio, well yeah, you’d have to think again* (Immuniser) [44]  *Protecting the child, but protecting all the other children as well. Yeah I think that’s a good beneﬁt to have* [63] |
| Vaccine safety | [26, 38, 40, 41, 43, 44, 47-51, 53-68, 70, 71, 73-75] | Both pro- and anti- immunisers were concerned about vaccines overloading even healthy but immature immune systems [43]  [The] age of the child and the state of the child’s health influenced mothers’ perceptions of susceptibility to severe complications of disease and influenced their consequent decisions about immunisation [43]  *The worry is putting all three in at one time, into that wee body. Individual ones for me is the way, it makes sense to not bombard it with too much chemicals all at one go* (Partial immuniser) [26]  *The vulnerable children are the ones who don’t have good diet or who are from, you know, poorer backgrounds and who obviously are more open to infection in the first place if there are epidemics* (Non-immuniser)[68]  Parents who chose not to vaccinate believed there were other protective measures and perceived their child to be less susceptible [65]  Non-immunisers perceived vaccines to be ineffective in preventing disease and actively harmful [43]  The risk of side effects was discussed in terms of long-term effects, short-term effects and ‘vulnerable’ children for whom there was an increased risk [59]  Most participants perceived that their children experienced only mild side effects and they were not alarmed when they occurred [62]  Inhibitors for non-vaccinators also included fears about permanent adverse effects, such as autism, sudden infant death syndrome, AIDS, and other immune diseases [42] |
| Societal demands | [38, 41, 42, 46, 49, 51, 55, 57-59, 62-64, 66, 73-75] | *You just do it. We didn’t think much about it. We talked a little about it at home, but there is a reason why it’s recommended* (Immuniser) [41]  It was a good parent’s obligation to ensure that his or her children were fully vaccinated and thus protected from disease [62]  However, whilst some parents were happy to comply with the recommended programme rather than researching their decision, others felt pressured into having the ﬁve-in-one [63]  *God created the immune system, not vaccinations* (N on-immuniser) [66] |
| **Influences on appointment attendance** | | |
| Access issues | [26, 43, 44, 54, 56, 57, 59-64, 66, 67, 70-72, 74] | Most comments centred on difficulties associated with actual physical access [56]  *She never seems well enough to go . . . I also had other children at home to look after* [56]  *I love the fact that they do have after-hour care for emergencies but I wish they would have it [well-baby check-ups] in the after hours. That would be a lot more convenient* [72]  *Not only do I miss a day to take [my child] in for shots, but I may have to take another day off if he gets sick*  [74] |
| Schedule awareness | [43, 48, 52-54, 57, 62-66, 71-75] | Likewise, some parents were suspicious about the immunization recommendations and did not understand why immunizations were given on a standardized time schedule [53]  Participants frequently discussed that parents may forget about the need to bring their children in for immunizations [57]  *As long as they send me reminders, I take my child in. Without reminders, I don’t know when shots are due. It’s too confusing* [66]  *...if you had a letter explaining to you, and nicely, and treating you as an adult...Rather than just a little card saying, ‘Your daughter is due for X on X’...I guess that that might make you go, ‘Oh yeah’ and take a bit more interest...* [64] |
| Procedural anxiety | [38, 40, 47, 57, 61, 63, 64, 66, 70, 71, 73, 75] | Mothers stated unanimously that having their children immunized was something that they did not enjoy [61]  The trauma of the immunization process for both parent and child also came up several times in the discussion [57]  *I think I cried more than they did. I felt really guilty, not because I was having them immunised, but because of the pain they were going through. Terribly embarrassing* [40]  *I’d be more worried about her now because when she’s older she can speak and she can say if she’s hurting or something, or if she doesn’t feel well. At the moment it worries me ‘cos she can’t tell me what she can feel* [63] |

3.4. Going beyond the data: Analytical themes and recommendations for intervention

Eight analytical themes related to the barriers and facilitators of immunisation were inferred from the descriptive themes presented above. Analytical themes related to factors influencing effective decision-making and appointment attendance. Effective decision-making (i.e. risk-benefit analysis) was complicated by five factors including: (1) a loss of decisional control, (2) the lack of balanced and evidence-based information, (3) poorly timed information, (4) mistrust in the medical profession, and (5) societal pressure to make a particular decision. Following a pro-vaccination decision, parents faced three main obstacles to appointment attendance: (6) limited access to healthcare services, (7) a lack of schedule awareness, and (8) procedural anxiety.

Eight recommendations for intervention were made following the consideration of the implications of analytical themes (Table 3.3). To promote decisional control, interventions should provide parents with: (1) balanced information that addresses parental concerns about vaccine risks as well as its benefits; (2) evidence-based information communicated in an understandable manner; and (3) information in a timely manner. For primary immunisations, information may be best received during pregnancy. Trust in the medical profession may be improved by (4) the opportunity to discuss vaccine concerns with medical professionals and (5) improved medical marketing to reduce misconceptions about the financial motives behind vaccination. To improve appointment attendance, interventions should provide parents with (6) out-of-hours well-baby care; (7) reminders about when childhood immunisations are due; and (8) guidance about what to expect from the procedure.

3.5. Bringing together the results of the quantitative and qualitative reviews

The second aim of the review was to integrate the conclusions of the thematic synthesis with those of a systematic review that examined parental interventions to improve uptake [1]. Recommendations for intervention from the qualitative studies are compared with the trials included in the quantitative systematic review in Table 3.3.

Recommendations relating to vaccine discussions and appointment reminders were supported by five [79-83] and 22 trials [84-103], respectively. Results from the meta-analysis of quantitative findings suggested that these interventions were associated with significant increases in vaccine uptake. Three trials [76-78] were identified in relation to the recommendation about balanced information. This comparison was not analysed in the original meta-analysis; study numbers were too small to explore intervention efficacy.

Gaps in the evidence were apparent where current interventions did not support themes from the qualitative data. A limited number of trials were identified in relation to two recommendations: timely information [79] and out of hours well-baby-care [84]. Further evidence to demonstrate the efficacy of these interventions is therefore needed. Trials did not address three recommendations: (1) the provision of understandable evidence-based information, (2) immunisation marketing, and (3) the need for strategies to reduce procedural anxiety. These areas are thus potential targets for future intervention.

Table 3.3. Comparison of themes arising from parental viewpoints with interventions evaluated in trials

|  |  |  |
| --- | --- | --- |
|  | **Recommendations from themes** | **Coverage in trials included in review of parental interventions [1]** |
|  | ***Recommendations to overcome barriers to decision-making*** | |
| 1. | Provide parents with balanced information that addresses the risks and benefits of vaccination | 3 studies [76-78] |
| 2. | Provide parents with understandable evidence-based information | None identified |
| 3. | Provide parents with vaccine-related information in a timely manner  For primary immunisations, provide information during pregnancy | 1 study [79] |
| 4. | Provide parents with the opportunity to discuss vaccine concerns with their GP | 5 studies identified [79-83].  Overall effect associated with a significant 12% increase in uptake (*p* = .014). |
| 5. | Market immunisations in a patient-orientated manner to reduce mistrust in ‘medical motives’ | None identified |
|  | ***Recommendations to overcome barriers to appointment attendance*** | |
| 6. | Offer parents out of hours well-baby-care | 1 study [84] |
| 7. | Provide parents with reminders about which and when childhood vaccines are due | 22 studies identified [84-103].  Overall effect associated with significant increases in uptake:  postal (n = 11) = 9.9% (*p* < .001); telephone (n = 5) = 4% (*p* = .019) and postal with telephone follow up (n = 3) = 14.7% (*p* < .001). |
| 8. | Provide parents with guidance about typical child responses to pain and effective soothing strategies | None identified |

# 4. Discussion

4.1. Statement of findings

This is the first known study to systematically review qualitative evidence regarding parental views about early childhood immunisation, and interpret findings in terms of trials. Previous studies have focused on single issues such as the controversy over MMR vaccinations and on the perceived dichotomy between the views of immunisers and non-immunisers. Evidence from this study suggests a much more nuanced and complex picture. Findings demonstrate a variety of positive and negative beliefs, and views that had a complex range of sources and outcomes. The findings highlight the importance of recognising the influence of parental emotions on uptake decisions. Parents’ emotional responses concerning the potential harms of vaccination may override the risk-benefit analysis conducted from an objective medical standpoint. These concerns should be acknowledged by the medical community seeking to increase vaccine confidence and facilitate effective decision-making.

When making decisions about vaccine uptake, parents weighed up the perceived risks and benefits of vaccination. Although many immunisers believed vaccines were safe, parents in all groups had concerns about vaccine efficacy. For some parents, decisions were hampered by the contradiction between medical information biased towards the protection offered by vaccination and the prevalence of vaccine-preventable disease in vaccinated children. Concerns regarding the permanence of vaccine side-effects played on the minds of all parents. Following a pro-vaccination decision, parents still reported barriers to appointment attendance related to schedule confusion, family and work commitments, and anxiety related to immunisation pain. On the other hand, parents who chose not to comply, or to alter, the recommended schedulesought homeopathic vaccines or tried to improve the natural immunity of their child using other methods.

The descriptive themes that emerged from the thematic synthesis are generally consistent with those of previous reviews [7, 17, 20, 21]. However, these reviews were limited in the number of studies included, and/or the scope of vaccine perceptions examined. By including a wider range of studies and by generating analytic themes, this review provides a more in depth account of parental viewpoints that can be applied to interventions across the early childhood vaccine schedule. For example, results from this review suggest that previously reported concerns about multiple antigens are primarily associated with inclusion of measles in the 12 to 13 month MMR vaccine, as opposed to the threat to the immune system posed by all vaccines containing multiple antigens. Paradoxically, and demonstrating the emotive nature of parental decision-making, parents did not raise similar concerns about the DTaP/IPV/Hib vaccine that provides protection against five diseases and is administered to infants between 2 and 4 months-old.

4.2. Implications and future directions

Comparison of recommendations made from the qualitative literature with the interventions summarised in a recent quantitative systematic review [1] showed that interventions in-line with recommendations inferred from parental viewpoints significantly improved vaccine uptake. These interventions – notably postal followed by telephone reminders, and discussion-based vaccine education – were associated with the greatest increases in vaccine uptake. Qualitative findings highlighted the mechanism behind these interventions. In particular, parents involved in the qualitative studies who had discussed vaccine concerns with their GP reported increased trust in medical professionals and more positive vaccine beliefs after their concerns had been acknowledged. Consequentially, these interventions are recommended for use in general practice.

Several gaps in the literature were identified where trials had not investigated the efficacy of qualitative recommendations. Issues related to balanced, timely and evidence-based information as well as procedural anxiety were important factors that have yet to be subject to rigorous intervention. If shown to be effective in future trials, these interventions could be implemented into practice. The identification of additional effective interventions may be particularly beneficial in light of recent reports of a decline in vaccine confidence and consequential uptake [6].

**4.3. Strengths and limitations**

This review provides a novel and timely summary of factors that influence parental decision-making and appointment attendance in relation to early childhood vaccine uptake. Although beyond the scope of the current study, whilst the merits of synthesising qualitative evidence are increasingly recognised, there is a continuing debate about the theoretical appropriateness of synthesising qualitative research [22]. Importantly however, the methods of review adopted in the present study maintained the established standards of review for both quantitative and qualitative evidence.

In addition, the conclusions of the thematic synthesis are limited by the scope of the original studies. Firstly, many of the original studies did not define their use of the word ‘parent(s)’ suggesting that the views reported are indicative of those *shared* by co-habiting and co-parenting individuals. Studies did not address how parents outside of these circumstances made vaccination decisions or how potentially conflicting beliefs about vaccination were resolved between two parents. Future research could explore the impact of these family dynamics on vaccine uptake and decision-making. Secondly, of the 38 studies, only one [67] was conducted in a low-income country. Hence, the conclusions of the review are more suited to inform policy within high-income countries experiencing a decline in vaccine uptake. Further research into the beliefs of parents residing in low-income countries is needed. Moreover, many of the included studies only examined parental viewpoints about the first dose of a specific vaccine or set of vaccines; most vaccination schedules require several ‘booster’ injections. Longitudinal studies exploring how parental decision-making changes during the course of childhood immunisations may specify the optimum timings for intervention.

**4.2. Conclusions**

This review provides further insight into the efficacy of current interventions. Parents may welcome reminder interventions to compensate for their lack of vaccine schedule awareness. The benefits of discussing vaccine concerns with a GP were also highlighted as a mechanism by which mistrust in the medical community can be decreased. The continued or renewed use of these strategies is recommended. Integrating the conclusions from the qualitative and quantitative reviews highlighted avenues for future intervention. In particular, interventions offering balanced, timely and evidence-based information may be especially useful and readily integrated into practice. Whilst future research is needed to evaluate these factors, such interventions may offer parents sufficient information to restore confidence in vaccine efficacy and promote uptake at a time when, for some, it is dwindling.

References

[1] Harvey H, Reissland N, Mason J. Parental reminder, recall and educational interventions to improve early childhood immunisation uptake: A systematic review and meta-analysis. Vaccine. 2015;33:2862–2880.

[2] Plotkin SL, Plotkin SA. A Short History of Vaccination. In: Plotkin SA, Orenstein WA, Offit PA, editors. *Vaccines*. Philadelphia: Sanders, Elsevier; 2008. p. 1-14.

[3] Maurice JM, Davey S. State of the World's Vaccines and Immunization. Geneva: World Health Organization; 2009

[4] Sadaf A, Richards JL, Glanz J, Salmon DA, Omer SB. A systematic review of interventions for reducing parental vaccine refusal and vaccine hesitancy. Vaccine. 2013;31:4293-304.

[5] World Health Organization. Global Measles and Rubella strategic plan: 2012-2020. Geneva: World Health Organization; 2012.

[6] World Health Organisation. [Internet],; WHO/Europe calls for scaled-up vaccination against measles. [cited 2015 March 25 2015]. Available from: <http://www.euro.who.int/en/media-centre/sections/press->releases/2015/whoeurope-calls-for-scaled-up-vaccination-against-measles.

[7] Mills E, Jadad AR, Ross C, Wilson K. Systematic review of qualitative studies exploring parental beliefs and attitudes toward childhood vaccination identifies common barriers to vaccination. J clinical epidemiology. 2005;58:1081-88.

[8] Kaufman, J, Synnot A, Ryan R, Hill S, Horey D, Willis N, Lin V, Robinson P. Face to face interventions for informing or educating parents about early childhood vaccination (review). Cochrane Database of Systematic Rev. 2013;5:1-69.

[9] Oyo-Ita A, Nawchukwu CE, Oringanje C, Meremikwu MM. Interventions for improving coverage of child immunization in low- and middle-income countries. Cochrane Database of Systematic Reviews. 2011;7:1-36.

[10] Glenton C, Scheel IB, Lewin S, Swingler GH. Can lay health workers increase the uptake of childhood immunisation? Systematic review and typology. Trop Med & Int Health. 2011;16:1044-53.

[11] Lewin S, Munabi‐Babigumira S, Glenton C, Daniels K, Bosch‐Capblanch X, van Wyk BE, Odgaard‐Jense J, et al. Lay health workers in primary and community health care for maternal and child health and the management of infectious diseases. Cochrane Database of Systematic Reviews. 2010.

[12] Vann Jacobson JC, Szilagyi P. Patient reminder and recall systems to improve immunization rates. The Cochrane Library. 2009;5:1-71.

[13] Higgins JPT, Green SE. Cochrane handbook for systematic reviews of interventions Version 5.1.0 [Updated March 2011]. The Cochrane Collaboration: 2011. Available from [www.cochrane-handbook.org](http://www.cochrane-handbook.org/).

[14] Thomas J, Harden A. Methods for the thematic synthesis of qualitative research in systematic reviews. BMC Med Res Methodol. 2008;8:45.

[15] Campbell R, Pound P, Pope C, Britten N, Pill R, Morgan M, Donovan J. Evaluating meta-ethnography: a synthesis of qualitative research on lay experiences of diabetes and diabetes care. Soc Sci Med. 2003;56:671-684.

[16] Tong A, Flemming K, McInnes E, Oliver S, Craig J.Enhancing transparency in reporting the synthesis of qualitative research: ENTREQ. BMC Med Res Methodol. 2012;12:181.

[17] Roberts KA, Dixon-Woods M, Fitzpatrick R, Abrams KR, Jones DR. Factors affecting uptake of childhood immunisation: a Bayesian synthesis of qualitative and quantitative evidence. Lancet. 2002;360:1596-1599.

[18] Thomas J, Harden A, Oakley A, Oliver S, Sutcliffe K, Rees R, Brunton G, Kavanagh J. Integrating qualitative research with trials in systematic reviews. BMJ. 2004;328:1010.

[19] Dixon-Woods M, Agarwal S, Young B, Jones D, Sutton A. Integrative approaches to qualitative and quantitative evidence. Health Development Agency: London; 2004.

[20] Nagaraj A. Does qualitative synthesis of anecdotal evidence with that from scientific research help in understanding public health issues: a review of low MMR uptake. The Eur J Public Health. 2006;16:85-88.

[21] Brown, K.F. Kroll SJ, Hudson MJ, Ramsay M, Green J, Long SJ, Vincent CA, Fraser G, Sevdalis N. Factors underlying parental decisions about combination childhood vaccinations including MMR: a systematic review. Vaccine. 2010;28:4235-4248.

[22] Dixon-Woods M, Agarwal S, Young B, Jones D, Sutton A. Synthesising qualitative and quantitative evidence: a review of possible methods. J Health Serv Res Policy. 2005;10:45-53B.

[23] Allan N, Harden J. Parental decision-making in uptake of the MMR vaccination: a systematic review of qualitative literature. J Public Health. 2014:fdu075.

[24] World Health Organisation. The World Health Report 2008 – Primary Health Care (Now More Than Ever). Geneva: World Health organisation: 2008.

[25] Harden A, Garcia J, Oliver S, Rees R, Shepherd J, Brunton G, Oakley A. Applying systematic review methods to studies of people’s views: an example from public health research. J Epidemiol Comm Health. 2004;58:794-800.

[26] Hilton S, Petticrew M and Hunt K. ‘Combined vaccines are like a sudden onslaught to the body's immune system’: Parental concerns about vaccine ‘overload’ and ‘immune-vulnerability’. Vaccine. 2006;24:4321-4327.

[27] CASP Qualitative Research Checklist. CASP: Oxford;2014.

[28] NVivo, Q. S. R (version 10). QSR International Pty Ltd; Australia; 2014.

[29] Gough D, Oliver S, Thomas J. *An introduction to systematic reviews*. London: Sage;2012.

[30] Bosu WK, Ahelegbe D, Edum-Fotwe E, Bainson KA, Turkson PK. Factors influencing attendance to immunization sessions for children in a rural district of Ghana. Acta Tropica. 1997;68:259-67.

[31] Rainey JJ, Watkins M, Ryman TK, Sandhu P, Bo A, Banerjee K. Reasons related to non-vaccination and under-vaccination of children in low and middle income countries: findings from a systematic review of the published literature, 1999-2009. Vaccine. 2011;29:8215-21.

[32] Samad L, Tate AR, Dezateux C, Peckham C, Butler N, Bedford H.Differences in risk factors for partial and no immunisation in the first year of life: Prospective cohort study. BMJ. 2006;332:1312-1313.

[33] Strobino D, Keane V, Holt E, Hughart N, Guyer B. Parental attitudes do not explain underimmunization. Pediatrics. 1996;98:1076-83.

[34] Whyte MD, Whyte J, Cormier E, Eccles DW. Factors Influencing Parental Decision Making When Parents Choose to Deviate From the Standard Pediatric Immunization Schedule. J Comm Health Nurs. 2011;28:204-214.

[35] Chantler T, Newton S, Lees A, Diggle L, Mayon-White R, Pollard AJ, Fitzpatrick R. Parental views on the introduction of an infant pneumococcal vaccine. Comm Practit. 2006;79:213-216.

[36] Gazmararian JA, Orenstein W, Prill M, Hitzhusen HB, Coleman MS, Pazol K, Oster NV. Maternal knowledge and attitudes toward influenza vaccination: a focus group study in metropolitan Atlanta. Clin Pediatr. 2010;49:1018-25.

[37] Keller T. Mexican American parent's perceptions of culturally congruent interpersonal processes of care during childhood immunization episodes- a pilot study. Online J Rural Nurs Health Care. 2008;8:33-41.

[38] Leask J, Chapman S, Hawe P, Burgess M. What maintains parental support for vaccination when challenged by anti-vaccination messages? A qualitative study. Vaccine. 2006;24:7238-45.

[39] Sampson R, Wong L, Macvicar R. Parental reasons for non-uptake of influenza vaccination in young at-risk groups: a qualitative study. Brit J Gen Pract. 2011;61: e386-91.

[40] Austin, H., Parents' perceptions of information on immunisations. J Child Health Care. 2001;5:54-59.

[41] Austvoll-Dahlgren A, Helseth S. What informs parents' decision-making about childhood vaccinations? J Adv Nurs. 2010;66:2421-2430.

[42] Benin AL, Wisler-Scher DJ, Colson E, Shapiro ED, Holmboe ES. Qualitative analysis of mothers' decision-making about vaccines for infants: the importance of trust. Pediatrics. 2006;117:1532-1541.

[43] Bond L, Nolan T, Lester R. Vaccine preventable diseases and immunisations: a qualitative study of mothers' perceptions of severity, susceptibility, benefits and barriers. Aust NZ J Publ Heal. 1998;22:441-6.

[43] Bond L, Nolan T. Making sense of perceptions of risk of diseases and vaccinations: a qualitative study combining models of health beliefs, decision-making and risk perception. BMC Pub health. 2011;11:943.

[45] Brown K, Long SJ, Ramsay M, Hudson MJ, Green J, Vincent CA, Kroll JS, Fraser G, Sevdalis N. U.K. parents' decision-making about measles-mumps-rubella (MMR) vaccine 10 years after the MMR-autism controversy: a qualitative analysis. Vaccine. 2012;30:1855-1864.

[46] Brunson EK. How parents make decisions about their children's vaccinations. Vaccine. 2013;31:5466-5470.

[47] Casiday RE. Children's health and the social theory of risk: insights from the British measles, mumps and rubella (MMR) controversy. Soc Sci Med. 2007;65: 1059-1070.

[48] Condon L. Maternal attitudes to preschool immunisations among ethnic minority groups. Health Educ J. 2002;61:180-189.

[49] Gardner B, Davies A, McAteer J, Michie S. Beliefs underlying UK parents' views towards MMR promotion interventions: a qualitative study. Psych Health Med. 2010;15:220-30.

[50] Gullion JS, Henry L, Gullion G. Deciding to opt out of childhood vaccination mandates. Pub Health Nurs. 2008;25:401-408.

[51] Hilton S, Petticrew M and Hunt K. Parents' champions vs. vested interests: who do parents believe about MMR? A qualitative study. BMC Pub Health. 2007;7:42.

[52] Hilton S, Petticrew M and Hunt K. Gaps in parental understandings and experiences of vaccine-preventable diseases: a qualitative study. Child Care Health Dev. 2007;33:170-179.

[53] Luthy KE, Beckstrand RL, Callister LC, Parental hesitation in immunizing children in Utah. Public Health Nurs. 2010;27:25-31.

[54] Marshall S, Swerissen H. A qualitative analysis of parental decision-making for childhood immunisation. Aust NZ J Pub Health. 1999;23:543-5.

[55] Miller NK, Verhoef M, Cardwell K. Rural parents' perspectives about information on child immunization. Rural Remote Health. 2008;8:863-863.

[56] New SJ, Senior ML.“I don't believe in needles”: Qualitative aspects of a study into the uptake of infant immunisation in two english health authorities. Soc Sci Med. 1991;33:509-518.

[57] Niederhauser VP, Markowitz M. Barriers to immunizations: multiethnic parents of under- and unimmunized children speak. J Am Acad Nurse Pract. 2007;19:15-23.

[58] Raithatha N, Holland R, Gerrard S, Harvey I. A qualitative investigation of vaccine risk perception amongst parents who immunize their children: a matter of public health concern. J Public Health Med. 2003;25:161-164.

[59] Sporton RK, Francis S-A. Choosing not to immunize: are parents making informed decisions? Fam Pract. 2001.18:181-188.

[60] Tarrant M, Gregory D. Mothers' perceptions of childhood immunizations in First Nations communities of the Sioux Lookout Zone. Can J Pub Health. 2001; 92: 42-45.

[61] Tarrant M, Gregory D. Exploring childhood immunization uptake with First Nations mothers in north-western Ontario, Canada. J Adv Nurs. 2003;41:63-72.

[62] Tarrant M, Thomson N. Secrets to success: a qualitative study of perceptions of childhood immunisations in a highly immunised population. J Paediatr Child H. 2008;44:541-7.

[63] Tickner S, Leman PJ, Woodcock A.‘It's just the normal thing to do’: Exploring parental decision-making about the ‘five-in-one’ vaccine. Vaccine. 2007;25:7399-7409.

[64] Tickner S, Leman PJ, Woodcock A. Parents' views about pre-school immunization: an interview study in southern England. Child: Care, Health Dev. 2010;36:190-197.

[65] Watson PB, Yarwood J, Chenery K. Meningococcal B: Tell me everything you know and everything you don't know. New Zealanders' decision-making regarding an immunisation programme. NZ Med J. 2007.

[66] Wilson T. Factors influencing the immunization status of children in a rural setting. J Paediatr Healthcare. 2000;14:117-121.

[67] Braka F, Asiimwe D, Soud F, Lewis RF, Makumbi I, Gust D. A Qualitative Analysis of Vaccine Safety Perceptions and Concerns Among Caretakers in Uganda. Mat Child Health J. 2012;16:1045-1052.

[68] Evans M, Stoddart H, Condon L, Freeman E, Grizzell M, Mullen R. Parents' perspectives on the MMR immunisation: a focus group study. Brit J Gen Pract. 2001;51:904-10.

[69] Glanz JM, Wagner NM, Narwaney KJ, Shoup JA, McClure DL, McCormick EV, Daley MF. A mixed methods study of parental vaccine decision-making and parent-provider trust. Acad Pediatr. 2013;13:481-488.

[70] Keane V, Stanton B, Horton L, Aronson R, Galbraith J, Hughart N. Perceptions of vaccine efficacy, illness, and health among inner-city parents. Clin Pediatr. 1993;32:2-7.

[71] Lannon C, Brack V, Stuart J, Caplow M, McNeill A, Bordley CW, Margolis P. What mothers say about why poor children fall behind on immunizations. A summary of focus groups in North Carolina. Arch Pediatr Adol Med. 1995;149: 1070-5.

[72] McCormick LK, Bartholomew LK, Lewis MJ, Brown MW, Hanson IC. Parental perceptions of barriers to childhood immunization: results of focus groups conducted in an urban population. Health Educ Res. 1997;12:355-62.

[73] Tomlinson N, Redwood S. Health beliefs about preschool immunisations: an exploration of the views of Somali women resident in the UK. Diversity & Equality in Health & Care. 2013;10:101-113.

[74] Topuzoglu A, Ay P, Hidiroglu S, Gurbuz Y. The barriers against childhood immunizations: a qualitative research among socio-economically disadvantaged mothers. Eur J Public Health. 2007;17:348-352.

[75] White GE, Thomson AN. "As every good mother should." Childhood immunization in New Zealand: a qualitative study. Health Soc Care Comm. 1995; 3: 73-82.

[76] Williams SE, Rothman ERL, Offit PA, Schaffner W, Sullivan M, Edwards, KM. A Randomized Trial to Increase Acceptance of Childhood Vaccines by Vaccine-Hesitant Parents: A Pilot Study. Acad Pediatr. 2013;13:475-80.

[77] Shourie S, Jackson C, Cheater FM, Bekker HL, Edlin R, Tubeuf S, Harrison W et al, A cluster randomised controlled trial of a web based decision aid to support parents' decisions about their child's Measles Mumps and Rubella (MMR) vaccination. Vaccine 2013;31:6003-10.

[78] Wroe AL, Turner N, Owens RG. Evaluation of a decision-making aid for parents regarding childhood immunizations. Health Psychol. 2005;24:539-47.

[79] Saitoh A, et al. Perinatal immunization education improves immunization rates and knowledge: A randomized controlled trial. Prev Med. 2013;56:398-405.

[80] Bolam A, Manandhar DS, Shrestha P, Ellis M, de L Costello AM. The effects of postnatal health education for mothers on infant care and family planning practices in Nepal: a randomised controlled trial. BMJ. 1998;316:805-11.

[81] Quinlivan JA Box H, Evans SF, Postnatal home visits in teenage mothers: a randomised controlled trial. Lancet. 2003;361:893-90082.

[82]Usman HR, Akhtar S, Habib F, Jehan I. Redesigned immunization card and center-based education to reduce childhood immunization dropouts in urban Pakistan: A randomized controlled trial. Vaccine 2009; 27:467-72.

[83] Usman HR, Rahbar MH, Kristensen S, Vermund SH, Kirby RS, Habib F, Chamot E. Randomized controlled trial to improve childhood immunization adherence in rural Pakistan: redesigned immunization card and maternal education. Trop Med & Int Health. 2011;16:334-42.

[84] Yokley JM Glenwick DS. Increasing The Immunization Of Preschool Children; An Evaluation Of Applied Community Interventions. J App Behav Anal. 1984;17:313-25.

[85] Abramson JS, O’Shea TM, Ratledge DL, Lawless MR, Givner LB. Development of a vaccine tracking system to improve the rate of age-appropriate primary immunization in children of lower socioeconomic status. J Pediat 1995;126:583-6.

[86] Alemi F, Alemagno SA, Goldhagen J, Ash L, Finkelstein B, Lavin A, Butts J, Ghadiri A. Computer Reminders Improve On-Time Immunization Rates. Med Care. 1996;34:OS45-51.

[87] Alto WA, Fury D, Cndo A, Doran M, Aduddell M. Improving The Immunization Coverage Of Children Less Than 7 Years Old In A Family Practice Residency. J Am Board Fam Practice. 1994;7:472-7.

[88] Atchison C, Zvoc M, Balakrishnan R. The evaluation of a standardized call/recall system for childhood immunizations in Wandsworth, England. J Comm Health. 2013;38:581-7.

[89] Bjornson GL, Scheifele DW, LaJeunesse C, Bell A. Effect of reminder notices on the timeliness of early childhood immunizations. Paediatr & Child Health. 1999;4:400-5.

[90] Campbell JR, Szilagyi PG, Rodewald LE, Doane C, Roghmann KJ. Patient-Specific Reminder Letters and Pediatric Well-Child-Care Show Rates. Clinical Pediatr. 1994;33:268-72.

[91] Dini EF, Linkins RF, Sigafoos J. The impact of computer-generated messages on childhood immunization coverage. Am J Prev Med. 2000;18:132-9.

[92] Goldstein KP, Lauderdale DS, Glushak C, Walter J, Daum RS. Immunization outreach in an inner-city housing development: reminder-recall on foot. Pediatrics.1999;104:69-75.

[93] Hicks P, Tarr GAM, Hicks XP. Reminder Cards and Immunization Rates Among Latinos and the Rural Poor in Northeast Colorado. J Am Board Fam Med. 2007. 20(6): p. 581-586.

[94] Irigoyen MM, Findley S, Earle B, Stambaugh K, Vaughn R. Impact of Appointment Reminders on Vaccination Coverage at an Urban Clinic. Pediatrics. 2000;106(S3):919-23.

[95] Irigoyen MM, Findley S, Wang D, Chen S, Chimkin F, Pena O, Mendonca E. Challenges and Successes of Immunization Registry Reminders at Inner-City Practices. Ambul Pediatr. 2006;6:100-4.

[96] LeBaron CW, Starnes DM, Rask. KJ. The impact of reminder-recall interventions on low vaccination coverage in an inner-city population. Arch Pediat Adol Med. 2004;158:255-61.

[97] Lieu TA, Black SB, Ray P, Schwalbe JA, Lewis EM, Lavetter A, Morozumi PA, Shinefiel HR. Computer-generated recall letters for underimmunized children: how cost-effective? J Pediatr Infect Disease. 1997;16:28-33.

[98] Lieu TA, Capra AM, Makol J, Black SB, Shinefield HR. Effectiveness and Cost-effectiveness of Letters, Automated Telephone Messages, or Both for Underimmunized Children in a Health Maintenance Organization. Pediatrics.1998;101:e3.

[99] Morgan MZ, Evans M. Initiatives to improve childhood immunisation uptake: a randomised controlled trial. BMJ. 1998;316:1570-71.

[100] Stehr-Green PA, Dini EF, Lindegren ML, Patriarca PA. Evaluation of telephoned computer-generated reminders to improve immunization coverage at inner-city clinics. Public Health Rep. 1993;108:426-31.

[101] Vivier PM, Alario AJ, O'Haire C, Dansereau LM, Jakum EB, Peter G. The impact of outreach efforts in reaching underimmunized children in a medicaid managed care practice. Arch Pediat Adol Med. 2000;154:1243-7.

[102] Vora S, Verber L, Potts S, Dozier T, Daum RS. Effect of a novel birth intervention and reminder-recall on on-time immunization compliance in high-risk children. Human Vaccines. 2009;5:395-402.

[103] Young SA, Halpin TJ, Johnson DA, Irvin JJ, Marks JS. Effectiveness of a mailed reminder on the immunization levels of infants at high risk of failure to complete immunizations Am J Public Health. 1980;70:422-4.

Chapter 4

Determinants of infant pain expression during immunisation: the role of the care-giver and consequences for uptake over the first year of life

Findings discussed in Chapters 2 and 3 suggested that current interventions do not address barriers to immunisation uptake associated with infant pain. Parental anxiety associated with infant pain has been associated with vaccine refusal and partial uptake. Hence, increasing parental awareness about strategies to reduce infant pain expression may contribute to increased vaccine adherence. As discussed in Chapter 1, previous research exploring the impact of care-giver behaviour on infant pain-related distress during routine immunisation has been inconclusive. Findings from larger cohort studies have questioned the deterministic role of the care-giver in infant pain expression, but findings have been conducted in a cohort where infants were vaccinated on an examination table, restricting the ability of the care-giver to interact with their infant. Better understanding of all of these issues may increase the specificity of future interventions seeking to target barriers and improve immunisation uptake. This chapter reports a prospective cohort study examining the relationship between care-giver behaviour on infant pain expression, and the impact of infant pain expression on subsequent vaccine uptake during the first year of life.

Abstract

Previous research exploring care-giver behaviours and infant pain-related distress during routine immunisation has been inconclusive. This study investigates the relationship between infant pain expression, care-giver behaviours and subsequent completion of immunisation during the first year of life. A total of 202 care-givers and their 2 month-old infants were recruited from 8 medical practices in the UK. Dyads were naturalistically observed and videotaped during the immunisation appointment. Videotapes were continuously coded for infant pain-related distress and care-giver behaviours. Findings indicated that there was, at best, a weak relationship between the majority of care-giver behaviours and infant pain expression. Only the use of a pacifier significantly reduced total infant pain expression, accounting for an 11% (95% CI: 3.25% to 18.28%) reduction during injection phases. Faster administration of injectable vaccines was associated with significantly reduced pain expression: pain expressed during injection phases increased by 7% (95% CI: 4.94% to 9.43%) for each additional second of injection. Thus, the recording of injection technique and the duration of administration is essential when conducting research into infant pain during immunisation. Neither infant pain nor care-giver characteristics predicted subsequent vaccine uptake. However, further research is needed in adequately powered studies to understand the mechanisms by which these factors moderate infant pain expression.

# 1. Introduction

Care-givers, usually mothers, play an important role in infant immunisation. Care-givers are responsible for decisions about uptake [1-3], and for assessing and managing pain-related distress in pre-verbal infants [4, 5]. In infancy, acute pain is communicated through a series of facial expressions, agitated body movements and high-pitched cry vocalisations [6-10]. Studies have reported mixed findings regarding the impact of care-giver behaviours, notably vocalisations [11-15] and proximal soothing [11, 16-20] on infant pain expression. Conversely pacifying, related to nutritive [21] and non-nutritive sucking [11, 17, 22], has been consistently associated with decreased infant pain expression.

A model of acute infant pain (The DIAPR model) [4, 23] proposes a cyclical relationship between infant and care-giver behaviours. Recent studies [17, 18] testing the model have found that care-giver behaviours accounted for little variance in infant pain regulation in comparison to levels of infant immediate distress reactivity before and after injection. However, these findings were obtained from a cohort of young infants immunised on an examination table [23]. These conditions restrict the natural style of care-giver-infant interaction and limit the extent to which care-givers could influence pain regulation. Furthermore, administering vaccines to infants laid supine has been associated with increased infant pain expression [24]. The influence of care-giver behaviour on pain regulation may therefore be best understood in acute pain procedures, like vaccination, where the infant is held by the caregiver. Previous studies have focussed on mother-infant interaction [5], neglecting the potential influence of the father; their role during immunisation remains to be examined.

The DIAPR model suggests that a range of factors can indirectly affect infant pain, mediated through the caregivers’ pain assessment and management [23]. These factors may include the psychological state of the care-giver [25-28], care-giver-infant attachment [29, 30], first-time immunisation [26], and which care-giver holds the infant during the procedure. Clinical factors associated with vaccine administration may also be important [24, 31].

Feedback loops within the DIAPR model imply that a care-giver’s pain schemas can be influenced by infant pain behaviours [23]. Pain schemas may relate to a care-giver’s vaccination beliefs, expectations before the procedure and their emotional responses to infant pain. Parental anxiety associated with infant pain [32-35] has been linked to partial uptake and/or vaccine refusal [10, 36, 37]. Thus, incongruences between infant pain expression and care-giver expectations may alter existing pain schemas, increasing procedural anxiety and the likelihood of incomplete uptake. Existing risk factors relate to poor access to healthcare, ethnicity, large family size and low educational achievement [38]. Infant pain expression may itself be an additional risk factor for incomplete uptake.

The present study has three aims: to explore (1) the relationship between care-giver behaviour and pain-related distress in 2 month-old infants held by care-givers during routine vaccination; (2) the influence of a range of care-giver attributes and clinical factors on infant pain expression, and (3) the impact of infant pain expression on vaccine uptake during the first year of life.

# 2. Method

2.1 Design

A prospective observational study was conducted in eight medical practices within County Durham, UK from November 2013 to March 2015. The study was granted ethical approval from the local National Research Ethics Service (NRES) and University ethics committees.

Care-giver infant dyads were recruited before their scheduled appointment and videotaped during the immunisation procedure. Fifteen practice nurses administered immunisations in accordance with the UK vaccination schedule. No changes were made to the vaccinations or the method of administration. Appointments were conducted with minimal interference from the primary author.

2.2 Participants

All potential participating dyads were sent written information about the study at least one week before their scheduled appointment. Dyads were eligible to participate if infants were 8 to 12 weeks-old on the day of their appointment. Infants born prematurely (< 37 weeks gestational age), at a low birth weight (< 2500g), with a congenital disorder associated with neurological impairment or those who had previous experience of painful procedures were excluded. For the purposes of the study, a care-giver was defined as the individual holding the infant during the procedure (e.g., mother, father, grandparent, aunt etc.). Dyads were excluded where care-givers had insufficient English to complete the questionnaire measures.

Upon arrival at the clinic, care-givers were given additional written information and an opportunity to ask questions before being invited to participate in the study.

2.3 Materials and measures

Two video cameras were used to capture the immunisation procedure. One camera in HD format to capture the infant’s facial expressions, and another placed on a tripod to record general infant behaviours and care-giver-infant interaction.

2.3.1. Questionnaire measures

2.3.1.1. Demographic information

Care-givers completed a background questionnaire including questions on their age, their relationship to the infant, familial characteristics, marital status, educational background as well as infant gender, birth weight, gestational age, previous pain experience and neurological conditions.

2.3.1.2. Psychological state

The Depression Anxiety and Stress Scale Short-Form (DASS-21) [39] was used to assess care-giver mental state, with minor alterations to improve readability. The DASS-21 is a 21 item self-report measure that assesses the frequency with which respondents have experienced negative emotions in the week prior to its completion. The measure consists of three sub-scales, each containing seven questions corresponding to their associated mental state. The scale has been found to be a reliable and valid measure of general psychological distress in addition to each of its respective sub-scales [40]. Although the scale assumes that sub-clinical and clinical scores lie along the same continuum, cut-offs from normal to extremely severe have been suggested [40]. Care-givers were classified as having a severe form of each emotional state if they had scores above or equal to 11 for depression, 8 for anxiety and 13 for stress (maximum = 21 for each sub-scale).

2.3.1.3. Care-giver-to-infant bonding

Care-giver-to-infant bonding was measured using either the Maternal (MPAS) [41] or Paternal Postnatal Attachment Scales (PPAS) [42]. Both scales assess the frequency with which care-givers have experienced the thoughts, feelings and behaviours associated with attachment. Each of the 19 items maps onto one of three sub-scales related to the quality of attachment, absence of hostility and pleasure in interaction. Both measures have been validated for use in the first year life. High scores indicate a high level of attachment (maximum = 95). Total scores that fall in the bottom 25th percentile have been associated with impaired attachment [42] but have yet to be validated for clinical use [43].

2.4 Procedure

Dyads were video-taped from just before the administration of the Rotarix vaccine, (an oral solution administered via syringe protecting against rotavirus), during the administration of two injected vaccinations (Pneumococcal and DTaP/IPV/Hib) and for at least 30 seconds after completion. Practice nurses administered all injected vaccines into the left or right thigh of participating infants. All infants were held by a care-giver during the procedure. Caregivers completed the questionnaires after the vaccination procedure.

2.4.1. Follow up data

After the videotaped immunisation visit, completion of the vaccine schedule was established from patient records. Data was sought for vaccinations offered to infants, as part of the UK primary vaccination schedule, at 3 to 4 months, as well as those offered at 12 to13 months. Infants were classed as incompletely immunised if they had not received the recommended immunisations within two months of the recommended age of administration.

2.5. Method of behavioural coding and analysis

2.5.1. Behavioural coding

Videos of each immunisation were coded for the presence of behaviours associated with infant pain-related distress and care-giver responsiveness using aspects of several well-validated coding schemes (Table 4.1).

2.5.1.1. Infant pain-related distress

The Modified Behavioural Pain Scale (MBPS) [7] was used to define the three broad parameters of infant pain-related distress: cry vocalisations, body movements and facial expressions. This scale has been found to be both a reliable and valid measure of infant pain expression during immunisation [44]. Codes from the movement (partial movement, rigidity, agitation and avoidance) and cry (laughing, whimper, sob, full-lunged cry) parameters were utilised in the present study.

Facial expressions were coded using the Neonatal Facial Action Coding Scheme (NFCS) [45].This measure has been widely used to examine infant facial movements in response to painful stimuli. The measure has been well-validated in infants [46, 47]. A series of 10 facial actions (brow bulge, eye squeeze, nasolabial furrow, open lips, vertical mouth stretch, horizontal mouth stretch, lip purse, taut tongue, chin quiver and tongue protrusion) associated with a ‘pain face’ were coded.

2.5.1.2. Care-giver responsiveness

The Child-Adult Medical Procedure Interaction Scale-Infant Version (CAMPIS-IV) [11] was used to code care-giver behaviours during the procedure. The scale consists of three parameters: adult vocalisations, adult motoric behaviours and positioning of the baby and infant behaviours. Adult vocalisations were defined as speech promoting infant distress (empathising, apologising and reassuring) or coping (non-procedural talk to infant) as well as that which was neutral (procedural talk to adult or child and non-procedural talk to adult). Adult motoric and touch behaviours (bounce, rock, pat and stroke) were also classed as soothing behaviours. Additional codes relating to hugging and kissing were coded because they had been observed in previous studies, including one carried out by this research team [26]. These behaviours were combined with the CAMPIS-IV code ‘belly-to-belly’ to create a behavioural parameter related to proximity seeking. Infant sucking was coded when care-givers offered the infant a pacifier and/or milk. The CAMPIS-IV code ‘object’ was not included as it was not observed during the video-taped interactions.

2.5.2. Behavioural analysis

Videos were coded continuously using the OBSERVER XT version 12 [48], a software package specifically designed for the analysis of observational data. Continuous coding provides the most representative account of video-recorded data [49]. Hence, continuous coding was chosen in favour of time epoch analysis utilised by previous studies as: (1) short time intervals may fail to capture the full extent of care-giver-infant interaction and (2) multiple occurrences of a particular behaviour within the same time interval (e.g., two tongue protrusions in the same 5 second period) are not accounted for. Hence, observed behaviours were coded frame-by-frame across the whole procedure. Behavioural coding could occur only when the infant’s face or body was visible. Phase durations were adjusted accordingly. On average, infants were not visible for 11.1 seconds (8.0%) within the total duration of the procedure (*M =*138.3, *SD =*51.0).

Behaviours were analysed within six procedural phases: (1) the rotavirus vaccine; (2) before the first vaccination; (3) the first injected vaccination; (4) between the first and second injections; (5) the second injected vaccine, and (6) until 30 seconds after the withdrawal of the last needle. To account for different phase lengths, observed behaviours were analysed as the percentage of behaviours observed for each phase. Percentages were calculated for each behavioural group from the individual behaviours within each parameter (see Table 4.1). A higher percentage denoted a higher level of observed distress or soothing behaviour. Aggregate behavioural measures for each procedural phase were calculated to facilitate the analysis of broad behavioural patterns. Total infant pain expression included the mean percentage facial expression, body movement and cry vocalisations observed in each case. Total care-giver behaviours included the mean percentage of touch, proximal soothing, motoric soothing, coping vocalisations and pacifying.

2.5.2.1. Reliability

Ten per cent of videos were randomly selected and double-coded by a by a trained coder blind to the study aims. A tolerance window of 1500ms was used to determine Cohen’s kappa values. Inter-rater reliability was high across aggregated behaviours (α *=* 0.86; range = 0.79 – 0.90), as well as within individual behavioural parameters (facial expression = 0.80; body movement = 0.84; cry vocalisations = 0.82; verbal care-giver behaviour = 0.80; non-verbal care-giver behaviour = 0.85) and procedural phases (α = 0.92).

Table 4.1. Coding scheme

|  | **Behavioural category** | **Definition** |
| --- | --- | --- |
| *Infant distress behaviours* | | |
| Facial movements  [NFCS; 45] | Brow bulge | A bulging and creasing of the vertical furrows above and between the eyebrows that occurs as a result of the eyebrows being lowered and drawn together. |
| Eye squeeze | Squeezing or bulging of the eyelids tightly shut. The fatty pads around the infant’s eyes are pronounced. |
| Open lips | Any separation of the lips. |
| Vertical mouth stretch | The lip corners are pulled tight because the jaw is pulled down. Only coded when the mouth is open and is opened further by an extra pull at the jaw. |
| Horizontal mouth stretch | A horizontal pull at the corners of the mouth. |
| Nasolabial furrow | The lines extending from the nostril wings beyond the lip corners are pulled upwards and deepened. |
| Lip purse | The lips come together in the shape that would be made if an ‘oo’ sound was made. |
| Taut tongue | The tongue is raised and cupped with sharp, tensed edges. This movement often (but not always) occurs with a wide open mouth. |
| Tongue protrusion | The tongue is stuck out between the lips and extends beyond the mouth. |
| Chin quiver | The lower jaw is moved up and down at a high frequency. |
| Body movements  [MBPS; 7] | No movement | The infant is resting and/or relaxed and performs usual movements and activity (baseline). |
| Partial | The infant moves slightly more than baseline and no longer appears relaxed (e.g., back arched, limbs clenched, squirming) |
| Avoidant | The infant attempts to avoid the distressing stimuli by withdrawing the associated body part (limb or head). |
| Agitation | Infant performs generalised, flailing and complex movements that involve more than one limb. A distress behaviour. |
| Rigidity | The infant becomes stiff and rigid in one or more limbs. |
| Cry vocalisations  [MBPS; 7] | No vocalisation | The infant is quiet |
| Laugh | A positive vocalisation (e.g. giggle) |
| Whimper | A quiet or moaning vocalisation or gentle whimpering cry |
| Sob | A full-lunged, sobbing, rhythmic cry |
| Full-lunged cry | A full-lunged cry more than baseline. Only coded when the infant is crying at the start of an observation. |
| Silent cry | Crying without noise. This behaviour is typically preceded by a long scream which tails off into silence and is typically followed by a sob or full-lunged cry as the infant catches their breath. |

|  |  |  |
| --- | --- | --- |
| *Care-giver soothing behaviours [CAMPIS-IV; 11]* | | |
| Vocalisations | Apologetic | The care-giver apologises to the baby for the pain or upset caused by the procedure (e.g. I’m sorry) |
|  | Empathetic | The care-giver shows an understanding of the infant’s emotion (e.g. I know it hurts) |
|  | Reassuring | The care-giver tries to reassure the baby in an attempt to soothe them (e.g. It’s OK) |
|  | Procedural talk | To adult or infant. The care-giver talks about any aspect of the procedure (e.g. current/ future injections, aftercare advice) |
|  | Non-procedural talk | To adult or infant. The care-giver talks about things unrelated to the medical procedure. |
| Touch behaviours | Pat | Repeated patting on the infant’s back, leg, bottom etc. |
|  | Stroke | Repeated movement of the hand over the infant in a gentle manner. |
|  | Touch | Static placement of the hand on the infant |
| Motoric behaviours | Bounce | Care-giver moves the infant up and down |
|  | Rock | Care-giver moves the infant back and forth or from side-to-side |
| Proximity seeking behaviours | Belly-to-belly | The infant is held facing inwards with their torso pressed up against that of their care-giver. |
| Hug | The care-giver squeezes the infant tightly towards them while they are being held. |
| Kiss | The care-giver kisses or attempts to kiss the infant. |
| Pacifying | Sucking | The infant takes or is offered a pacifier in the form of a dummy or food (by breast or bottle) |

2.6 Method of statistical analysis

All statistical analysis was conducted using SPSS version 21 [50]. The primary aim of the study was to explore a range of determinants of infant pain expression (e.g. care-giver behaviour, care-giver mental state, attachment status, injection time). Partial correlations were used to describe the relationship between infant pain and care-giver behaviour over the course of the immunisation procedure. However, between group-differences were used (1) to provide a more specific analysis of particular care-giver behaviours on infant pain expression and (2) to explore the impact of a range of wider determinants on infant pain expression (e.g. mental state, attachment status and clinical factors) during injection phases. Hence, the influence of between-group factors on infant pain expression was central to the statistical analysis, and tests of analysis of variance were thus used to inform the original power calculation.

Indicative power calculations showed that a sample size of 200 healthy dyads had 94% power to detect effect sizes of 0.5 (small effects) for between-group factors that equally divided the group 1:1, or 80% power for factors dividing the group 4:1. Because the study aimed to explore a range of determinants of infant pain, adjustment for multiple testing was not appropriate and statistical significance at 5% was considered indicative of an effect.

2.6.1. Care-giver behaviour and infant pain expression

Because infant pain and care-giver behaviours were coded over six procedural phases, repeated-measures analyses of variance tests were used to characterise the pattern of infant pain-related distress and care-giver behaviour during the immunisation procedure.

The relationship between infant pain-related distress and care-giver behaviours were estimated using partial correlations. Partial correlations were utilised to describe the effect of procedural phase on infant and care-giver behaviours. Partial correlations were estimated using the Generalised Estimating Equations (GEE) function in SPSS. Variables were standardised so that regression coefficients (β) estimated the direct correlation coefficient between infant pain-related distress and care-giver responsiveness, and vice versa, across the immunisation procedure. Separate correlations were run for individual infant (facial expression; body movement; cry vocalisations) and care-giver (pacifier; distress-promoting, coping-promoting, neutral vocalisations; motoric soothing; proximity seeking; touch) behaviours as well as aggregate measures (total infant pain expression, total care-giver responsiveness). Multivariate models exploring the covariance of infant pain and caregiver behaviours over time were considered but not pursued because of low levels of correlation between the two constructs [51].

2.6.2. Wider determinants of infant pain expression

Possible determinants of infant pain (care-giver psychological state, attachment status, care-giver type, family size, and injection duration) were explored as between-subject factors. A separate mixed-model analysis of variance was run for each possible determinant, with the six procedural phases as the repeating elements and the possible determinant as the between-subjects factor. Mauchley’s tests indicated that sphericity assumptions were violated so Greenhouse Geisser corrections were applied to all models.

2.6.3. Immunisation uptake

The secondary aim of the study was to explore the impact of infant pain expression and other risk factors upon the completion of the immunisation schedule. This was explored using logistic regression. A logistic regression model was chosen because the outcome variable (immunisation status) was binary; infants were either completely or incompletely immunised according to the UK schedule. To ensure sampling adequacy, groups within several categorical independent variables were combined to ensure all cell counts were equal to or greater than one. Ethnicity and care-giver age could not be included as predictor variables due to insufficient cell frequencies. Infant pain expression (aggregated over all 6 phases), parental education status (± 18 years), and family size (> 1 other child) were included as predictor variables. Subject level risk factors were entered into step 1 of the regression model, and total infant pain expression (aggregated over all 6 phases) into step 2. Separate regression models were run for primary (between 2 to 4 months) and subsequent 12 to 13 month-old vaccinations.

# 3. Results

3.1. Study population

In total, 400 dyads were contacted; written informed consent was obtained from 225 care-givers, with 203 dyads subsequently participating in the study. One video was removed from the behavioural analysis due to poor quality, leaving a final sample of 202 care-giver-infant dyads. Recruitment with reasons for exclusion is shown in Figure 4.1. The most common reason for ineligibility was premature birth (57/198 = 28%).

**Contacted** (n = 400)

**Consented** (n = 225)

**Consent not obtained** (n = 175)

Refused to participate (n = 89)

Did not attend appointment (n = 51)

Ineligible (n = 35)

91 Did Not Attend; 31 Ineligible

**Analysed** (n = 202)

**Follow-up**

Primary immunisation follow-up (n = 190)

12 to 13 month immunisation follow-up (n = 100)

**Excluded** (n = 23)

Ineligible (n = 22)

Poor video quality (n = 1)

Figure 4.1. Participant flowchart

Demographic characteristics are presented in Table 4.2. Ninety-five percent of care-givers identified themselves as British. Caregivers were aged between 17 and 66 years (*M =*31.12, *SD =* 7.42) and 87.1% were married or living with their partner. Infants (52% male) were aged between 8 to 12 weeks (*M =*8.48, *SD =* .84) at the time of the appointment. Eighty percent of infants were held by their mothers during the appointment.

Table 4.2. Demographic characteristics

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variable (*n)* | | | | *n* | (%) |
| Relationship to infant (*n* = 202) | | | | | |
|  | Mother | | | 162 | (80.20) |
|  | Father | | | 29 | (14.36) |
|  | Other | | | 11 | (5.45) |
| Marital status (*n* = 201) | | | | | |
|  | Married | | | 91 | (45.05) |
|  | Living with Partner | | | 85 | (42.08) |
|  | Single | | | 23 | (11.39) |
|  | Divorced | | | 1 | (0.50) |
|  | Widowed | | | 1 | (0.50) |
| Education (*n* = 200) | | | | | |
|  | Before 16 | | | 16 | (7.92) |
|  | 16-18 | | | 96 | (47.52) |
|  | 19-22 | | | 58 | (28.71) |
|  | 23+ | | | 30 | (14.85) |
| Lifestyle habits during pregnancy | | | | | |
|  | Smoking | | | | |
|  |  | Not at all | | 162 | (80.20) |
|  |  | Daily | | 27 | (13.37) |
|  | Alcohol | | | | |
|  |  | Not at all | | 128 | (63.37) |
|  |  | Daily | | 2 | (0.99) |
| Other children *(n* = 198) | | | | | |
|  | Primparous | | | 71 | (35.15) |
|  | Multiparous | | | 127 | (62.87) |
|  |  | No.of other children (*M,SD*) | | 1.07 | (1.30) |
|  |  | Immunisation status of siblings (*n* = 195) | | |  |
|  |  |  | Fully Immunised | 125 | (61.88) |
|  |  |  | Not immunised | 1 | (0.50) |
| Infant sex (*n* = 202) | | | | | |
|  | Male | | | 106 | (52.48) |
|  | Female | | | 96 | (47.52) |

Measures of mental state and care-giver-infant bonding are presented in Table 4.3. Most care-givers had mild and moderate scores across all psychological sub-scales on the DASS-21. The use of established cut-offs identified seven care-givers with a severe score on at least one sub-scale. These care-givers were grouped to allow the exploration of psychological distress in subsequent analysis. In general, care-givers reported a high level of attachment towards their infants. Six care-givers were considered to have an impaired bond with their infant.

Table 4.3. Psychosocial factors

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | | | Care-giver | | | | | | | | | | |
|  |  | | | Mother (n = 153) | | | | Father (n = 28) | | | Other (n = 9) | | | |
| DASS-21 score (*M, SD*) | | | | | | | | | | | | | | |
|  | | Depression | | 1.18 | | (2.09) | | 0.75 | | (1.35) | | 2.13 | | (4.45) |
|  | | Anxiety | | 0.92 | | (1.88) | | 0.82 | | (1.36) | | 0.50 | | (1.07) |
|  | | Stress | | 3.12 | | (3.24) | | 3.07 | | (3.82) | | 1.13 | | (3.18) |
|  | | Total score | | 5.22 | | (6.19) | | 4.64 | | (5.53) | | 3.75 | | (8.63) |
| Severe sub-scale score (*n,* %) | | | | | | | | | | | | | | |
|  | | Depression | | 1 | | (0.65) | | - | | - | | 1 | | (11.11) |
|  | | Anxiety | | 3 | | (1.96) | | - | | - | | - | | - |
|  | | Stress | | 4 | | (2.61) | | 1 | | (3.57) | | - | | - |
| MPAS/ PPAS score *(M, SD)* | | | | | | | | | | | | | | |
|  | Factor 1 | | 42.66 | | (3.37) | | 34.80 | | (3.80) | | 43.21 | | (2.36) | |
|  | Factor 2 | | 22.49 | | (2.83) | | 29.63 | | (3.35) | | 24.12 | | (1.86) | |
|  | Factor 3 | | 24.10 | | (5.55) | | 19.48 | | (1.48) | | 23.07 | | (2.49) | |
|  | Total score | | 88.96 | | (5.61) | | 83.91 | | (6.40) | | 90.40 | | (5.80) | |
|  | < 25% (total score ≤ 74.82; *n, %*) | | 5 | | (0.30) | | 1 | | (0.10) | | - | | - | |

*Note.* Mothers and Others completed the MPAS: factor 1 = quality of attachment, factor 2 = absence of hostility, factor 3 = pleasure in interaction. Fathers completed the PPAS: factor 1 = Pleasure and tolerance, factor 2 = pleasure in interaction, factor 3 = affection and pride.

3.2. Procedural timing and discrepancies

The total duration of procedural phases are presented in Table 4.4. In six instances, infants were held by more than one care-giver: three infants were passed to another care-giver before the first injection, and three after the second injection. Four infants received the vaccines in a different order, receiving the rotavirus vaccine between the two injections. Eleven infants did not receive the rotavirus vaccine because of contraindications, nurse error or care-giver refusal. Two infants regurgitated the solution. Levels of procedural deviation were too low to explore their impact on infant pain.

Table 4.4. Procedural phase durations

|  |  |  |
| --- | --- | --- |
| Procedural phase | Time (s) | |
| *M* | *(SD)* |
| Rotavirus | 50.13 | (27.00) |
| Pre-needle | 37.56 | (24.52) |
| First injection | 2.58 | (1.38) |
| Between injections | 18.38 | (11.12) |
| Second injection | 2.56 | (1.17) |
| 30s post-injections | 29.54 | (1.91) |
| Total duration | 138.34 | (50.96) |
| *Note.* Rotavirus *n* = 191. All other phases *n* = 202 | | |

3.3. Care-giver behaviour and infant pain expression

The pattern of infant pain-related distress and care-giver behaviour across the immunisation procedure is presented in Figure 4.2. Repeated-measures analyses of variance indicated that both aggregate measures of infant pain expression, *F* (3.40, 646.02) = 289.01, *p* < .001, ηp2 = .60 and care-giver behaviour, *F* (4.13, 785.80) = 98.15, *p* < .001, ηp2 = .34 changed significantly during the procedure.

Infant pain expression remained constant during the rotavirus and pre-needle phases, significantly increased between the first and second injections before slightly reducing in the 30s post-needle. Across all phases, motoric soothing, touch, distress-promoting vocalisations and offering a pacifier were the most frequently observed care-giver behaviours, increasing as the procedure progressed. Across the procedure, proximity seeking behaviours as well as coping and neutral vocalisations were rarely observed (< 10% of the time).

Figure 4.2. Mean percentage of infant pain-related distress and care-giver behaviours observed during each procedural phase

3.3.2. Relationship between infant pain expression and care-giver behaviour

Partial correlations for infant-pain-related distress and care-giver behaviours were estimated (Table 4.5).

Table 4.5. Partial correlations between infant pain and care-giver behaviours (accounting for procedural phase)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Care-giver behaviour | Infant pain behaviour | | | | | | | | |
| Total infant pain | | | Facial pain | | Body movement | | Cry vocalisations | | |
| Offer pacifier | | -0.07\* | (0.014) | -0.09 | (0.084) | -0.06\* | (0.038) | -0.11\* | (0.008) |
| Distress-promoting vocalisations | | 0.06 | (0.114) | 0.03 | (0.449) | 0.06 | (0.114) | 0.06\* | (0.014) |
| Neutral vocalisations | | -0.06 | (0.160) | -0.10\* | (0.008) | -0.03 | (0.244) | -0.07 | (0.077) |
| Coping vocalisations | | -0.02 | (0.167) | -0.04\* | (0.016) | 0.00 | (0.904) | -0.03\* | (0.006) |
| Motoric soothing | | -0.03 | (0.474) | -0.06 | (0.392) | -0.01 | (0.855) | -0.03 | (0.595) |
| Proximity seeking | | 0.05 | (0.246) | -0.01 | (0.866) | -0.01 | (0.766) | 0.00 | (0.990) |
| Touch | | 0.05 | (0.159) | 0.00 | (0.977) | 0.04 | (0.239) | 0.05 | (0.064) |
| Total responsiveness | | 0.00 | (0.969) | -0.07 | (0.238) | -0.01 | (0.730) | -0.03 | (0.398) |
| *Note. P* values are in parentheses. \* *p* < 0.05 | | | | | | | | | |

Accounting for procedural phase, correlation coefficients ranged from -0.11 to 0.06. Few care-giver behaviours were significantly related to individual pain behaviours. Only pacifying was significantly associated with a decrease in total infant pain expression (*r* = -0.07, *p =* 0.014; Table 4.5) across the whole immunisation procedure (including both pain and non-painful phases). To explore the potential clinical importance of pacifier use on infant pain more specifically, the efficacy of its use during the painful injection phases (taken as the average total infant pain over the two needle phases) was explored using a one-way ANOVA. There was a significant effect of pacifier use on total infant pain expression during needle insertion *F* (1, 200) = 7.99, *p* < .005, ηp2 = .04. Use of a pacifier during needle insertion was associated with a 10.79% (95% CI: 3.25% to 18.28%) decrease in total infant pain expression.

A moderate correlation (0.3 to 0.9) between competing dependent variables (infant pain expression and care-giver behaviours) would necessitate a multivariate model [51]. Such low correlations indicate a weak relationship between care-giver behaviours and infant pain-related distress and imply that care-giver behaviours do not meaningfully influence infant pain expression, or vice versa. Consequently, phase-specific care-giver behaviours were removed from subsequent models of infant pain expression and the effects of between-subjects factors were explored using univariate models.

3.4. Influence of care-giver attributes on infant pain

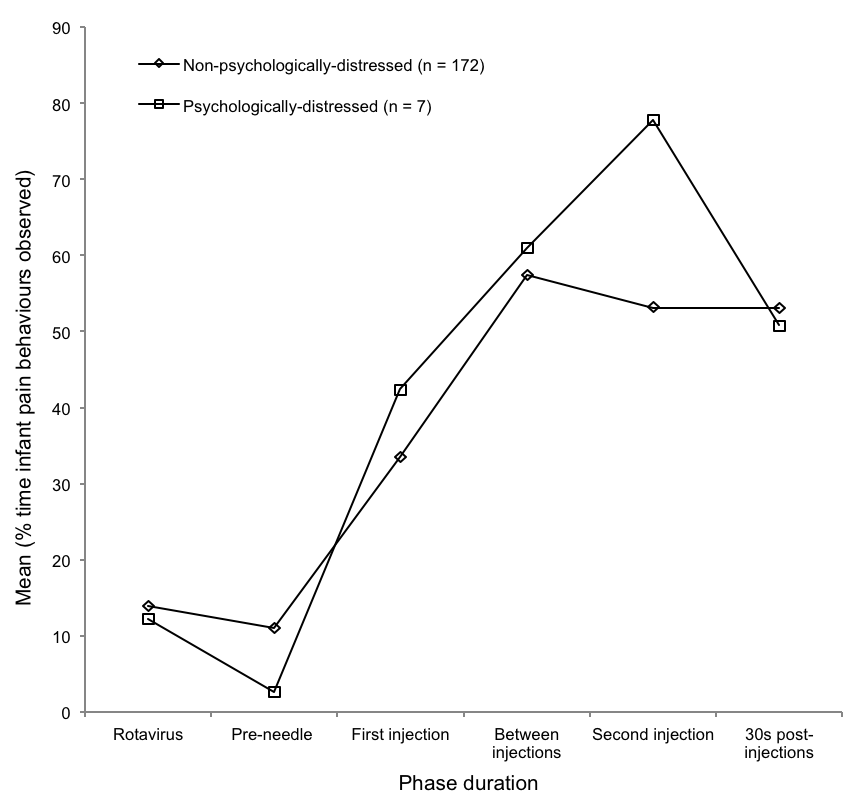
A number of models examined the effect of psychosocial factors and familial characteristics on aggregate and individual measures of infant pain expression.

3.4.1. Psychosocial factors

Differences in infant pain expression between care-givers with and without severe psychological distress or impaired attachment were explored. There was no effect of care-giver-infant attachment status on any measure of infant pain expression.

There was a significant interaction between total infant pain expressed throughout the procedure and the psychological state of the care-giver, *F* (3.40, 605.49) = 2.77, *p* = 0.034, ηp2 = .02 (Figure 4.3). Considering individual pain-related distress behaviours, this effect was significant for infant body movement but not facial expression or cry vocalisations. Exploring the interaction within each phase using independent samples *t*-tests showed that infants whose care-givers were severely psychologically distressed expressed significantly more total pain and body movement in response to the second needle than infants whose parents were not severely psychologically distressed; *t* (186) = 2.07, *p* = 0.040 (two-tailed) and *t* (6.84) = 2.99, *p* = 0.021 (two-tailed), respectively.

Figure 4.3. Total infant pain-related distress expressed across the procedure according to care-giver psychological state



3.4.2. Familial characteristics

Differences between different care-givers holding the infant (mother, father, other) and the effect of parity were explored as familial characteristics. The pain response of infants was not affected either by who held them during the procedure or whether they were the first-born child. For either factor, there was no main effect or interaction with infant pain response over the procedural phases for any specific pain behaviour or for total infant pain expression.

3.5. Clinical influences

Clinical factors included whether or not infants received the rotavirus vaccine and the primary care site at which the immunisations were administered. Infants who had received the rotavirus vaccine could be compared with those who had not, over five phases only (pre-needle to 30s post-injection). There was no significant difference in the degree of pain-related distress expressed by infants who did and did not receive the rotavirus vaccine. Results were similar for both aggregate and individual measures of infant pain.

There was significant variation in aggregate and individual measures of infant pain expression by site (aggregate pain; *F*(7, 183) = 7.32, *p* < 0.001, ηp2 = .22 ). One surgery with only one case had to be removed to allow the computation of post-hoc tests (*n =* 190). Infants immunised at three sites consistently expressed significantly less pain than those immunised at other sites during injection phases. The cause of these differences was explored as a function of procedural phase duration. Faster injection has previously been associated with decreased levels of pain expression [52] and could therefore account for observed differences.

There was significant variation in mean injection duration by clinical practice site, *F*(7, 194) = 18.65, *p* < 0.001, ηp2 = .40 (Figure 4.4). As such, mean injection time was taken as the average time (in seconds) taken to complete both injections (*M* = 2.57; *SD* = 1.18) and mean injection pain (*M* = 43.96; *SD* = 20.85) was taken as the average total infant pain expressed during both injection phases.

Figure 5. Variability in mean injection duration across primary care sites. Error bars depict 95% Confidence Intervals



Figure 4.4. Variability in mean injection duration across primary care sites. Error bars depict 95% Confidence Intervals

A one-way ANOVA co-varying for needle duration found that injection duration was significantly associated with total infant pain expression *F* (1, 200) = 39.75, *p* < 0.001, ηp2 = .17. A one second increase in injection duration was associated with a 7.12% (95% CI: 4.94% to 9.43%) *increase* in total infant expressed during the needle insertion (Figure 4.5). There was no significant interaction between total infant pain expression and oral dose time.



Figure 4.5. Association between injection duration and total infant pain expression

3.6. Infant pain and vaccine uptake during the first year of life

3.6.1. Immunisation status between 2 to 4 months

Primary immunisation uptake data was available for 190 infants included in the final study sample (178 complete, 12 incomplete). Neither the inclusion of known risk factors or infant pain expression significantly improved the model. Nagelkerke’s *R2* values indicated a weak relationship between predictor variables (step 1 *R2* = .012; step 2 *R2*= .013) and immunisation uptake: the predictor variables did not reliably distinguish between complete and incompletely immunised infants. This was supported by examination of the case classification table. Although the final model correctly classified 93.7% of cases, it failed to correctly identify any incompletely immunised infants (100% for immunised and 0% for incomplete).

3.6.2. Immunisation status at 12 to 13 months-old

Data relating to vaccines scheduled to be received between 12 and 13 months-old was available for 100 infants (84 complete, 16 incomplete). Results were similar to the primary immunisation model. Neither known risk factors nor the addition of infant pain expression in step 2 improved the predictive power of the model. Overall, the model correctly predicted the immunisation status of 84% of infants, yet again, failed to correctly classify all incomplete cases.

# 4. Discussion

This study examined the relationship between care-giver behaviour and infant pain-related distress during an infant’s first routine immunisation. It is the first study of its kind to explore these issues in an adequately powered sample of more than 200 caregiver-infant dyads, where the caregiver holds the infant (consistent with effective clinical practice guidelines [24]). Previous studies have examined the determinants of infant pain expression using small numbers of dyads or within a cohort where infants were laid supine on an examination table for the procedure. Evidence from this study suggests that there is little relationship between (1) care-giver behaviour, their attributes and infant pain, or of (2) risk factors related to the completion of vaccinations during the first year of life. Instead, clinical factors associated with injection technique appear to have the greatest influence on infant pain expression.

4.1. Care-giver behaviour and infant pain

Although care-giver and infant behaviours followed a similar pattern during the immunisation procedure, there was no relationship between the two constructs. Care-giver behaviour did not appear to influence infant pain expression, or vice versa. These findings are in contrast to others in the literature that have found a negative relationship between infant pain and care-giver behaviours, notably coping-promoting vocalisations [11, 14, 15] and proximal soothing [11, 16], and a positive relationship with distress-promoting vocalisations [11-13]. However, the majority of these studies were conducted in underpowered samples and thus, may indicate chance findings. These limitations may have contributed to inconsistencies in the literature and point to the importance of adequately sampled prospective study designs. Correspondingly, the results of the present study support more recent findings from larger cohort studies [17, 18] indicating that care-giver behaviours have a negligible influence on infant pain reactivity and regulation.

Only pacifying was found to have a small but significant negative relationship with total infant pain expression. Partial correlations were used to explore the statistical relationship between infant and care-giver behaviour across the whole immunisation procedure. Whilst these results suggested a negative relationship between the use of a pacifier and infant pain expression, they included periods of the procedure where no painful stimuli (i.e. needles) were present. In addition, owing to the range of behaviours explored in such a large sample, the extent to which correlational findings can be used to make meaningful inferences regarding the efficacy of particular care-giver behaviours must be acknowledged when interpreting these findings.

However, to explore the clinical importance of the use of a pacifier more directly, their use during the painful injection phases of the procedure was examined using analysis of variance. The use of a pacifier (compared to no use) was associated with a 10.79% reduction in overall infant pain expression across needle phases; a small to medium effect. The direction of these results are consistent with previous studies [11, 17], including two Cochrane Reviews [21, 22] that have found the overall effect of pacifying, through the mechanisms of both nutritive and non-nutritive sucking, to be beneficial in reducing infant pain. However, the magnitude of the effect observed in the present study is smaller than the large effects reported in the Cochrane reviews [21,22] suggesting that further research is necessary in order to make consistent recommendations regarding pacifier use. Despite this, the studies reported in the Cochrane reviews examined the impact of one variable (i.e. pacifier use) on infant pain expression. In the present study, multiple variables were examined and hence, it may not be appropriate to compare these findings.

Yet, whilst results suggesting that pacifier use is associated with a 10% reduction in infant pain are encouraging given the range of the determinants explored in the present study, the importance of these results should not be overestimated. Owing to the exploratory nature of the study design and the range of determinants explored, it is important to replicate these results using more controlled designs. If future studies are able to demonstrate medium to large effect sizes comparable to those found in the above Cochrane reviews, more robust recommendations regarding the use of pacifiers in routine practice may be made.

4.2. The influence of care-giver attributes and clinical factors on infant pain

Results examining the influence of indirect factors on infant pain expression indicated that the psychological state of the care-giver and the duration of procedural phases influenced infant pain expression.

Infants whose care-givers reported a severe form of psychological distress expressed more pain-related distress in response to the second injection than infants whose care-givers were not psychologically distressed. These findings are consistent with one study [25] that found higher levels of maternal depression predicted increased infant pain, but contradict others that did not find a relationship [26-28]. Although there were insufficient cases to examine the effects of different emotional states on infant pain expression, results suggest that more severe levels of psychological distress may contribute to increased pain responses. Taken with results regarding the weak relationship between care-giver and infant behaviours, this finding suggests that the mechanism by which psychological distress impacts upon infant pain is *unlikely* to be through the alteration of observable care-giver behaviours. Instead, psychological distress may moderate generalised emotional regulation through more subtle channels of communication established outside of the immunisation context during early social interaction.

Clinical factors reliably influenced infant pain expression. The speed at which immunisations were administered affected the level of infant pain expression. Faster administration of the injectable vaccines was associated with decreased levels of pain. These findings support previous research associated with rapid injection [52] and thus extend previous recommendations for the use of this method in practice [24, 31]. Furthermore, these findings lend support to more recent findings suggesting that infant pain reactivity is the best predictor of later pain regulation [17, 18]. Faster injection may have an impact on the degree to which infants experience injections as noxious and therefore accounts for more variance in overall pain expression than any soothing behaviours deployed by care-giver after their administration. On the other hand, taking more time to administer the oral rotavirus vaccine was not associated with distress. This finding may be explained by the rotavirus vaccine preceding injection stimuli, containing a sweet-tasting solution [24, 31] and its association with sucking [11, 17, 22].

4.3. Predictors of immunisation uptake

No variables predicted immunisation uptake across the first year of life. Surprisingly, known risk factors associated with family size and educational attainment did not predict uptake. In relation to primary immunisation, the frequency of medical appointments in the first few months of life may maintain vaccine schedule awareness and the social norms surrounding vaccination [34]. At 12 to13 months of age, barriers associated with access to healthcare, work commitments and beliefs about specific vaccines such as MMR may play a larger role in uptake decisions than demographic characteristics [35]. However, parental beliefs about vaccination were not examined in the present study. Future studies should investigate the interaction between parental beliefs and vaccine uptake as well as how parental views change over the first year of life. Understanding when vaccine beliefs begin to influence uptake decisions may highlight the optimum time for intervention.

The addition of infant pain expression did not improve the predictive power of the regression model. In terms of the DIAPR model [4, 23], this suggests that the influence of previous infant pain expression does not sufficiently alter care-giver pain schemas to change decisions regarding vaccine uptake. Alternatively, the experience of the procedure may have increased parental confidence and so reduced parental anxiety about future procedures – having coped with their infant during one procedure parents did not feel anxious about returning to the clinic. Additionally, as infants develop and experience additional painful episodes as a consequence of their increased mobility, care-givers may be more accustomed to instances of pain-related distress. These experiences may have further contributed to pain schemas; further increasing care-giver’s confidence in coping with infant pain at the 12 to 13 month appointment.

4.4. Strengths and limitations

The present study provides a comprehensive account of the relationship between infant and care-giver behaviour in a homogeneous cohort. The use of videotape observations provides a specific source of normative data for infants held by their care-givers during the procedure. Furthermore, the use of continuous coding permitted a complete analysis of care-giver and infant behaviours throughout the immunisation procedure. However, the observational nature of study impacted upon the size of groups included in between-group group comparisons. Thus, it is important to keep the unbalanced nature of the group sizes in mind when interpreting the results. The small number of incompletely compared to completely immunised infants needs to be taken into account when interpreting the results of the logistic regression. Unequal and small group sizes may have introduced additional bias into the models that may have reduced the power of the test to predict group membership.

The current study used partial correlations to account for inconsistencies in the literature regarding the directionality of influence between care-giver and infant behaviours. The use of uni-directional regression models predicting infant pain from care-giver behaviours, do not account for the cyclical nature of dyadic interactions proposed by the DIAPR model [4, 23]. Despite the weak relationship between the majority of care-giver and infant behaviours, this study cannot say anything of the causality of behaviour. For example, although findings indicate that the use of a pacifier might be associated with a weak reduction in infant pain expression, this study cannot specify whether infant pain prompted a care-giver to offer the infant a pacifier, or, vice versa, whether the care-giver’s offer of a pacifier led to a reduction in infant pain expression. Future studies might use experimental designs to examine the use or omission of pacifier use on the reduction in infant pain expressed in response to immunisation to examine causality. Alternatively, Bayesian networks might be used to explore any causality between care-giver and infant behaviours. The research team is currently pursuing this method of analysis.

4.5. Conclusions and implications for intervention

The results of the present study indicate that there is a weak relationship between care-giver behaviours and infant pain-related distress expressed during routine 2 month-old immunisation. Whilst the use of a pacifier was associated with a significant 10% reduction in infant pain expression during injection phases, the exploratory nature of the study limits the extent to which conclusions can be made regarding the efficacy of pacifiers as a pain relieving intervention. Before meaningful recommendations about the use of pacifiers in routine practice can be made, further research is necessary. The results also suggest the importance of indirect factors associated with the psychological state of the care-giver but point clearly to the impact of administration technique on infant pain. Understanding the mechanisms behind these factors may have important implications for infant pain experience and are thus an important focus for future research and intervention.

# References

[1] Sadaf A, Richards JL, Glanz J, Salmon DA, Omer SB. A systematic review of interventions for reducing parental vaccine refusal and vaccine hesitancy. Vaccine. 2013;31:4293-304.

[2] Austvoll-Dahlgren A, Helseth S. What informs parents' decision-making about childhood vaccinations? J Adv Nurs. 2010;66:2421-2430.

[3] Brunson EK. How parents make decisions about their children's vaccinations. Vaccine. 2013;31:5466-5470.

[4] Pillai Riddell R, Racine N. Assessing pain in infancy: the caregiver context. Pain Res Manag. 2009;14:27-32.

[5] Birnie KA, Boerner KE, Chambers C.Families and pain. In: McGrath PJ, Stevens BJ, Walker SM, Zempsky WT, editors. *Oxford Textbook of Paediatric Pain.* Oxford: Oxford University Press; 2013,111-119 .

[6] Johnston CC, Strada ME. Acute pain response in infants: a multidimensional description. Pain. 1986;24:373-382.

[7] Taddio A, Nulman I, Koren BS, Stevens B, Koren G. A revised measure of acute pain in infants. J Pain Symptom Manag. 1995;10:456-463.

[8] Lilley CM, Craig KD, Grunau RE. The expression of pain in infants and toddlers: developmental changes in facial action. Pain. 1997;72:161-170.

[9] Cohen LL, Bernard RS, McClelland CB, MacLaren LE. Assessing Medical Room Behavior During Infants' Painful Procedures: The Measure of Adult and Infant Soothing and Distress (MAISD). Child Health Care. 2005;34:81-94.

[10] Taddio A, Chambers CT, Halperin SA, Ipp M, Lockett D, Rieder MJ, Shah V. Inadequate pain management during routine childhood immunizations: the nerve of it. Clin Ther. 2009;31:S152-67.

[11] Blount RL, Devine KA, Cheng PS, Simons LE, Hayutin L. The impact of adult behaviors and vocalizations on infant distress during immunizations. J Pediatr Psychol. 2008;33:1163-1174.

[12] Racine NM, Pillai Riddell R, Flora D, Garfield H, Greenberg S. A Longitudinal Examination of Verbal Reassurance During Infant Immunization: Occurrence and Examination of Emotional Availability as a Potential Moderator. J Pediatr Psychol. 2012;37:935-944.

[13] Sweet SD, McGrath PJ. Relative importance of mothers' versus medical staffs' behavior in the prediction of infant immunization pain behavior. J Pediatr Psychol. 1998;23:249-256.

[14] Piira T, Champion DG, Bustos T, Donnelly N, Lui K. Factors associated with infant pain response following an immunization injection. Early Hum Dev. 2007;83: 319-326.

[15] Bustos T, Jaaniste T, Salmon K, Champion GD. Evaluation of a Brief Parent Intervention Teaching Coping-Promoting Behavior for the Infant Immunization Context A Randomized Controlled Trial. Behav Modif, 2008. 32(4): p. 450-467.

[16] Jahromi LB, Putnam SP, Stifter CA. Maternal regulation of infant reactivity from 2 to 6 months. Dev Psychol. 2004;40:477.

[17] Lisi D, Campbell L, Pillai Riddell R, Garfield H, Greenberg S. Naturalistic parental pain management during immunizations during the first year of life: Observational norms from the OUCH cohort. Pain. 2013;154:1245-1253.

[18] Campbell L, Pillai Riddell R, Garfield H, Greenberg S. A cross-sectional examination of the relationships between caregiver proximal soothing and infant pain over the first year of life. Pain. 2013;154:813-823.

[19] Axia G, Bonichini S. Are babies sensitive to the context of acute pain episodes? Infant distress and maternal soothing during immunization routines at 3 and 5 months of age. Infant Child Dev. 2005;14:51-62.

[20] Lewis M, Ramsay DS. Effect of maternal soothing on infant stress response. Child Dev. 1999:11-20.

[21] Shah PS, Aliwalas LL, Shah VS. Breastfeeding or breast milk for procedural pain in neonates. Cochrane Database Systematic Reviews. 2012;12.

[22] Pillai Riddell R, Racine NM, Turcotte K, Uman LS, Horton RE, Osmun LD, Ahola Kohut S, J Hillgrove Stuart, Stevens B, Gerwitz-Stern A. Non-pharmacological management of infant and young child procedural pain. Cochrane Database Systematic Reviews. 2011;10.

[23] Pillai Riddell R, Racine N, Craig K, Campbell L. Psychological theories and biopsychosocial models in paediatric pain. In: McGrath PJ, Stevens BJ, Walker SM, Zempsky WT, editors. *Oxford Textbook of Paediatric Pain.* Oxford: Oxford University Press; 2013, 85-94.

[24] Taddio, A, Appleton M, Bortolussi R, Chambers C, Dubey V, Halperin S et al. Reducing the pain of childhood vaccination: an evidence-based clinical practice guideline. Can Med Assoc J, 2010. 182(18): p. E843-E855.

[25] Moscardino U, Axia G, Altoe G. The role of maternal depressed mood and behavioural soothing on infant response to routine vaccination. Acta Paediatr. 2006; 95:1680-1684.

[26] Reissland N, Harvey H, Mason J. Effects of maternal parity, depression and stress on two-month-old infant expression of pain. J Reprod and Infant Psychology. 2012;30:363-376.

[27] Frank NC, Blount RL, Smith AJ, Manimala MR, Martin JK. Parent and Staff Behavior, Previous Child Medical Experience, and Maternal Anxiety as They Relate to Child Procedural Distress and Coping. J Pediatr Psychol. 1995;20:277-289.

[28] Bernard R, Cohen LL. Parent Anxiety and Infant Pain During Pediatric Immunizations. J Clin Psychol Med S. 2006;13:282-287.

[29] Horton RE, Pillai Riddell R, Flora D, Moran G, Pederson D. Distress Regulation in Infancy: Attachment and Temperament in the Context of Acute Pain. J Dev Behav Pediatr. 2015;36:35-44.

[30] Pillai Riddell RR, Stevens B, Cohen LL, Flora D, Greenberg S. Predicting maternal and behavioral measures of infant pain: the relative contribution of maternal factors. Pain. 2007;133:138-149.

[31] Taddio A, Ilersich AL, Ipp M, Kikuta A, Shah V. Physical interventions and injection techniques for reducing injection pain during routine childhood immunisations: Systematic review of randomized controlled trials and quasi-randomized controlled trials. Clin Ther. 2009:31: S48-S76.

[32] Austin, H., Parents' perceptions of information on immunisations. J Child Health Care. 2001;5:54-59.

[33] Tarrant M, Gregory D. Exploring childhood immunization uptake with First Nations mothers in north-western Ontario, Canada. J Adv Nurs. 2003;41:63-72.

[34] Tickner S, Leman PJ, Woodcock A.‘It's just the normal thing to do’: Exploring parental decision-making about the ‘five-in-one’ vaccine. Vaccine. 2007;25:7399-7409.

[35] Tickner S, Leman PJ, Woodcock A. Parents' views about pre-school immunization: an interview study in southern England. Child: Care, Health Dev. 2010;36:190-197.

[36] Mills E, Jadad AR, Ross C, Wilson K. Systematic review of qualitative studies exploring parental beliefs and attitudes toward childhood vaccination identifies common barriers to vaccination. J clinical epidemiology. 2005;58:1081-88.

[37] Wilson T. Factors influencing the immunization status of children in a rural setting. J Paediatr Healthcare. 2000;14:117-121.

[38] Kaufman, J, Synnot A, Ryan R, Hill S, Horey D, Willis N, Lin V, Robinson P. Face to face interventions for informing or educating parents about early childhood vaccination (review). Cochrane Database of Systematic Rev. 2013;5:1-69.

[39] Lovibond SH, Lovibond PF. *Manual for the depression anxiety stress scales* (2nd ed). Sydney: Psychology Foundation of Australia; 1995

[40] Henry JD, Crawford JR. The short-form version of the Depression Anxiety Stress Scales (DASS-21): Construct validity and normative data in a large non-clinical sample. Brit J Clin Psych. 2005;44:227-239.

[41] Condon JT, Corkindale CJ. The assessment of parent-to-infant attachment: Development of a self-report questionnaire instrument. J Reprod Infant Psych. 1998; 16:57-76.

[42] Condon JT, Corkindale CJ, Boyce P. Assessment of postnatal paternal–infant attachment: Development of a questionnaire instrument. J Reprod Infant Psych. 2008;26:195-210.

[43] Feldstein S, Hane AA, Morrison BM, Huang YK. Relation of the Postnatal Attachment Questionnaire to the Attachment Q‐Set. J Reprod Infant Psychol. 2004;22:111-121.

[44] Taddio, A, Hogan ME, Moyer P, Girgis A, Gerges S, Wang L, Ipp M. Evaluation of the reliability, validity and practicality of 3 measures of acute pain in infants undergoing immunization injections. Vaccine. 2011;29:1390-1394.

[45] Grunau RV, Craig KD, Pain expression in neonates: facial action and cry. Pain. 1987;28:395-410.

[46] Craig K, Hadjistavropoulos HD, Grunau RVE, Whitfield MF. A comparison of two measures of facial activity during pain in the newborn child. J Pediatr Psychol. 1994;19:305-318.

[47] Ahola Kohut S, Pillai Riddell RR. Does the Neonatal Facial Coding System differentiate between infants experiencing pain-related and non-pain-related distress? J Pain, 2009;10:214-220.

[48] Noldus Information Technology. The Observet XT (version 12).2014.

[49] MacLaren CJ, McMurty C. Behavioural measurements of pain. In: McGrath PJ, Stevens BJ, Walker SM, Zempsky WT, editors. Oxford Textbook of Paediatric Pain. Oxford: Oxford University Press; 2013, 85-94.

[50] IBM. IBM SPSS Statistics (version 21). 2012.

[51] Brace N, Kemp R, Snelgar RS. *SPSS for psychologists: a guide to data analysis using SPSS for Windows* (3rd ed.) New York: Palgrave Macmillan; 2006.

[52] Ipp M, taddio A, Sam J, Gladbach M, Parkin PC. Vaccine‐related pain: randomised controlled trial of two injection techniques. Arch Dis Child. 2007;92: 1105-1108.

**Chapter 5**

**A Q-methodology study of parental understandings of infant immunisation: Implications for healthcare advice[[2]](#footnote-2)**

Findings from the systematic review of qualitative literature reported in Chapter 3 indicated that parents who differed in their immunisation decisions had both shared and distinct views about early childhood vaccination. Furthermore, similarities and differences existed within each group. To date, much research has explored parental viewpoints in anticipation of impending immunisations. Understanding the beliefs of immunisers *after* they have experienced a vaccination procedure may highlight key views that could be targeted in future interventions to increase uptake amongst partial immunisers. Furthermore, results from Chapter 4 suggested that the experience of infant pain expressed in response to immunisation did not alter care-giver pain schemas. However, Chapter 5 did not directly examine care-giver beliefs about immunisation; the effect of infant pain on pain schemas was inferred through data pertaining to immunisation uptake. This chapter reports the use of Q-methodology to explore parental beliefs about immunisation and infant pain responses following the recent experience of vaccination.

Abstract

This study used Q-methodology to explore systematically parental judgements about infant immunisation. Forty-five parents completed a 31 statement Q-sort. Data was collected after vaccination in GP practices or a private day nursery. Q factor analysis revealed four distinct viewpoints: a duty to immunise based on medical benefits; child-orientated protection based on parental belief; concern and distress; and surprise at non-compliance. Additionally, there was a common view amongst parents that they did not regret immunising their children. Implications of these results are discussed in terms of healthcare policy and future research.

# 1. Introduction

Vaccinations prevent two to three million infant deaths each year [1], making them one of the most important international health interventions. However, in order to benefit from this protection, infants must undergo a number of painful injections [2] that many find distressing [3].

Infants in the UK are offered a course of primary vaccinations at 2, 3 and 4 months of age to protect them from eight of the most harmful diseases [4]. However, because vaccine uptake is not compulsory [5, 6], parents must decide whether or not to immunise their child [7]. The outcome of the decisions made in infancy impact on health throughout the lifespan. For example, the recent Measles outbreak in unvaccinated UK adolescents may be a consequence of parental decisions made after the 1998 Measles, Mumps and Rubella (MMR) controversy caused by Wakefield et al. [9], that resulted in a 10% drop in immunisation rates [9]. Although MMR uptake is currently higher than it was in 1998 (91.2% vs. 88.3%) [10] this example demonstrates the influence of parental beliefs on decision outcomes. Parents who are concerned about vaccine safety may leave their child unvaccinated [11], whereas those who believe in the protective benefits of immunisation may make pro-vaccination decisions [11-13].

A number of previous studies have used qualitative methods to identify parental concerns about vaccines that prevent immunisation compliance. Barriers include: a lack of awareness about the immunisation schedule and procedure, and concerns about infant harm [14], vaccine safety [5, 15], and side effects [14, 16]. However, this focus has led to a paucity of understanding of the views of parents who have made pro-vaccination choices.

Research that has examined the decision-making processes of vaccinating parents cite several reasons for uptake; namely, the protection against disease gained by the child [11, 17], a sense of duty to attend to increase population immunity [11, 13 18, 19], trust in the National Health Service (NHS), and a positive experience of previous immunisation [11]. As such, parents who had vaccinated their child expressed surprise that others left their children unvaccinated [18]. However, not all immunising parents have reported such confidence in vaccinations. Some parents remain concerned about the side-effects of vaccinations despite their appointment attendance [18, 20]. Furthermore, first-time parents have reported less confidence in their immunisation decisions than parents with more than one child [11].

Previous research has found that both infants and their parents experience severe discomfort in relation to immunisations [11, 14, 20]. Despite a desire to protect their infant from disease, many parents anticipate feelings of fear, responsibility and guilt [11] regarding the potential distress caused to infants by the procedure. Mothers believed that these feelings would be exaggerated by concerns about the effectiveness of their soothing responses [20, 21] and expected that they might regret their decision to immunise [15]. However, whilst these studies highlight the emotional expectations of vaccinating parents, their reactions were not followed up after the procedure. With this in mind, the present study was designed to use Q-methodology to explore parental understandings of immunisation *after* the administration of 2 month-old infant vaccinations. Furthermore, the design of this study differs from a number of studies [5, 6, 14, 22], as it will examine the views of parents who opted *for* infant immunisation. Hence, this study will aim to understand factors that influenced parental decisions, viewpoints about the immunisation procedure, and reactions to infant pain behaviours. Findings will be discussed in terms of their potential implications for health policy and in particular, immunisation advice.

# 2. Method

2.1. Q-methodology

Q-methodology permits the scientific study of similarities and differences in understanding regarding a specific topic. Participant views are expressed by means of a Q-sort, the organisation of a number of statements into a quasi-normal fixed response grid in terms of agreement or disagreement. The distribution of each response is then used to group participants in terms of their shared and distinct viewpoints. The grouping of participants is analysed through the inversion of traditional factor analytic techniques [23], such that sorted statements become the study sample, and participants become the variables between which correlations in opinion are established [24]. As such, Q-methodology is an ideal technique with which to investigate points of view related to health [25]. Q-methodology has been repeatedly applied to health related processes, particularly those surrounding chronic pain [24-28], but has not yet been used to investigate attitudes towards acute pain such as routine infant immunisation.

2.2. Sampling the concourse and defining the Q-set

The first stage in any Q-methodological study is to define the concourse. The concourse is a set of all the possible statements that exist or can be devised surrounding a topic [29]. In this study, items were generated from a literature review of material regarding parental views on infant immunisation and pain expression. Additional items were added from five informal interviews conducted with mothers after the immunisation of their 2 month-old infants. Mothers were asked to comment on dyadic interaction during three videos of infant immunisation. After the transcription of voice-recordings, key themes were added to the concourse. Ninety-seven statements were generated from academic literature and parental comments. Statements that duplicated key themes were removed. Statements were then sorted into 12 categories (e.g., vaccine safety, awareness of distress, emotional response to pain) whereby a subset of 31 statements, the Q-set, was obtained based on each item’s ability to convey the overriding theme of the category. Each statement was then transcribed onto a set of numbered cards to be used in the Q-sort procedure.

2.3. Participants

Because Q-methodological studies aim to explore diverse viewpoints within a particular set of people, they do not employ formal experimental designs. In the present study, parent-infant dyads were purposefully selected based on their recent experience of 2 month-old infant immunisation.

The study was grantedethical permission by the local NRES and university ethics committees. Parents were recruited from one of two medical practices, a drop-in Well-baby clinic or a private day nursery. Potential participants recruited from medical practices were sent a letter one week before their scheduled appointment informing them of the study’s commencement. Participants recruited from the private day nursery and drop-in Well-Baby clinic were approached by the primary author upon arrival at the setting after the verification of infant age and immunisation status. Of the 70 parent-infant dyads asked to participate in the study, 48 gave written informed consent of which three did not complete the Q-sort because of time constraints.Thus, a total of 45parents were included in the final sample: 22 from medical practices, four from the Well-Baby clinic, and 19 from the private day nursery. The majority of parents were mothers (4 fathers); 22 parents had more than one child aged between 1 to 7 years-old. Parents had a mean age of 29.07 years-old (*SD =* 4.99*)*. Infants (22 male) about whose immunisation the Q-sort was based, had a mean age of 10.29 weeks (*SD =* 2.88).

2.4. Procedure

All Q-sorts were conducted independently. First, participants read an instruction sheet detailing the Q-sort process. Statements were sorted according to a forced-choice distribution. The Q-sort distribution contained nine ranking values that ranged from +4 to -4. The forced-choice nature of the distribution required two statements to be ranked at the extremes of the distribution (+4; -4), and seven items in the middle (0). Participants read through the 31 statements and sorted them into three roughly equal piles ranging from +4 (strongly agree) through zero (neutral/ unsure) to -4 (strongly disagree). Participants then sorted the statements again, placing the two statements they most agreed with in the +4 column of the response grid (Figure 5.1), followed by the two they least agreed with in the -4 column. Participants continued to alternate between the agree and disagree piles until all statements were sorted into the relevant columns. As participants neared the centre of the grid (0), they were encouraged to combine the remaining statements with the neutral pile to aid statement placement.

During the procedure, participants placed the statement cards onto an enlarged response grid to allow them to visualise their Q-sort more clearly. Participants were given the opportunity to rearrange statements before its completion. The number of each statement in the completed Q-sort was then transposed into the corresponding location on the response sheet. Finally, participants were asked to complete a demographic questionnaire before being fully debriefed.

**DISAGREE AGREE**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| -4  (2) | -3  (3) | -2  (3) | -1  (4) | 0  (7) | +1  (4) | +2  (3) | +3  (3) | +4  (2) |
| 5. I regret my decision about immunising my child | 3. I believe that there are alternative ways of protecting my child form harmful illnesses instead of vaccinations | 19. My child’s vaccination was worse than ones that I can recall | 14. I would have liked more information about infant immunisations before I took my child to the well-baby clinic for their immunisation appointment | 18. I put myself in my infant’s shoes when they got their injections | 26. I tried not to show my anxiety to my child during the immunisation | 30. My child responded well to my attempts to soothe them after the immunisation | 31. I felt confident in my ability to cope with my infant during the immunisation procedure | 13. I believe that immunisations are safe |
| 12. The immunisation procedure caused more distress to my infant than if they caught the disease that they had been vaccinated against | 4. I found it stressful to decide whether or not to immunise my child | 10. I felt scared/ fearful about taking my baby to get their immunisations | 16. I could tell that my child was distressed by their injections because of their general behaviour during the immunisation | 15. My infant experienced pain because of their immunisations | 29. I felt able to respond well to my infant’s reaction to the immunisation | 27. Although the procedure was not nice, I knew my child would be OK after a cuddle | 9. I followed the advice of medical professionals when deciding whether to immunise my child | 7. It is my ‘job’ to protect my child from harmful diseases |
|  | 11. I worry about the side-effects that my infant may experience as a result of immunisation | 28. During the immunisation procedure, I was worried that my baby couldn’t communicate their feelings to me | 22. I could tell that my child was distressed by their immunisation because of their body movements | 23. I could tell that my child was distressed because they went red in colour | 8. My decision to vaccinate my child was not influenced by my family or friends | 2. I believe that infant immunisations should be compulsory | 6. I believe it is part of my duty as a good citizen to immunise my child, to prevent the spread of harmful diseases within the population |  |
|  |  |  | 21. I could tell that my child was distressed by their immunisation because of their facial expression | 24. I found watching my infant get immunised distressing | 1. I am surprised that some parents chose not to immunise their children against harmful diseases |  |  |  |
|  |  |  |  | 20. I could tell that my child was distressed by their immunisation because of the sounds they made |  |  |  |  |
|  |  |  |  | 17. My child was more shocked than in pain when they received their injections |  |  |  |  |
|  |  |  |  | 25. I felt guilty about upsetting/ causing harm to my infant during the immunisation |  |  |  |  |

Figure 5.1. Quasi-normal fixed response grid. Statements in the Q-set are arranged according to the Q-sort exemplified by participants who significantly loaded onto Factor A. Numbers in (brackets) show the number of statements that should be sorted under each column.

2.5. Statistical analysis

All data were analysed using PCQ [30]. The 45 Q-sorts in the final data set were entered into the program. A by-person correlation [31] of each Q-sort with every other was computed. The resulting correlation matrix was then subject to centroid factor analysis (CFA). CFA is a method of simple summation and thus, according to Stephenson, facilitates the study of subjectivity [32]. CFA allows the identification of the most appropriate factor structure based on the data and relevant theory [33]. As such in Q-methodology, CFA is preferred over factor analytic methods (e.g. Principal Components Analysis) that dictate the single best solution on mathematical grounds. Extracted factors were orthogonally rotated using varimax. Rotation was stopped after the computation of a five-factor solution because no Q-sorts loaded significantly onto a sixth factor. A factor array was then computed for each factor. Each factor denotes a shared viewpoint. The factor array identifies the average ranking assigned to each item by the participants significantly associated with each factor, and therefore represents an idealised Q-sort that characterises the shared viewpoint of participants on each factor (Figure 5.1 shows the factor array for factor A). There is therefore a similarity between the configuration of one factor array and the associated Q-sorts that varies with how strongly one Q-sort loads on its factor. The number of statements in the Q-set (n = 31) determined the significance level of the correlation value such that a Q-sort loaded significantly onto one factor if it had a correlation equal to or greater than .46 at *p* < .01 level.

A statistical report was generated for the two, three, four and five factor solutions. In Q-methodology, there are no fixed guidelines for determining which factor solution to accept [33]. The four-factor solution was selected after the examination of each solution’s overall ability to convey parental opinion. This solution was chosen because it provided additional viewpoints to those identified in the two and three-factor solutions, and because no further viewpoints were evidenced in the five-factor solution. The four-factor solution accounted for 63% of the variance in parental understandings of infant immunisation and explained the views of 36 participants. Three of the remaining nine Q-sorts were confounded, thereby denoting a broader view of infant immunisation because they loaded significantly on more than one factor. The six remaining Q-sorts were non-significant. It is common in Q-methodology for some sorts not to load onto any factor. This reflects the fact that the idiosyncratic view of these parents was not shared by others in the sample.

# 3. Results

Each factor was interpreted in turn. Statements given the highest (+4, +3) and lowest (-4, -3) rankings within each factor array, and items ranked highest or lowest in the relevant factor compared to the others were noted (Table 5.1).

Next, the demographic information of significantly loading parents was used to contextualise each factor. Finally, factor arrays were further examined and additional statements that were considered relevant, such as those that distinguished one factor from another sorted at least three piles apart, were added to the list of statements. A holistic interpretation of each factor was then created using a narrative style [32]. Initial factor interpretation was carried out by the primary author. Interpretations were then discussed in detail with the co-authors to develop a detailed and cohesive account of each factor. In the interpretations that follow, statements will be identified in brackets by (number and: ranking).

Table 5.1. By-factor rankings of statements in the Q-set. Numbers in bold font indicate the highest ranking and italics indicate the lowest ranking

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| No. | Statement | A | B | C | D |
| 1 | I am surprised that some parents choose not to immunise their children against harmful diseases. | +1 | +1 | *-1* | **+4** |
| 2 | I believe that infant immunisation should be compulsory | +2 | *0* | -3 | **+3** |
| 3 | I believe that there are alternative ways of protecting my child from harmful illnesses instead of vaccinations | *-3* | *-3* | **-2** | *-3* |
| 4 | I found it stressful to decide whether or not to immunise my child | **-3** | *-4* | **-3** | **-3** |
| 5 | I regret my decision about immunising my child | **-4** | **-4** | **-4** | **-4** |
| 6 | I believe it is part of my duty as a good citizen to immunise my child, to prevent the spread of harmful diseases within the population. | **+3** | *0* | **+3** | +1 |
| 7 | It is my ‘job’ to protect my child from harmful diseases | **+4** | **+4** | +3 | *+2* |
| 8 | My decision to vaccinate my child was not influenced by my family or friends | **+1** | **+1** | **+1** | **+1** |
| 9 | I followed the advice of medical professionals when deciding whether to immunise my child. | +3 | *-1* | **+4** | 0 |
| 10 | I felt scared/ fearful about taking my baby to get their immunisations | *-2* | -1 | **0** | **0** |
| 11 | I worry about the side-effects that my infant may experience as a result of immunisation | *-3* | -1 | **+2** | *-3* |
| 12 | The immunisation procedure caused more distress to my infant than if they caught the disease that they had been immunised against | *-4* | **-2** | *-4* | *-4* |
| 13 | I believe that immunisations are safe | **+4** | +3 | *0* | +1 |
| 14 | I would have liked more information about infant immunisations before I took my child to the well-baby clinic for their immunisation appointment | **-1** | *-3* | **-1** | -2 |
| 15 | My infant experienced pain because of their immunisations | *0* | +1 | **+2** | *0* |
| 16 | I could tell that my child was distressed by their injections because of their general behaviour during their immunisation | *-1* | 0 | **+2** | +1 |
| 17 | My child was more shocked than in pain when they received their injections | 0 | **+2** | *-2* | 0 |
| 18 | I put myself in my infant’s shoes when they got their injections | **0** | *-1* | *-1* | *-1* |
| 19 | My child’s vaccination was worse than ones that I can recall | **-2** | *-3* | **-2** | **-2** |
| 20 | I could tell that my child was distressed by their immunisation because of the sounds they made | *0* | +2 | **+3** | +2 |
| 21 | I could tell that my child was distressed by their immunisation because of their facial expression | *-1* | +1 | +1 | **+3** |
| 22 | I could tell that my child was distressed by their immunisation because of their body movements | *-1* | 0 | **+1** | 0 |
| 23 | I could tell that my child was distressed because they went red in colour | **0** | **0** | **0** | *-1* |
| 24 | I found watching my infant get immunised distressing | *0* | *0* | **+4** | **+4** |
| 25 | I felt guilty about upsetting/ causing harm to my infant during the immunisation | 0 | *-2* | 0 | **+2** |
| 26 | I tried not to show my anxiety to my child during the immunisation | **+1** | 0 | 0 | *-1* |
| 27 | Although the procedure was not nice, I knew my child would be OK after a cuddle. | +2 | **+4** | *0* | +3 |
| 28 | During the immunisation procedure, I was worried that my baby couldn’t communicate their feelings to me | **-2** | **-2** | *-3* | **-2** |
| 29 | I felt able to respond well to my infant’s reaction to the immunisation | +1 | **+2** | *0* | *0* |
| 30 | My child responded well to my attempts to soothe them after the immunisation | +2 | **+3** | +1 | *0* |
| 31 | I felt confident in my ability to cope with my infant during the immunisation procedure | **+3** | **+3** | *-1* | *-1* |

*Note.* A = Because the Doctor told me to; B = I know what’s best for my baby; C = Will they really be OK? D = Why wouldn’t you protect them? Ranking assigned to the 31 statements for each factor array. The columns denote the arrangement of statements that make up one factor. Hence, parents in factor A ranked statement 1 at +1, suggesting that they were slightly surprised some parents did not immunise their child. The table rows provide a comparative view of each statement ranked across the factors.

3.1. Factor A. Because the Doctor told me to.

Factor A explained 24% of the variance in parental understanding of infant immunisation and was exemplified by 15 Q-sorts; 14 mothers (8 primiparous) aged 20 to 36. Infants (9 female) were aged 8 to 15 weeks.

Parents focused on the medical benefits of immunisation, believing that accepting the protection offered by vaccinations was part of their job as a parent (7; +4) and duty as a good citizen (6: +3). Parents followed medical advice when deciding whether or not to immunise their infant (9: +3), and hence believed that vaccinations provided an unrivalled protection against disease (3: -3). Consistent with this view, parents strongly believed that immunisations were safe (13: +4), did not worry about their side-effects (11: -3) and felt that vaccinations caused relatively less distress than the diseases themselves (12: -4). Because of their reliance on medical advice, parents completed the decision-making process without stress (4: -3), felt prepared for the immunisation (14: -1), were not scared about attending the appointment (10: -2) and so did not regret their decision after the procedure (5: -4).

Parents were less concerned by infant distress (15: 0), and instead felt confident in their ability to cope with their infant during the procedure (31: +3). Hence, parents did not worry about their infant’s ability to communicate their feelings during the appointment (28: -2) and showed little concern for the identification of behaviours indicative of distress (16: -1; 20: 0; 21: -1; 22: -1; 23: 0). For these parents, pain-related distress was a short-lived consequence of the broader protection offered by immunisations (27: +2) and as such, they felt relatively little guilt (25:0) or distress (24: 0) in response to the observation of infant pain.

3.2. Factor B. I know what’s best for my baby.

Factor B explained 17% of the study variance and accounted for the views of 11 parents (8 mothers) aged 24 to 28 of which seven had other children. Infants (5 female) were 8 to 12 weeks.

Parents were not concerned about external influences upon their vaccination decision; their decisions were neither influenced by medical advice (9: 0) nor that of family and friends (8: +1). Parents did not have strong views on compulsory immunisation uptake (2: 0) suggesting that parents made an independent decision to immunise based on the protective benefits offered to their child alone. Correspondingly, parents believed that taking their child to be vaccinated fulfilled the protective role of parenthood (7: +4), but were not especially concerned about the additional protection vaccines offer the wider community (9: 0). Nevertheless, parents had a positive view of immunisation built on sufficient information (14: -3) that made their decision straight-forward (4: -4). Parents felt that immunisations provided the only form of protection against disease (3: -3), were safe (13: +3), without side-effects (11: -1) and caused less distress to infants than the diseases vaccinated against (12: -2).

Parents were particularly confident in their ability to cope with their infant (31: +3). They were not worried about their infant’s ability to communicate distress (28: -2), or the effectiveness of their resulting soothing strategies (30: +3); parents knew that infant distress would be short-lived (27: +4) and were prepared for it. As such, parents did not find the procedure especially distressing to watch (24: 0) or relate infant distress to pain (17: +2). Consistent with their child-orientated view, immunisations were viewed as a necessary form of protection from disease, and infant distress an outcome that did not warrant feelings of guilt (25: -2) or regret (5: -4).

3.3. Factor C. Will they really be OK?

Factor C explained 13% of the variance, accounting for the views of eight participants; seven mothers (5 primiparous) aged 26 to 38. Infants (5 female), were aged 8 to 24 weeks.

Parents followed the advice of medical professionals when making their immunisation decision (9: +4). They felt it was their 'job' to protect their child from harmful diseases (7: +3) and felt they had a duty to aid the protection of others by attending the appointment (6: +3). Despite this however, parents believed that immunisation uptake was a matter of choice (2: -3) and were not surprised that others opted against vaccination (1: -1).

Despite being confident in the protection offered by immunisations (3: -2), parents seemed unsure about vaccine safety (13: 0); and hence, worried about possible side-effects (11: +2). This suggests that, although parents had sufficient information before their appointment (14: -1), the medical advice received did not instil parental confidence in all aspects of the immunisation procedure (10: 0).

Yet, whilst parental decisions were assured (4: -4; 5: -4), their responses to infant pain expression were less positive. Although parents recognised that the immunisation caused less distress to infants than the diseases being vaccinated against (12: -4), parents believed that infants felt pain because of the injection (15: +2; 17: -2). As such, they found the injection extremely distressing to watch (24: +4) – perhaps because they did not feel particularly able to respond to (29: 0), or cope with (31: -1) their infant during the procedure. Nevertheless, parents were not concerned about their infant’s ability to communicate their distress (28: -3), using general behaviour (16: +2), facial expressions (22: +1), and sounds (20: +3) to identify pain-related distress.

3.4. Factor D. Why wouldn’t you protect them?

Factor C explained 9% of the variance of parental views of immunisation and was exemplified by two first-time mothers aged 21 and 27.

Parents believed that immunisations should be compulsory (2: +3). They were surprised that some infants were not immunised (1: +4) because they believed that it was one’s job as a parent to protect infants from harm (7: +2). Owing to the protection offered by vaccines, the decision making process was not stressful (4: -3), and was therefore made with little influence from medical professionals (9: 0), or family and friends (8: +1).

Parents thought that vaccinations provided the best form of protection against disease (3: -3) and did not worry about any potential side effects (11: -3). Parents strongly believed that vaccinations caused less distress than the diseases they protected against (12: -4), and recognised that although unpleasant, infant pain was a necessary consequence of immunisation (15: 0) that was soon soothed (27: +3). Therefore, whilst parents did not regret their decision (5: -4), they showed great concern for the short-term distress experienced by their infants during the procedure.Parents found the procedure very distressing to watch (24: +4) and felt guilty for the distress the injection inflicted upon their infant (25: +2). Furthermore, parents did not feel very confident in their ability to cope with their infant during the procedure (31: -1), and were unsure about their ability to respond to infant distress (29: 0) and effectiveness of their soothing strategies (30: 0).

# 4. Discussion

The present study investigated the distinctive shared viewpoints of a group of parents who had vaccinated their 2 month-old infants. Four accounts were identified that reflect different understandings of infant immunisation. Whilst these factors are not representative of all possible views about infant immunisation, the findings from the present study were gained from parents who were purposefully selected based on their decision to immunise their infants. Thus, the factors that emerged from the analysis represent a structured understanding of the overriding views of the current study sample. Importantly, although the analysis of the four factors was shaped by distinct viewpoints, there were also some areas of commonality between the views expressed; namely that vaccines provided the best form of protection against disease, and that parents did not regret their pro vaccination choice.

All factor solutions included the shared view that vaccinations provided unrivalled protection against disease. This view is in line with the primary reason for vaccine uptake cited by Tickner et al., [11]. This shared view seems unsurprising given the purposeful selection of participants in terms of their pro-vaccination decision. Yet, whilst this shared view suggests a positive view of the protective outcome gained by immunisation, there were differences between parents regarding their view of the vaccines themselves. Consistent with Tickner et al., [11], parents significantly associated with factors A, B and D shared the view that vaccinations were safe and without any side-effects. However, parents in factor C were distinguished by feelings of uncertainty surrounding vaccine safety and worry about side-effects.

The distinction between factor C and the rest of the sample highlights one of the advantages of investigating health related views using Q-methodology. The unique view of factor C would have been overlooked if parental understandings of immunisation had been studied using traditional methodologies and their ‘one size fits all’ approach. This more cautious view corresponds to that cited by New and Senior [18] and Raithatha et al., [20]. Despite their decision to fully immunise their infants, parents were mindful of potential side-effects. New and Senior [18] reported that this mindfulness made the decision-making process more complex. However, in contrast to New and Senior [18], such difficulty was not corroborated by parents in the current study. This finding suggests that the benefits of protection from disease outweighed concerns about vaccine safety to initiate a simple pro-vaccination decision. This shared view supports findings by Tickner et al., [11], who reported that decisions surrounding vaccination uptake were stress-free because infant immunisation was “the normal thing to do” (p. 6). The demographic composition of the factors suggested that all parents in the present study sample, regardless of parity [cf. 11], found their decision stress-free. Hence, the views of parents in the current study support the notion made by Tickner and colleagues [11] that immunisation uptake has become a social norm, and suggests that there may have been a conceptual shift in the complexity of the decision-making process. However, the attitudes expressed by parents may have been influenced by the completion of the Q-sort after the immunisation. This may have prompted parents to try and justify their decision (both to themselves and the researcher), making them more likely to disagree with statements relating to the process and emotions surrounding their decision.

Yet, the completion of the Q-sort after the immunisation, allowed the exploration of parents’ emotional response to infant pain expression. Factor interpretations however, suggested that the confidence shared by parents in their decision-making, was not felt by all parents during the procedure. Parents in factors C and D were less confident in their ability to cope with their infant during the procedure and the effectiveness of their soothing strategies than those associated with factors A and B. This finding suggests that previous experience may increase parental confidence in their ability to identify and respond to infant pain behaviours [34]. Yet, despite varying opinion on the effectiveness of parental sensitivity, in contrast to the anticipated regret reported by Wroe et al., [15] parents did not regret their decision to immunise their infant. Findings from the current study therefore highlight a shared view that was not identified by prospective studies of parental opinion. This view suggests that feelings of regret are reduced by actual immunisation experience so that feelings of regret are not realised when parents are asked about their opinion after the immunisation.

4.1. Implications and future directions

The views of infant immunisation highlighted in the present study have implications for the medical advice given to parents during their decision-making process. In particular, health care professionals need to take account of the different views about vaccination that parents may have when giving immunisation advice. Parents may benefit from the recognition and normalisation of any regret anticipated during their discussions with medical professionals during the decision-making process. Furthermore, future research could examine whether parental regret expressed after the immunisation procedure can be used as a marker for incomplete fulfilment of the recommended immunisation schedule.

4.2. Strengths and limitations

This study is the first to use Q-methodology to explore distinct parental understandings of routine infant immunisations. Q-sorts were conducted after the immunisation appointment, meaning that previously unidentified differences between parental views about immunisation were highlighted. The use of Q-methodology emphasised elements of diversity that may have been overlooked by traditional methods of standardisation. However, the intrinsic differences between traditional and Q- methodologies mean that there is contention around the extent to which findings can be generalised.

The inherent and deliberate use of small sample sizes in Q-methodology allows the specific viewpoints of a particular group to be established. Whilst it is not part of the rationale of Q-methodology studies, this design means that findings cannot be generalised to the wider population [35]. Nevertheless, this does not make generalisation redundant [33]. Indeed, it is interesting to note that the factor arrays from which interpretations are drawn, are themselves generalisations of the views shared by the significantly loading sorts associated with each factor [36, 37]. Instead, the concepts underlying these interpretations can be *theoretically* generalised to parents with similar characteristics to the current study sample [38]. Nevertheless, these concepts cannot be generalised to parents of older infants, or be related to decisions about different vaccines. Future research could utilise the principles of ‘single case’ Q-methodology and administer the same Q-sort to one parent at multiple immunisation appointments to establish similarities and differences in opinion across time.

4.3. Conclusion

This study demonstrates that parents who have decided to immunise their infants have different views about vaccination. This has implications for health care policy. In particular, there is a need for health care professionals to tailor the advice given to parents during their decision-making process, so that it augments pre-existing ideas about immunisation. For example, advice should include effective soothing strategies to increase parental confidence, particularly in first-time parents, and should provide additional information for parents who continue to be uncertain about vaccine safety after initial consultation. This strategy may prevent negative views of immunisation post-administration that could impact upon future uptake.

# References

[1] World Health Organisation [Internet],; [cited 30th April 2013]. Available from: <http://www.who.int/topics/immunisation/en/>

[2] Taddio A, Ilersich AL, Ipp M, Kikuta A, Shah V. Physical interventions and injection techniques for reducing injection pain during routine childhood immunisations: Systematic review of randomized controlled trials and quasi-randomized controlled trials. Clin Ther. 2009:31: S48-S76.

[3] Cohen LL, Bernard RS, McClelland CB, MacLaren JE. Assessing Medical Room Behavior During Infants' Painful Procedures: The Measure of Adult and Infant Soothing and Distress (MAISD). Child Health Care. 2005;34: 81-94.

[4] Public Health England. Immunisations against infectios disease. London: The Stationery Office; 2013.

[5] Samad L, Butler N, Peckham C, Bedford H, Millennium Cohort Stucy Child Health Group. Incomplete immunisation uptake in infancy: Maternal reasons. Vaccine. 2006;24:6823-6829.

[6] Tickner S, Leman PJ, Woodcock A. Factors underlying suboptimal childhood immunisation. Vaccine. 2006;24:7030-7036.

[7] Coyer SM. Understanding parental concerns about immunisations. J Pediatr Health Care. 2002;16:193-196.

[8] Wakefield AJ, Murch SH, Anthony A, Linnell J, Casson DM, Malik M, Berelowitz M, Dhillon AP, Thomson MA, Harvey P, Valentine A, Davie SE, Walker-Smith JA. RETRACTED: Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children. Lancet. 1998;351:637-641.

[9] Wise J. Measles outbreak hits northeast England. BMJ. 2013; 346.

[10] The Health and Social Care Immunisation Centre, Screening and Immunisations team NHS Immunisation Statistics 2011-2012, England. London: The Health and Social Care Immunisation Centre, Screening and Immunisations team; 2012.

[11] Tickner S, Leman PJ, Woodcock A.‘It's just the normal thing to do’: Exploring parental decision-making about the ‘five-in-one’ vaccine. Vaccine. 2007;25:7399-7409.

[12] Heininger U. An internet-based survey on parental attitudes towards immunisation. Vaccine. 2006;24:6351-6355.

[13] Benin AL, Wisler-Scher DJ, Colson E, Shapiro ED, Holmboe ES. Qualitative analysis of mothers' decision-making about vaccines for infants: the importance of trust. Pediatrics. 2006;117:1532-1541.

[14] Mills E, Jadad AR, Ross C, Wilson K. Systematic review of qualitative studies exploring parental beliefs and attitudes toward childhood vaccination identifies common barriers to vaccination. J Clin Epidemiol. 2005;58:1081-1088.

[15] Wroe AL, Turner N, Salkovskis PM. Understanding and Predicting Parental Decisions About Early Childhood Immunisations. Health Psychol. 2004;23:33-41.

[16] Sporton RK, Francis S-A. Choosing not to immunize: are parents making informed decisions? Fam Pract. 2001.18:181-188.

[17] Hilton S, Petticrew M and Hunt K. ‘Combined vaccines are like a sudden onslaught to the body's immune system’: Parental concerns about vaccine ‘overload’ and ‘immune-vulnerability’. Vaccine. 2006;24:4321-4327.

[18] New SJ, Senior ML.“I don't believe in needles”: Qualitative aspects of a study into the uptake of infant immunisation in two english health authorities. Soc Sci Med. 1991;33:509-518.

[19] Brownlie J, Howson A. ‘Between the demands of truth and government’: Health practitioners, trust and immunisation work. Soc Sci Med. 2006;62:433-443.

[20] Raithatha N, Holland R, Gerrard S, Harvey I. A qualitative investigation of vaccine risk perception amongst parents who immunize their children: a matter of public health concern. J Public Health Med. 2003;25:161-164.

[21] Ritov I, Baron J. Reluctance to vaccinate: omission bias and ambiguity. J Behav Decis Making. 1990;3:263-267.

[22] Harrington PM, Woodman C, Shannon WF. Low immunisation uptake: Is the process the problem? J Clin Epidemiol. 2000;54:394-394.

[23] **Stephenson W. Technique of factor analysis.**Nature. 1935;**136-297.**

[24] **Stephenson, W. Correlating persons instead of tests.**Character and Personality. 1935**;4: 17-24.**

[25] Risdon A, Eccleston C, Crombez G, McCracken L. How can we learn to live with pain? A Q-methodological analysis of the diverse understandings of acceptance of chronic pain. Soc Sci Med. 2003;56:375-386.

[26] Aldrich S and  [Eccleston C.](http://www.bath.ac.uk/view/person_id/392.html) [Making sense of everyday pain.](http://opus.bath.ac.uk/18085/) Soc Sci Med. 2000;50: 1631-1641.

[27] Eccleston C, D Williams AC and Rogers WS. Patients' and professionals' understandings of the causes of chronic pain: Blame, responsibility and identity protection. Soc Sci Med. 1997;45:699-709.

[28] McParland J, Hezeltine L, Serpell M, Eccleston C, Stenner P. An investigation of constructions of justice and injustice in chronic pain: a Q-methodology approach. J Health Psychol. 2011;16:873-883.

[29] Van Exel J, de Graaf G. [Internet] Q methodology: A sneak preview. Online document available from <http://www.qmethod.org>*;* 2005.

[30] Stricklin M. PCQ – Analysis Software for Q-technique; 1992.

[31] Watts S, Stenner P. The subjective experience of partnership love: a Q methodological study. Brit J Soc Psychol. 2005;44: 1-26.

[32] McKeown B, Thomas DB. Q-methodology (2nd ed.). London: Sage; 2013.

[33] Watts S, Stenner P. Doing Q Methodological Research: Theory, Method & Interpretation. London: Sage; 2012.

[34] Pillai Riddell R, Racine N. Assessing pain in infancy: the caregiver context. Pain Res Manag. 2009;14:27-32.

[35] Brown, S. (2002). Q technique and questionnaires. Operant subjectivity. 2003;25:117-126.

[36] Brown. S. Re: Question on generalizability of Q Method findings [Electronic mailing list; 6th July 2010]. Retrieved from [Q-METHOD@LISTSERV.KENT.EDU](mailto:Q-METHOD@LISTSERV.KENT.EDU).

[37] Brown, S. Re: Literature generalization question [Electronic mailing list; 21st August 2012]. Retrieved from [Q-METHOD@LISTSERV.KENT.EDU](mailto:Q-METHOD@LISTSERV.KENT.EDU).

[38] Radley A and Chamberlain K. Health psychology and the study of the case: from method to analytic concern. Soc Sci Med. 2001;53:321-332.

Chapter 6

Parental understandings of infant immunisation and links to vaccine uptake: A Q-methodology study

The results of Chapter 5 indicated that immunising parents express different views about infant immunisation. Parents significantly associated with factors A (*Because the Doctor told me to*) and B (*I know what’s best for my baby*) appeared to be confident in their vaccination decisions and reactions to the procedure. However, those in factors C (*Will they really be OK?*) and D (*Why wouldn’t you protect them?*) were more concerned about their infant’s response and their abilities to manage infant pain responses. In terms of the DIAPR model of infant pain discussed in Chapters 1 and 4, such experiences may alter parental pain schemas and thus affect future immunisation decisions. The more negative views about vaccination shared by parents in factors C and D may therefore be linked to partial vaccine uptake. However, the Q-study reported in Chapter 5 did not examine the relationship between parental viewpoints about subsequent immunisation decisions. Therefore, this chapter presents a further Q-methodology study which re-examines parental viewpoints about immunisation and contextualises factor interpretations using information regarding immunisation uptake.

Abstract

Despite the success of global childhood vaccination programs, parental confidence in vaccine efficacy is dwindling. This study used Q-methodology to explore attitudes amongst parents following the first vaccination of their infants. The aim was to identify beliefs influencing subsequent vaccination decisions and identify potential targets for intervention to promote completion of the UK vaccination schedule. Thirty parents completed a 31-item Q-sort immediately following routine 2 month-old immunisation. Q factor analysis revealed two distinct viewpoints: (1) confidence in vaccinations and decision-making owing to the assurance of protection from disease and (2) concern and distress about the procedure. Results are discussed in terms of shared and distinct viewpoints. Findings indicate that parents’ decisions to vaccinate are dominated by the shared view that vaccination provides the most effective form of protection from disease. Parents who raised concerns about vaccine side-effects and who found the procedure distressing appeared to put these views aside to ensure the continued protection of their children by attending future appointments. Implications are discussed in terms of immunisation advice and future interventions. Specifically, interventions should aim to increase parental confidence in the protection offered by vaccination as a means of overcoming vaccine hesitancy.

# 1. Introduction

The reduction in mortality associated with childhood vaccination is second only to that afforded by clean drinking water [1]. However, during childhood, vaccine uptake is primarily reliant on parental decision-making; firstly to make a pro-vaccination decision and then to attend the scheduled appointment [2].

When making vaccine decisions, many parents perform a risk-benefit analysis whereby factors associated with the advantages of vaccination are weighed against the disadvantages [3-8]. Hence, parental decision-making can be influenced by the evaluation of a number of issues. Common issues include: the quality of vaccine-related information received [4, 6, 9-12]; trust in medical professionals [3, 13-15]; perceptions about vaccine safety [11, 16], vaccine efficacy [4, 8] and the extent to which vaccination may overload infant immune systems [17, 18]; procedural anxiety regarding infant distress [3, 19-21]; a lack of schedule awareness [19, 22-24]; access issues [7, 22, 25, 26]; and societal [8, 13, 20] and/or religious [24, 27] norms. Moreover, these barriers have been found to affect decision-making cross-culturally, and independent of familial income levels [28].

Many parents report a great sense of responsibility to make the ‘right’ decision for their child [5, 29-31]. However, decision outcomes are often met with varying degrees of confidence [16, 20]. For example, a recent study [32] found that whilst most parents vaccinated their children, two thirds had not made an informed decision and that some experienced decisional regret.

Beyond the dichotomy of pro- and anti-vaccination decision outcomes [33], previous studies have found that parents have varied beliefs about immunisation, particularly with regards to vaccine side-effects [4, 9, 17]. In a previous Q-methodology study conducted within a group of vaccinating parents, four distinct viewpoints were found [34] associated with parents who (a) felt they had a duty to vaccinate, (b) immunised for the good of their child alone, (c) were concerned and distressed by vaccination or (d) were surprised at non-compliance with the schedule. Nevertheless, these parents were united in their view that vaccinations provided the best protection from disease, caused less distress to infants than the diseases vaccinated against and that they did not regret their decision to vaccinate.

Variation in parental beliefs about vaccination has implications for the nature of the advice offered to parents during their decision-making process. Given the impact of trusted information upon decision-making [3, 7, 9, 12, 13], advice may need to be tailored to parents’ pre-existing ideas to support an informed risk-benefit analysis. The importance of appropriate information is paramount considering findings that suggest that vaccine decisions made in infancy affect health through childhood and beyond [35]. Moreover, the outcome of vaccine decisions has significant consequences for community health if uptake rates fall below the threshold needed to maintain herd immunity. At present, this risk has been increased by the growth of anti-vaccination movements that threaten the success of current vaccination programmes by casting doubt on vaccine safety and efficacy [2, 36]. In correspondence with these changing views, a small but increasing number of parents are choosing not to immunise their children [36]. Moreover, the break in herd immunity caused by these decreases has been directly linked to current Measles outbreaks that are threatening the eradication of the disease within several global regions by the end of 2015 [37]. Our previous Q-methodology study did not explore the relationship between parental viewpoints and immunisation uptake. Hence, the present study examines parental beliefs within the context of immunisation uptake within the UK primary vaccination schedule.

In addition, previous research has found that the immunisation status of infants at their first scheduled appointment is an important predictor of complete uptake at 2 years [38]. Although primary immunisation uptake is the highest of all the vaccinations due across early childhood [39], with recent changes in vaccine confidence and the UK immunisation schedule, the re-examination of parental viewpoints is timely.

The current study has two aims: firstly, to use Q-methodology to re-examine understandings of infant immunisation in a group of parents who had decided to attend the first vaccination appointment; and secondly to contextualise factor interpretations using information about infant immunisation uptake across the primary vaccination schedule (administered at 2, 3 and 4 months). Findings are discussed in terms of their implications for developing interventions to increase vaccine uptake and policy related to immunisation advice.

# 2. Materials and Methods

2.1. Q-methodology

Q-methodology was developed by William Stephenson to facilitate the scientific study of subjectivity [40]. Participant views are established by means of a Q-sort, in which a participant organises a number of pre-defined statements into a quasi-normal fixed response grid in accordance with their level of agreement or disagreement. The distributions of individual responses are used to group participants in terms of their shared and distinct viewpoints. As such, the sorted statements are treated as the study sample, and the participants as the variables between which similar viewpoints are established [41].

Q-methodology has been used to provide insight into a number of health-related topics [42-44], including understandings of pain [45, 46] and immunisation [34]. The present study extends previous findings related to parental understandings of infant immunisation by using uptake information to contextualise factor interpretations.

2.1.1 Sample size, generalisation and replication in Q-methodology

Because Q-methodology studies aim to describe a range of ideas within a specific population [47], they do not utilise the same experimental designs as R-methodology studies. In Q-methodology, because the participants become the variables between which correlations are established [41], a meaningful factor structure can be established with fewer participants [48-50]. Correspondingly, Q-methodology does not seek to make generalisations from a particular sample to the whole population [49]. Instead, the concepts underlying a particular topic can be *theoretically* generalised from a group of individuals characterising one view to others of a similar type [49, 51]. Therefore, in Q-methodology replicability is the most important form of reliability [52]. Replicability concerns whether or not similar viewpoints about a topic can be found across a similarly structured sample of participants [53, 54]. Hence, replicability can be confirmed by the extent to which “reliable schematics” [49, 55] appear in the underlying meaning of structured viewpoints (i.e. factors) identified in different studies [53]. Previous studies [54, 56] have found consistent results across similar Q-studies conducted after one- to –two-year intervals, thus demonstrating the reliability of Q-method over time.

2.2. Sampling the concourse and designing the Q-set

One of the first steps in Q-methodology study design is to determine the content and number of statements that will be sorted in the Q-sort. Statements were derived from the concourse, a set of all the possible statements that exist or can be devised pertaining to a topic [52]. Statements within the concourse were selected from studies identified from a broad review of relevant literature. Statements were then sorted into 12 categories (e.g., vaccine safety, infant pain-related distress and emotional responses to pain) from which a subset of 31 items were derived as described in Chapter 6.

2.3. Participants

The study was granted ethical approval by the local National Research Ethics Service (NRES) and University ethics committee. Participants were recruited as part of a wider study into the determinants of infant immunisation from one of five medical practices in the North East of England. Potential participants received written information about the study at least one week before their infant’s appointment for their 2 month-old immunisations. In total, 225 care-giver-infant dyads were recruited into the wider study, from which a sample of 30 parents were targeted to participate in the Q-study.

2.4. Procedure

Participants completed the Q-sort immediately after their immunisation appointment. First, participants read through the 31 statements and were instructed to sort them into three roughly equal piles depending on their level of agreement; from strongly agree (+4) through impartiality (0) to strongly disagree (-4). Participants then re-sorted the statements, alternating between the ‘agree’ and ‘disagree’ piles, until all of the statements had been sorted into the appropriate columns on the response grid (Figure 6.1). As participants approached the centre of the grid (0), they were advised to combine the remaining statements with the neutral pile to assist with the placement of the final statements. Participants were then given the opportunity to re-arrange any statements and to comment on the final distribution of items. Finally, participants completed a demographic questionnaire and were fully debriefed.

Approximately 3 months after completion of the Q-sort, the uptake information in relation to the remaining vaccines in the primary schedule (administered at 3 and 4 months) were established from patient records. Records relating to one infant could not be obtained.

# 2.5. Statistical analysis

The 30 Q-sorts in the final dataset were entered into PCQ [57], a software package specifically developed for Q-sort analysis. A by-person correlation of each Q-sort with every other was then computed to generate a correlation matrix. This matrix was then subject to centroid factor analysis before the extracted factors were rotated using varimax. Factor rotation was stopped after two factors because no Q-sorts loaded significantly onto a third factor. Next, a factor array was generated for each factor. The factor array depicts an idealised Q-sort that demonstrates the shared view of the participants associated with each factor (Figure 6.1). It is generated by the calculation of the average ranking assigned to each item by the participants that significantly load onto each factor. Hence, there is a similarity between the arrangement of items within an individual Q-sort and its associated factor array that varies in accordance with the strength of its loading on that factor. The significance level of this correlation value is determined by the number of items in the Q-set (n = 31). As such, a Q-sort significantly loaded onto one factor if it had a correlation greater than or equal to .46 at *p <* .01 level.

The two-factor solution explained 61% of the variance in parental views about infant immunisation, accounting for the views of 22 parents. Six of the remaining Q-sorts were confounded as they significantly loaded onto more than one factor, thus characterising a broader view of the topic. The remaining two Q-sorts were non-significant as they did not significantly load onto either factor.



Figure 6.1. Fixed response grid. Here, statements in the grid are arranged in accordance with the factor array associated with Factor A. Numbers in (brackets) indicate the number of statements sorted under each column. During the procedure, participants placed statements into a blank response grid.

# 3. Results

3.1. Study sample

The final sample included 29 mothers and one father. Parents were aged between 17 and 41 years (*M =* 30.70, *SD =* 5.47). The majority of parents were married (n = 17) or living with their partner (n = 10) and had a least one child in addition to the infant being immunised (n = 18). Infants (18 female) due for immunisation were aged between 8 and 12 weeks (*M =* 8.57, *SD =* .935). Immunisation uptake data was available for 29 of the 30 infants. Of these, only one had not completed the recommended primary course of vaccinations. Consequently, the extent to which different patterns of vaccine uptake (e.g. incomplete, partial, complete) could be used to contextualise factor interpretations was limited. As such, the factor interpretations that follow provide insight into the different viewpoints of parents who chose to completely immunise their infants in the first 3 months of life.

3.2. Factor Interpretation

Factors were interpreted in turn. Factors were interpreted using the crib sheet methods described by Watts and Stenner [48]. Statements given the highest and lowest rakings (+4, -4) within each factor array in addition to those ranked higher or lower in factor A compared to factor B were noted (Table 6.1). Next relevant demographic information as well as the immunisation status of infants associated with significantly loading sorts (most of which were classed as immunised) was used to contextualise factor interpretations. Other pertinent statements, such as those distinguishing each factor by being located at least 3 piles apart in each factor array were added to the crib sheet by re-examining factor arrays.

The primary author prepared initial narrative interpretations that were discussed in detail with the remaining study authors to develop a holistic account of each factor. Comments made by participants about their item placement were also transcribed and used to enhance factor interpretations. In the interpretations that follow, statements will be identified in brackets by (number: ranking).

Table 6.1. By-factor rankings of statements in the Q-set.

|  |  |  |  |
| --- | --- | --- | --- |
| **No.** | **Statement** | **A** | **B** |
| 1 | I am surprised that some parents choose not to immunise their children against harmful diseases. | +4 | -2 |
| 2 | I believe that infant immunisation should be compulsory | +3 | -1 |
| 3 | I believe that there are alternative ways of protecting my child from harmful illnesses instead of vaccinations | -4 | -3 |
| 4 | I found it stressful to decide whether or not to immunise my child | -3 | -3 |
| 5 | I regret my decision about immunising my child | -3 | -4 |
| 6 | I believe it is part of my duty as a good citizen to immunise my child, to prevent the spread of harmful diseases within the population. | +3 | 0 |
| 7 | It is my ‘job’ to protect my child from harmful diseases | +4 | +4 |
| 8 | My decision to vaccinate my child was not influenced by my family or friends | +1 | -1 |
| 9 | I followed the advice of medical professionals when deciding whether to immunise my child. | +2 | +1 |
| 10 | I felt scared/ fearful about taking my baby to get their immunisations | -2 | -1 |
| 11 | I worry about the side-effects that my infant may experience as a result of immunisation | -1 | +2 |
| 12 | The immunisation procedure caused more distress to my infant than if they caught the disease that they had been immunised against | -4 | -4 |
| 13 | I believe that immunisations are safe | +1 | +2 |
| 14 | I would have liked more information about infant immunisations before I took my child to the well-baby clinic for their immunisation appointment | -2 | -2 |
| 15 | My infant experienced pain because of their immunisations | 0 | 0 |
| 16 | I could tell that my child was distressed by their injections because of their general behaviour during their immunisation | 0 | +3 |
| 17 | My child was more shocked than in pain when they received their injections | +1 | -1 |
| 18 | I put myself in my infant’s shoes when they got their injections | -1 | +1 |
| 19 | My child’s vaccination was worse than ones that I can recall | -2 | -2 |
| 20 | I could tell that my child was distressed by their immunisation because of the sounds they made | 0 | 0 |
| 21 | I could tell that my child was distressed by their immunisation because of their facial expression | 0 | +1 |
| 22 | I could tell that my child was distressed by their immunisation because of their body movements | 0 | 0 |
| 23 | I could tell that my child was distressed because they went red in colour | -1 | +2 |
| 24 | I found watching my infant get immunised distressing | 0 | +4 |
| 25 | I felt guilty about upsetting/ causing harm to my infant during the immunisation | -3 | 0 |
| 26 | I tried not to show my anxiety to my child during the immunisation | 0 | +3 |
| 27 | Although the procedure was not nice, I knew my child would be OK after a cuddle. | +3 | +1 |
| 28 | During the immunisation procedure, I was worried that my baby couldn’t communicate their feelings to me | -1 | -3 |
| 29 | I felt able to respond well to my infant’s reaction to the immunisation | +2 | 0 |
| 30 | My child responded well to my attempts to soothe them after the immunisation | +1 | +3 |
| 31 | I felt confident in my ability to cope with my infant during the immunisation procedure | +2 | 0 |

*Note*. A = There’s a risk involved in everything. Just the risk of the injections is less; B = I think Mam’s dreading this more than he is. Columns denote factor scores within one factor. The columns denote the arrangement of statements that make up one factor (e.g., parents in factor B ranked statement 24 at +4, indicating that they found the procedure very distressing to watch). Rows allow statement rankings to be compared between factors.

3.2.1. Factor A: There’s a risk involved in everything, just the risk of the injections is less.

Factor A explained 38% of the variance in parental views about infant immunisation and was characterised by 14 Q-sorts: 13 mothers (1 father) aged between 20 to 35 years (*M =* 30.36, *SD =* 4.09). Ten had more than one child and four were first-time parents. Twelve infants had completed the primary immunisation course. One infant had not received the final vaccination due at 4 months. Because the majority of parents had chosen to vaccinate their infants, the views summarised in the factors interpretations reflect this demographic.

Parents strongly believed that vaccination provided the best protection from disease (3: -4). For these parents, the risk of disease far outweighed that of vaccination (12: -4): “There’s a risk involved in everything. Just the risk of the injections is less” (Q25)*.* Consequentially, issues surrounding vaccine safety (13: +1) and potential side-effects (11: -1) were not central to their view. As one parent stated: “It’s not that I think they’re unsafe or safe, but that they’re necessary” (Q25). Beliefs related to the necessity of immunisation influenced parental views about decision-making. Parents had “*strong opinions about parents who [did not] vaccinate” (Q27)*, believing that infant immunisation should be compulsory (2: +3). For these parents, the act of infant immunisation facilitated their perceived role to protect both their child (7: +4) and wider society (6: +3). As such, parents were surprised that others did not share their views and instead chose not to immunise their children (1: +4).

The strength of these beliefs inspired confidence within this group of parents. Parents felt confident during the decision-making process (4: -3) and subsequently, did not regret their decision to vaccinate (5: -3). Similarly, parents did not experience negative emotions in anticipation of (10: -2), or during, the procedure (31: +2; 26: 0). Convinced about the necessity of immunisation, parents did not feel guilty (25: -3) about the pain experienced by infants during the procedure. Parents were not distressed by their child’s reaction to the injections (24: 0), as they knew that their distress would be short-lived (27: +3). Hence, they were relatively unconcerned by the distress behaviours expressed by infants response to the injections (16: 0; 21: 0; 23: -1) and associated them with shock of the injections rather than pain (17: +1). Furthermore, parents were confident in their ability to cope with their distressed infants (31: +2) and that their adopted soothing strategies were effective (30: +1; 29: +2).

3.2.2. Factor B: I think Mam’s dreading this more than he is.

Factor B explained 23% of the study variance and was exemplified by eight parents. All were mothers aged between 17 to 41 years (*M =* 30.63, *SD =* 7.19). Three were first-time parents and five had more than one child. At follow-up, all infants had completed the primary course of immunisations, therefore factors were interpreted in light of this, and reflect the views of immunising parents. .

Views appeared to be shaped by the potential consequences of vaccination for individual children (7: +4), rather than the wider community (6: 0): “*That’s the overall goal isn’t it?” (Q.4).* Consequently, parents believed that vaccination should be a choice (2: -1) and that they made autonomous decisions that were not influenced by external sources of information (9: +1; 8: -1). As such, parents were not surprised that other parents chose not immunise their children (1: -2). However, for these parents, vaccination provided the best protection from disease (3: -3; 12: -4), and hence for *their* child, it was the obvious choice. As such, these parents did not report any regret after the procedure (5: -4). One parent commented: “*I can tell you why they don’t come, its ‘cos they don’t know…. If you showed them a video of a child with the diseases then suddenly a little prick doesn’t seem so bad” (Q9).*

Despite their confidence in the efficacy of the protection provided by vaccination, parents appeared more uncertain about the risk of side-effects (11: +2) and vaccine safety (13: +2). One parent stated, “*I don’t know the answer – that’s something I’ve struggled with. I believe generally they’re safe, but not for everyone” (Q13).*

Similarly, parents were also concerned about the procedure itself. Whilst parents did not feel particularly apprehensive before the procedure (10: -1), their emotions seemed to change during the procedure. For example, parents found it extremely distressing to watch their infant get immunised (24: +4), and tried not to show their anxiety to their infant during the procedure (26: +3); *“I think Mam’s [been] dreading this more than he [has]” (Q13).* This emotional state prompted an acute awareness of infant pain (17: -1) and the behaviours expressed in response to the procedure (16: +3; 21: +1; 23: +2). Correspondingly, parents were not worried about their infant’s ability to communicate their distress (28: -3). However, they were unsure about their own ability to cope with their infant after the procedure (31. 0; 29: 0) and doubted whether they would be easily soothed (27: +1). However, this uncertainty appeared to decrease as parents saw that their soothing strategies relieve infant distress (30: +3).

# 4. Discussion

This study examined parental viewpoints about immunisation. To our knowledge, this is the first study to examine parental viewpoints about immunisation after first vaccination and to follow subsequent uptake across the primary vaccine schedule. However, because the majority of parents had infants who completed the primary vaccine schedule, factor interpretations reflect the views of a group of immunising parents rather than the views of parents who had made a range of different decisions regarding vaccine uptake as intended in the study design. Two distinct viewpoints were identified that were shared by the parents within each factor. Three main themes distinguished parental viewpoints: choice regarding decision outcomes, emotional responses to the procedure and concerns about vaccine side-effects.

Comparing factors, parents had different views regarding the degree of choice that should be permitted over decisions about vaccine uptake. Parents in factor B (*Mam’s dread*) valued decisional choice and were open-minded about the decisions of non-immunising parents. This view is in line with opinions about decision-making advocated by parents in previous studies [4, 9, 16, 20, 27] and with parents in factor C (*Will they really be OK?*) identified in the previous Q-study [34]. However, the tolerance of anti-vaccination decisions made by other parents indicates that parents in factor B (*Mam’s dread*) were not motivated to vaccinate in order to comply with social norms [cf. 8, 11, 20]. Furthermore, these parents seemed to be less surprised that other parents might not vaccinate their children than those in the previous Q-study. This view may therefore reflect the growing prevalence of alternative vaccination decisions that have been advocated by the rise of anti-vaccine movements. Conversely, parents in factor A (*Risk in everything*) believed that immunisations should be compulsory and negatively judged those who had decided against vaccination, reflecting concern regarding the acknowledgement of non-compliance reported in previous studies [10, 15]. As such, for these parents, who are invested in herd immunity, advocating compulsory vaccination guarantees protection from disease for all, and promotes social norms associated with immunisation.

Parents in each factor were also distinguished by their views about the vaccines themselves. Consistent with previous studies [4, 9, 17], parents had different views about vaccine safety and side-effects despite their shared decision to immunise. Parents in factor A (*Risk in everything*) were relatively less concerned about vaccine safety and side-effects than those in factor B (*Mam’s dread*). This more cautious view suggests that, without an adequate alternative method of protection, parents in factor B put their concerns aside to ensure their child was protected against harmful diseases. These views are reflected by those identified in the previous Q-study in factors B (*I know what’s best for my baby*) and C (*Will they really be OK?*), respectively. However, the viewpoints identified in the present study did not reflect the complete lack of concern by parents in factors A (*Because the Doctor told me to*) and D (*Why wouldn’t you protect them?*) of the previous study [34]. The absence of this view perhaps further reflects the decreases in vaccine confidence that have been recently reported [2, 36, 37].

In the present study, parents who were more concerned about vaccination also had an increased emotional response to the procedure. Parents in factor B (*Mam’s dread*) found the procedure more distressing to watch than those in factor A (*Risk in everything*), corroborating notions of procedural anxiety reported in previous studies [3, 19-21, 34]. This anxiety may have been exaggerated by concerns about vaccine side-effects and a lack of confidence regarding their own ability to cope with infant pain. As such, parents in factor B may have been acutely aware of infant pain-related behaviours and thus found them more distressing to watch compared to parents in Factor A who did not share these concerns.

The emotional responses expressed by parents in factor B may suggest implications for the nature of immunisation advice. Parents who are distressed prior to infant immunisation may find additional support regarding the nature of infant pain expression and appropriate soothing strategies (e.g. encouraging the use of a pacifier [58, 59]) helpful. Such information may increase parental confidence associated with infant soothing during the procedure. Moreover, previous research has suggested that parental concerns or distress about vaccination can lead to needle fear and an aversion to seeking medical treatment for both themselves and their child [60]. Thus, increasing parental confidence during the procedure may prevent these views from being passed onto children in future vaccination appointments.

Despite the differences between parental viewpoints, high levels of vaccine uptake also suggest some that *shared* views about vaccination drive parental decisions about uptake. Corroborating the findings of previous studies [20], parents shared the view that it was their ‘job’ as a parent to protect their child from harm. Believing that vaccinations provide the best protection from disease, vaccination was the obvious choice for these parents. Hence, parents in factor B (*Mam’s dread*) were able to tolerate the distress of the procedure to ensure their child received the necessary protection from disease.

Emphasising the most pertinent views amongst immunising parents may highlight potential targets for future intervention. Findings from the present study suggest that parents who believed that vaccination provided the best course of protection were able to put aside their concerns about vaccination, and/or the procedure, aside to fulfil their primary aim of ensuring that their child was not at risk of disease. However, in parents who are more uncertain about the efficacy of vaccination, views associated with these issues may exaggerate vaccine hesitancy and impact upon uptake decisions. Therefore, future research should examine the efficacy of interventions to increase parental confidence in vaccine efficacy and investigate the impact of increased confidence on uptake.

4.1. Strengths and limitations

The present study is the first to explore parental viewpoints about immunisation after the first immunisation appointment and prospective decisions about vaccine uptake during the primary immunisation schedule. Although parents had different views regarding immunisation, the majority of parents returned to the clinic for future immunisations. Hence, the high rate of immunisation uptake within the sample, limits the extent to which the immunisation status of infants could be used to contextualise factor interpretations. Consequently, insights gained into parental viewpoints about vaccination relate to those that are shared between completely immunising parents rather than those that might distinguish completely and partially immunising parents. The use of Q-methodology highlighted shared views amongst immunising parents that may be of principal importance when making uptake decisions. Although these shared views do not represent an exhaustive account of all parental viewpoints regarding immunisation, they represent a structured understanding of the dominant views within the current study sample. In addition, findings from the present study replicate previous Q-findings [34] related to shared views about the overriding desire to protect children from disease prompting a lack of stress and regret associated with vaccine decisions, and distinct viewpoints about the compulsory nature of vaccination, and emotional responses to the procedure.

Nevertheless, several differences were apparent between the two studies. Firstly, the distinct views of parents in factors A (*Because the Doctor told me to*), B (*I know what’s best for my baby*) and D (*Why wouldn’t you protect them?*) identified in the first Q-study appear to have, to some degree, been incorporated into the views shared by parents in factor A (*Risk in everything*) identified in the second Q-study. Secondly, the extent to which parents followed medical advice in Factor A and C of the first study was not as apparent in the second study. Given that Q-methodology aims to explore notions of subjectivity, it is unclear whether these views are simply a measurement of that subjectivity - as one participant stated: *“This is my knee jerk reaction to my experience, if you asked me tomorrow it would probably be different”(Q4)*; or whether these views do in fact demonstrate a change in viewpoint from the previous Q-study. However, given that many of the underlying concepts identified in both studies were representative of similar shared views, the absence of such strong agreement with medical advice could be attributed to reported increases in vaccine hesitancy and an increasing independence in vaccine decision-making. Parents may have been more aware of the messages proposed by anti-vaccination movements during their decision-making and thus, conducted a more in-depth risk-benefit analysis rather than simply following medical advice.

However, the present study cannot comment on parental viewpoints beyond those associated with immunisations in the primary vaccination schedule. Findings from the present study cannot be generalised to the views of parents who have refused vaccination or to vaccinations administered after the primary schedule. A further Q-methodology study with a group of parents who have decided to accept or to reject vaccination, and which also explores viewpoints regarding other vaccinations (e.g. MMR), might provide additional insight into the hierarchical nature of immunisation belief that could be utilised to increase the specificity of current interventions.

4.2. Conclusions

Findings from the present study suggest that parents who have decided to immunise their children have different views about vaccination. However, information relating to immunisation uptake suggested that shared views about immunisation provide clues to uptake decisions. These findings suggest that the main aim of immunising parents is to ensure that their child is protected from disease and that vaccination is the most effective form of protection. Even parents who found the procedure particularly distressing were able to put these emotions aside to ensure that their child was protected from disease. In light of the recent rise of anti-vaccination movements that cast doubt on vaccine efficacy, these findings suggest that future interventions should aim to target parental perceptions of vaccine efficacy in an attempt to overcome vaccine hesitancy and increase future vaccine uptake.

References

[1] Plotkin SL, Plotkin SA. A Short History of Vaccination. In: Plotkin SA, Orenstein WA, Offit PA, editors. *Vaccines*. Philadelphia: Sanders, Elsevier; 2008. p. 1-14.

[2] Sadaf A, Richards JL, Glanz J, Salmon DA, Omer SB. A systematic review of interventions for reducing parental vaccine refusal and vaccine hesitancy. Vaccine. 2013;31:4293-304.

[3] Austin, H., Parents' perceptions of information on immunisations. J Child Health Care. 2001;5:54-59.

[4] Bond L, Nolan T, Lester R. Vaccine preventable diseases and immunisations: a qualitative study of mothers' perceptions of severity, susceptibility, benefits and barriers. Aust NZ J Publ Heal. 1998;22:441-6.

[5] Glanz JM, Wagner NM, Narwaney KJ, Shoup JA, McClure DL, McCormick EV, Daley MF. A mixed methods study of parental vaccine decision-making and parent-provider trust. Acad Pediatr. 2013;13:481-488.

[6] Gullion JS, Henry L, Gullion G. Deciding to opt out of childhood vaccination mandates. Pub Health Nurs. 2008;25:401-408.

[7] New SJ, Senior ML.“I don't believe in needles”: Qualitative aspects of a study into the uptake of infant immunisation in two english health authorities. Soc Sci Med. 1991;33:509-518.

[8] Tarrant M, Thomson N. Secrets to success: a qualitative study of perceptions of childhood immunisations in a highly immunised population. J Paediatr Child H. 2008;44:541-7.

[9] Bond L, Nolan T. Making sense of perceptions of risk of diseases and vaccinations: a qualitative study combining models of health beliefs, decision-making and risk perception. BMC Pub health. 2011;11:943.

[10] Gardner B, Davies A, McAteer J, Michie S. Beliefs underlying UK parents' views towards MMR promotion interventions: a qualitative study. Psych Health Med. 2010;15:220-30.

[11] Evans M, Stoddart H, Condon L, Freeman E, Grizzell M, Mullen R. Parents' perspectives on the MMR immunisation: a focus group study. Brit J Gen Pract. 2001;51:904-10.

[12] Miller NK, Verhoef M, Cardwell K. Rural parents' perspectives about information on child immunization. Rural Remote Health. 2008;8:863-863.

[13] Austvoll-Dahlgren A, Helseth S. What informs parents' decision-making about childhood vaccinations? J Adv Nurs. 2010;66:2421-2430.

[14] Benin AL, Wisler-Scher DJ, Colson E, Shapiro ED, Holmboe ES. Qualitative analysis of mothers' decision-making about vaccines for infants: the importance of trust. Pediatrics. 2006;117:1532-1541.

[15] Hilton S, Petticrew M and Hunt K. Parents' champions vs. vested interests: who do parents believe about MMR? A qualitative study. BMC Pub Health. 2007;7:42.

[16] Watson PB, Yarwood J, Chenery K. Meningococcal B: Tell me everything you know and everything you don't know. New Zealanders' decision-making regarding an immunisation programme. NZ Med J. 2007.

[17] Hilton S, Petticrew M and Hunt K. ‘Combined vaccines are like a sudden onslaught to the body's immune system’: Parental concerns about vaccine ‘overload’ and ‘immune-vulnerability’. Vaccine. 2006;24:4321-4327.

[18] Hulsey E, Bland T. Immune overload: Parental attitudes toward combination and single antigen vaccines. Vaccine. 2015;33:2546-50.

[19] Niederhauser VP, Markowitz M. Barriers to immunizations: multiethnic parents of under- and unimmunized children speak. J Am Acad Nurse Pract. 2007;19:15-23.

[20] Tickner S, Leman PJ, Woodcock A.‘It's just the normal thing to do’: Exploring parental decision-making about the ‘five-in-one’ vaccine. Vaccine. 2007;25:7399-7409.

[21] Tarrant M, Gregory D. Exploring childhood immunization uptake with First Nations mothers in north-western Ontario, Canada. J Adv Nurs. 2003;41:63-72.

[22] Luthy KE, Beckstrand RL, Callister LC, Parental hesitation in immunizing children in Utah. Public Health Nurs. 2010;27:25-31.

[23] Tickner S, Leman PJ, Woodcock A. Parents' views about pre-school immunization: an interview study in southern England. Child: Care, Health Dev. 2010;36:190-197.

[24] Wilson T. Factors influencing the immunization status of children in a rural setting. J Paediatr Healthcare. 2000;14:117-121.

[25] McCormick LK, Bartholomew LK, Lewis MJ, Brown MW, Hanson IC. Parental perceptions of barriers to childhood immunization: results of focus groups conducted in an urban population. Health Educ Res. 1997;12:355-62.

[26] Topuzoglu A, Ay P, Hidiroglu S, Gurbuz Y. The barriers against childhood immunizations: a qualitative research among socio-economically disadvantaged mothers. Eur J Public Health. 2007;17:348-352.

[27] Tomlinson N, Redwood S. Health beliefs about preschool immunisations: an exploration of the views of Somali women resident in the UK. Diversity & Equality in Health & Care. 2013;10:101-113.

[28] Kaufman, J, Synnot A, Ryan R, Hill S, Horey D, Willis N, Lin V, Robinson P. Face to face interventions for informing or educating parents about early childhood vaccination (review). Cochrane Database of Systematic Rev. 2013;5:1-69.

[29] Leask J, Chapman S, Hawe P, Burgess M. What maintains parental support for vaccination when challenged by anti-vaccination messages? A qualitative study. Vaccine. 2006;24:7238-45.

[30] Brown K, Long SJ, Ramsay M, Hudson MJ, Green J, Vincent CA, Kroll JS, Fraser G, Sevdalis N. U.K. parents' decision-making about measles-mumps-rubella (MMR) vaccine 10 years after the MMR-autism controversy: a qualitative analysis. Vaccine. 2012;30:1855-1864.

[31] Sporton RK, Francis S-A. Choosing not to immunize: are parents making informed decisions? Fam Pract. 2001.18:181-188.

[32] Shourie S, Jackson C, Cheater FM, Bekker HL, Edlin R, Tubeuf S, Harrison W et al, A cluster randomised controlled trial of a web based decision aid to support parents' decisions about their child's Measles Mumps and Rubella (MMR) vaccination. Vaccine 2013;31:6003-10.

[33] Gust D, Brown C, Sheedy K, Hibbs B, Weaver D, Nowak G. Immunization attitudes and beliefs among parents: beyond a dichotomous perspective. Am J Health Behav. 2005;29:81-92.

[34] Harvey H, Good J, Mason J, Reissland N. A Q-methodology study of parental understandings of infant immunisation: implications for health-care advice. J Heal Psychol. 2013.

[35] Taddio A, Chambers CT, Halperin SA, Ipp M, Lockett D, Rieder MJ, Shah V. Inadequate pain management during routine childhood immunizations: the nerve of it. Clin Ther. 2009;31:S152-67.

[36] Tafuri S, Gallone MS, Cappelli MG, Martinelli D, Prato R, Germinario C. Addressing the anti-vaccination movement and the role of HCWs. Vaccine. 2014;32:4860-4865.

[37] World Health Organisation. [Internet],; WHO/Europe calls for scaled-up vaccination against measles. [cited 2015 March 25 2015]. Available from: <http://www.euro.who.int/en/media-centre/sections/press->releases/2015/whoeurope-calls-for-scaled-up-vaccination-against-measles.

[38] Rainger W, Solomon N, Jones N, Jarman J, Turner N, Lennon D, Stewart J. Immunisation coverage and risk factors for immunisation failure in Auckland and Northland. NZ Public Health Rep. 1998;5:49 -51.

[39] The Health and Social Care Immunisation Centre, Screening and Immunisations team NHS Immunisation Statistics 2012-2013, England. London: The Health and Social Care Immunisation Centre, Screening and Immunisations team; 2014.

[40] **Stephenson W. Technique of factor analysis.**Nature. 1935;**136-297.**

[41] **Stephenson, W. Correlating persons instead of tests*.***Character and Personality. 1935;**4: 17-24.**

[42] Bryant LD, Green JM, Hewison J. Understandings of Down's syndrome: AQ methodological investigation. Soc Sci Med. 2006;63:1188-1200.

[43] Van Exel J, de Graaf G Brouwer W. Care for a break? An investigation of informal caregivers’ attitudes toward respite care using Q-methodology. Health Policy. 2007;83:332-342.

[44] Akhtar-Danesh N, Dehghan M, Morrison KM, Fonseka S. Parents’ perceptions and attitudes on childhood obesity: AQ‐methodology study. J Am Acad Nurse Pract. 2011;23:67-75.

[45] Aldrich S and  [Eccleston C.](http://www.bath.ac.uk/view/person_id/392.html) [Making sense of everyday pain.](http://opus.bath.ac.uk/18085/) Soc Sci Med. 2000;50: 1631-1641.

[46] McParland J, Hezeltine L, Serpell M, Eccleston C, Stenner P. An investigation of constructions of justice and injustice in chronic pain: a Q-methodology approach. J Health Psychol. 2011;16:873-883.

[47] Risdon A, Eccleston C, Crombez G, McCracken L. How can we learn to live with pain? A Q-methodological analysis of the diverse understandings of acceptance of chronic pain. Soc Sci Med. 2003;56:375-386.

[48] Watts S, Stenner P. Doing Q Methodological Research: Theory, Method & Interpretation. London: Sage; 2012.

[49] Brown SR. *Political subjectivity: Applications of Q methodology in political science.* Yale University Press; 1980.

[50] **Stephenson, W.** *The study of behavior; Q-technique and its methodology.* 1953.

[51] Radley A and Chamberlain K. Health psychology and the study of the case: from method to analytic concern. Soc Sci Med. 2001;53:321-332.

[52] Van Exel J, de Graaf G. [Internet] Q methodology: A sneak preview. Online document available from <http://www.qmethod.org>*;* 2005.

[53] D'Agostino B. Replicability of results with theoretical rotation. Operant Subjectivity. 1984;73:81-87.

[54] Fairweather J. Reliability and validity of Q-method results: Some empirical evidence. Operant Subjectivity. 1981;5:2-16.

[55] Thomas DB, Baas LR. The issue of generalization in Q methodology:“Reliable schematics” revisited. Operant Subjectivity. 1992;16: 18-36.

[56] Brenner DJ. The Dynamics of Public Opinion on the Vietnam War. Sci Psychol

Comm. 1972.

[57] Stricklin M. PCQ – Analysis Software for Q-technique; 1992.

[58] Pillai Riddell R, Racine NM, Turcotte K, Uman LS, Horton RE, Osmun LD, Ahola Kohut S, J Hillgrove Stuart, Stevens B, Gerwitz-Stern A. Non-pharmacological management of infant and young child procedural pain. Cochrane Database Systematic Reviews. 2011;10.

[59] Shah PS, Aliwalas LL, Shah VS. Breastfeeding or breast milk for procedural pain in neonates. Cochrane Database Systematic Reviews. 2012;12.

[60] Taddio A, Ipp M, Thivakaran S, Jamal A, Parikh C, Smart S, Sovran J, Stephens D, Katz J. Survey of the prevalence of immunization non-compliance due to needle fears in children and adults. Vaccine. 2012;30:4807-4812.

Chapter 7

General Discussion

The studies presented in this thesis have investigated a number of factors associated with the role of the care-giver in infant immunisation uptake and pain expression. This chapter provides an overview of the main findings reported in this thesis, discusses their implications for clinical practice and future intervention, and considers methodological issues arising from the primary research conducted.

# 1. Summary of findings

A systematic review and meta-analysis of interventions to improve parental uptake of early childhood (0-5 years) vaccinations, namely parental reminders and methods of education, was presented in Chapter 2. Findings from the meta-analysis indicated that that all interventions were to some extent effective. Receiving postal and telephone reminders was the most effective type of intervention. The success of vaccine-related education was particularly successful in low to middle income countries (LMICs) and when it was delivered via discussion with a medical professional. The systematic review of qualitative studies in Chapter 3 explored parental views about early childhood immunisation, and identified eight recommendations for infant immunisation programmes. To assess the appropriateness of current interventions to improve uptake and to inform future trials, qualitative review findings were then integrated with the results of the meta-analysis from Chapter 2. Findings from the thematic synthesis show that parents hold a variety of positive and negative views and beliefs about vaccination that lead to a complex range of outcomes. Integrating these findings with trials supported the use of reminder and discussion-based educational interventions to promote vaccine uptake, but suggested that current uptake interventions did not acknowledge the need for balanced, timely and evidence-based information.

The prospective cohort study (Chapter 4) showed that there was, at best, a weak relationship between care-giver behaviour and infant pain expression throughout the routine immunisation procedure. More specific analysis of the injection phases within the procedure suggested that injection technique and use of pacifying (via dummy, breast or bottle) might be important sources of variance in infant pain expression; associated with 7% and 10% reductions in pain, respectively. However, whilst encouraging, given exploratory nature of the study and the breadth of determinants explored, conclusions drawn from these findings should not be overestimated. Further research is needed before more concrete recommendations for routine practice can be made regarding the efficacy of these strategies. Additionally, neither infant pain expression nor caregiver characteristics predicted subsequent vaccine uptake during the first year of life.

Chapters 5 and 6 used Q-methodology to explore parental viewpoints about infant immunisation. In chapter 6, owing to the immunisation status of the infants whose vaccinations were the focus of study, factors exemplified the views of parents who had completely immunised their children according to the primary vaccination schedule. Consequently, the views of parents who had made alternative vaccine decisions could not be exemplified in the factor interpretations. Findings indicated that, although immunising parents had distinct viewpoints about immunisation, they also had shared views. Immunising parents had shared views regarding a duty to protect children and shared beliefs that immunisations provided the best protection from disease, dominated uptake decisions.

Overall, this thesis has addressed questions relating to the role of the care-giver in (1) immunisation uptake and (2) infant pain expression. Related to immunisation uptake, previous research had not examined the efficacy or appropriateness of current interventions targeting early childhood vaccine uptake, or the impact of immunisation experience on parental views and decision-making. Concerning infant pain expression, previous research examining the extent to which care-giver behaviour influences infant pain expression has been hampered by inconsistent findings associated with small sample sizes and the varying contexts of observations. These issues limit our understanding of the value of parental strategies to reduce infant pain. Findings related to immunisation uptake and infant pain are discussed in turn; emphasising how the primary and secondary research conducted in this thesis has contributed to the field.

# 2. Vaccine uptake

A number of barriers to immunisation uptake have been suggested: parental concern about the risks of vaccination and immunisation pain; discordance between advice from medical professionals and from family and friends; and lack of schedule awareness and access issues [1-5]. Additionally, previous studies have suggested a dichotomy between the positive views of parents who made a pro-vaccination decision and the negative views of those who had opted against immunisation.

Whilst the key themes highlighted in the qualitative review conducted in this thesis support those of previous systematic reviews [1-5], findings from this thesis suggest that parental views about early childhood vaccination cannot be constructed as a simple dichotomy. Instead, findings from the qualitative review and Q-methodology studies presented in Chapters 3, 5 and 6 suggest a more complex picture. Factors that influence parental decision-making and vaccine beliefs are more nuanced. Immunisers may share concerns about vaccine efficacy and side-effects, while non-immunisers may not be wholly resistant to vaccination. Previous studies have been dominated by parental viewpoints about the MMR vaccine, potentially misleading policy makers that parents are unconcerned about other vaccinations given to infants as part of the primary schedule. However, findings from both Q-studies reported in this thesis suggest that is not the case. In both studies a group of parents could be distinguished by their shared concern regarding vaccine side-effects. However, despite these concerns, findings from chapter 6 suggested that that majority of parents still chose to immunise their infants against all vaccines in the primary schedule.

Published findings suggest that immunisation pain acts as a barrier to immunisation uptake [5]. However, studies have not differentiated between whether concern about immunisation pain prevents initial uptake, or whether experience of the procedure and subsequent infant pain expression prevents future appointment attendance, resulting in partial uptake. Chapter 4 showed that neither infant pain expression nor parental demographics were related to subsequent immunisation uptake during the first year of life. Similarly, views related to infant pain did not dominate the parental viewpoints reported in Chapters 5 and 6. Contrary to findings from studies conducted in anticipation of the vaccination procedure, these findings suggest that parents did not feel especially guilty or responsible for infant pain, indicating that for immunising parents at least, pain is an accepted part of their decision to vaccinate. Instead, some parents could be differentiated by the level of increased distress they reported in response to the procedure. However, most parents were able to overcome the distress evoked by their first immunisation experience to attend subsequent appointments in the primary schedule.

The use of Q-methodology in chapters 5 and 6 permitted the exploration of the hierarchical nature of parental viewpoints about vaccination; an aspect of parental views that has not been investigated by previous studies using interview and focus group methods. In terms of the DIAPR model, these findings could be seen as a more in-depth exploration of parental ‘pain schemas’ that shape parental beliefs about all aspects of vaccination. Linking parental views to immunisation uptake in chapter 6 indicated that parental viewpoints amongst those who had decided to completely adhere to the primary vaccine schedule were dominated by a desire to protect their child from harm, and the corresponding belief that vaccination provided the most effective protection from disease. Therefore, despite the fact that some parents could be distinguished by their concerns about vaccine side-effects, their own emotional response and perceived level of confidence to cope with their infant’s pain expression during the procedure, most parents were able to put these feelings aside in order to ensure that their child was protected from disease. Hence, findings from these studies suggest that the overriding notion of protecting their children is the primary motivation of parents’ decision-making (a concept contingent to definitions of parental bonding [6, 7]). For immunisers, the best way to do this was through immunisation.

These findings have implications for future interventions to promote uptake, suggesting the need to work with parents’ sense of duty to protect their child by promoting confidence in the protection offered by vaccination. Parents value vaccine information that is balanced and scientific. For example, future interventions could consider educating parents regarding the concept of herd immunity, thus addressing why vaccines may not seem effective. Allowing parents to make balanced judgements regarding the superior protection offered by vaccination for the individual and the wider community may reduce vaccine hesitancy and thus increase uptake. Educational interventions implemented via discussion with a medical professional appear more effective than receiving education via written information, thus future research could examine the efficacy of informed discussion opportunities within, for example, a midwife-led post-natal class.

# 3. Infant pain expression

Focussing on the role of the care-giver in infant pain expression, the interpretation of previous research has been limited by inconsistent study findings. Thus, there has been uncertainty about the role of the care-giver in infant pain expressed in response to acute pain procedures such as immunisation. Some studies have been conducted on the assumption that the actions of the care-giver have a causal influence over infant pain behaviours; after assessing infant pain, care-givers alleviate pain through their actions.

Findings from the prospective cohort study cast doubt on this assumption by indicating, at best, a weak relationship between care-giver behaviours and infant pain, and vice versa across the vaccination procedure. Results from this thesis support more recent findings from larger cohort studies indicating that care-giver behaviours account for little or no variance in infant pain expression [8, 9]. Only the use of a pacifier (via a dummy, breast or bottle) was associated with lower levels of total infant pain expression; accounting for a 10% reduction in infant pain expression during injection phases. This finding is consistent with previous reports relating to the efficacy of pacifiers for infant pain relief [8, 10-12]. However, the magnitude of the associated effect size was small to medium, (suggesting that the use of a pacifier only accounts for a small percentage of the variance in infant pain expression). Yet, given the range of determinants explored in this study, whilst results regarding the utility of a pacifier need to be interpreted accordingly, its identification as a potential determinant of infant pain expression warrants further investigation. The replication of this effect in future studies may lead to the recommendation of pacifier use during injections in routine practice.

Results presented in the cohort study did not support previous reports associating reassuring vocalisations with a higher level of infant pain expression [11, 13, 14]. Contrary to previous studies, Chapter 4 showed that, although care-givers used a high proportion of purportedly distress-promoting vocalisations (defined as the combination of empathetic, apologetic and reassuring speech observed in a procedural phase) across the procedure, there was no effect on total infant pain expression. The fact that these findings did not replicate those of a large cohort study [14] may be explained by differences in the position of the infant during the procedure [15]. Being held by the care-giver may negate the influence of soothing behaviours such as vocalisations that may appear influential when the vocalisation is the only mechanism of care-giver comfort.

The pattern of infant pain expression and care-giver behaviours observed in the cohort study fits the series of events proposed by the Social Communication Model (SCM) of acute pain [16]. Following needle insertion, and an increase in infant pain expression, care-givers assess and respond to infant pain as implied by the corresponding increase in care-giving behaviour. However, whilst care-givers were found to respond to infant pain behaviours, Chapter 4 showed that care-giving behaviours were not significantly associated with infant pain regulation, and vice versa, with the exception of the offer of a pacifier. Thus, these findings are more consistent with the DIAPR model [15, 17] and corresponding studies [9] that place the deterministic role of the care-giver in the periphery, and propose that infant pain reactivity (the immediate response to a painful event) is the biggest determinant of pain regulation (the modulation of behaviours back to baseline levels).

Cohort study findings also support steps in the model that suggest broader social contexts may have an indirect effect on infant pain expression. For example, infants of care-givers who reported severe levels of psychological distress expressed significantly more pain than infants whose parents did not. Several previous studies [18, 19] have suggested, to some extent, that infant pain may be affected by broader social contexts associated with social interaction established outside of the vaccine procedure. Post-hoc analysis revealed that these effects were only present in response to the second injection, indicating that the impact of the care-givers psychological state may only be apparent when infant pain is at its peak. However, the mechanisms by which the psychological state of the care-giver may mediate infant pain are unknown, suggesting that between-group differences in care-giver infant interaction need to be examined in larger, balanced designs that examine dyadic interactions during typical and stressful situations.

The DIAPR model [15, 17] also proposes that clinical factors indirectly influence infant pain expression via their wider impact on care-giver behaviour during the procedure. In the cohort study, faster administration of injectable vaccinations was associated with significantly reduced levels of total infant pain. Thus, faster needle injection may reduce the level to which the pain stimulus activates the infant’s sensory threshold, leading to decreased levels of pain reactivity and faster pain regulation (observed by reduced pain expression in the 30s post-needle phase). At least for the first immunisation where, for the majority of infants, previous pain experiences have been minimal, clinical factors associated with vaccine administration have a direct impact on infant pain. Furthermore, as pain regulation is incorporated into experiential influences that impact upon an infant’s noxious sensory threshold, feedback loops within the DIAPR model [15, 17] suggest faster injection may improve pain reactivity in response to future acute pain episodes. Correspondingly, to validate the model and explore the long-term impact of such clinical factors, future research should examine the effect of faster injection on infant pain during subsequent immunisation procedures during the first year of life.

# 4. Implications for clinical practice and vaccine policy

In terms of clinical practice, the implications of this thesis are three-fold. Firstly, the use of a pacifier during the injection phases of the immunisation procedure *might* be associated with a reduction in infant pain expression. However, before support can be lent to the use of pacifiers to relieve infant pain expression during acute pain procedures, further research is necessary. Secondly, faster needle administration is linked to reduced infant pain expression suggesting that vaccine administration has a direct impact on infant pain expression. The variability in injection time observed suggests that the administration of immunisations is not as standardised as might be assumed. Faster needle administration should be emphasised in clinical practice guidelines. Thirdly, findings support the continued use of parental reminders to encourage vaccine uptake; specifically, postal reminders are recommended for use in early childhood. Additionally, clinicians may consider the use of recall strategies and/or discussions about vaccine concerns in parents at high risk of non-compliance, although further research is needed to assess the appropriateness of these strategies.

In terms of vaccine policy, findings from the thesis suggest that, in order to increase uptake, immunisation strategies should acknowledge the diverse range of viewpoints that encapsulates parental belief about immunisation and the nuanced manner in which these beliefs shape uptake decisions. Furthermore, policy should draw upon parents’ desire to protect their infants, using this as part of a strategy to implement balanced information and advice. Vaccine-hesitant parents, in particular, may benefit from balanced information addressing concerns about vaccine efficacy that target parental beliefs about the protection gained by vaccination as part of their decision-making process. Again, further research is needed to assess the efficacy of these strategies.

# 5. Limitations

Study-specific limitations have been discussed in respective chapters; however a number of general limitations relating to the insights gained by the research conducted within the thesis were apparent.

In terms of the original aims of the thesis, a major limitation was the failure of this thesis to recruit dyads into the opioid-dependent (O-D) and Down Syndrome (DS) groups. Hence, secondary aims associated with the impact of pre-natal opioid exposure and DS on infant pain expression, care-giver behaviours and parental views about immunisation could not be explored. The main barrier to the recruitment of dyads within these two groups was insufficient resources to support recruitment. These related to the chaotic lifestyle and unreliable appointment attendance in the opioid-dependent dyads, and lack of availability of appropriately aged infants with Down Syndrome. Important questions remain unanswered about the impact of in vitro exposures and congenital disorders on infant pain expression and remain a topic for future research utilising different methods of recruitment.

The change to the focus of the thesis associated with this limitation may have impacted upon the conclusions that can be drawn from the primary research conducted. In particular, whilst the methods may not have constrained the findings related to typical infant pain expression and care-giver behaviour, they may have impacted upon the conclusions made regarding immunisation uptake.

Inherent to its design, the primary research conducted in the thesis only included infants whose parents had decided to immunise and had attended their first scheduled vaccination appointment. Therefore, the findings from the thesis can only provide insight regarding factors that may have led to complete or partial uptake. As indicated in the qualitative review, factors that prevent initial uptake may be different to the more service-related issues that prevented partial uptake. The design of the studies conducted within this thesis cannot provide insight into beliefs and behaviours that might influence complete vaccine refusal.

Furthermore, the convenience sampling approach taken to the recruitment of dyads in both the cohort and Q-methodology studies impacted upon the extent to which incompletely (partially) immunised infants were represented within the sample. The under-representation of this sub-group, may therefore limit the conclusions that could be made about factors (be they demographic characteristics or immunisation beliefs) that influence vaccine uptake during the first year of life. Future research may ask similar research questions related to uptake but to ensure more balanced group sizes, use a different study design to purposefully recruit dyads based on their immunisation beliefs and intentions.

In addition, within the cohort study, whilst the use of observational methods allowed for a large amount of normative data to be collected (and its influence on infant pain and uptake measured accordingly), the design was not suited to the analysis of uncommon factors such as psychological distress or impaired care-giver to infant bonding. The unbalanced nature of the groups analysed must be taken into account when interpreting these findings. Future research might investigate the impact of psychological distress and impaired attachment on infant pain expression in a balanced matched-groups design.

The exploration of the relationship between care-giver and infant behaviours in the cohort study may have impacted upon the degree to which an infant’s facial expressions of ‘pain’ were coded. For example, when the care-giver offered the infant a pacifier the mouth was obscured, meaning that the ‘boxed-mouth’ [20] used to characterise infant pain could not be observed. Whilst sucking is incompatible with a boxed-mouth if performed properly, in instances where infants did not latch onto the pacifier, facial movements associated with the mouth could not be coded.

Furthermore, the relationship between care-giver behaviour and infant pain has been limited to the utility of non-pharmacological care-giver behaviours. Parental use of pharmacological techniques such as sugar solutions and topical anaesthetics was not investigated in Chapter 4. Whilst the use of these strategies was not observed in any of the videotapes collected, parents were not asked about their use of these or other pain relieving methods (such as Paracetamol) before the vaccination procedure. Despite the low frequency with which parents have been reported to use pharmacological techniques [8], owing to their efficacy [21], future research should endeavour to record and control for these effects.

Whilst every effort was made to keep interactions with care-givers, infants and medical staff to a minimum, the extent to which videotaping affected the occurrence of observed behaviours is unknown. Similarly, infant pain responses during the vaccination procedure may have impacted on the views expressed by parents who participated in the Q-methodology studies conducted after vaccination. Whilst the use of Q-methodology elevated the voices of parents within these studies beyond the inferences made by observations of their behaviour, and allowed inferences to be made about the influence of infant pain on vaccine uptake, care-givers may have only opted to take part in the Q-sort if their infant was more settled after the procedure (indicating reduced pain reactivity and/or quicker pain regulation). Correspondingly, these experiences may have shaped parental viewpoints about the procedure, specifically those related to infant pain.

While statements within the Q-set referred to a number of the barriers and facilitators of immunisation highlighted in the systematic review of parental viewpoints (Chapter 3), the statements did not address issues related to clinic access or schedule awareness. Hence, it was not possible to gain an understanding about how these issues affected parental viewpoints about vaccination, or their place in the hierarchy of viewpoints that was used to make inferences about continued uptake decisions.

Finally, in terms of the secondary research conducted, insights may have been lost following the rule-based protocol inherent to systematic review methods. For example, in Chapter 2, studies were excluded from the meta-analysis if only one study of its kind (e.g. home vaccination) had been identified. Whilst this intervention [22] reported a significant improvement in uptake following the provision of a home vaccination service, the lack of available data prevented pooled analysis and its further discussion in the review. The strict inclusion and exclusion criteria implemented in the systematic reviews conducted in Chapters 2 and 3 may have impacted on the scope of the research summarised and thus the breadth of the conclusions drawn. Hence, insights regarding potentially useful interventions may have been lost – the efficacy of home vaccination was potentially overlooked in favour of interventions for which a greater number of studies had been reported.

In terms of the qualitative systematic review reported in Chapter 3, the majority of studies included interview or focus group methods. Studies utilising these methods were included because of the nuanced understanding of the vaccination decision-making processes that they permit. However, because these studies reported many issues, factors that were fundamental to decision outcomes were less clear. Additional insights may be gained by conducting a systematic review of survey data. Summarising survey data may allow a more direct exploration of the link between parental belief and immunisation behaviour and/or vaccine hesitancy. Furthermore, methods of data collection may highlight novel and diverse determinants of immunisation uptake. The nature of the typically open-ended questionnaires completed in private may allow non-immunising parents to write openly about their beliefs, attitudes and actions without the fear of judgement from the researcher and/or their peers. Hence, a systematic review of survey data may add to current knowledge regarding immunisation beliefs by highlighting the views of parents who may be potentially qualitatively different to those who chose to take part in studies utilising face-to-face methods of data collection.

# 6. Future research

Future research utilising alternative methods and designs may be conducted to investigate some of the issues outlined above. Research questions remain unanswered regarding potential differences in the pain expression and behaviour of O-D and DS dyads in comparison to controls. However, in light of the recruitment difficulties reported in this thesis, it may be more appropriate to target these groups separately. Future studies might recruit dyads during pregnancy via hospital referrals related to pre-natal screening or through specialist antenatal classes for drug-using mothers. This method would promote sufficient time to contact relevant primary care practices, coordinate immunisation appointments and, in the O-D group allow accurate pre-natal data relating to drug-use to be collated.

To overcome some of the issues regarding immunisation uptake, future research might adopt alternative methods and research designs. For example, future research may implement case-control designs to compare the attitudes of partially (case) and completely (control) immunising parents. Groups could be balanced in size and parents matched in terms of pertinent risk factors (e.g. family size, educational attainment, ethnicity) to isolate the effect of immunisation belief on uptake behaviour. In addition, future research might follow-up parents who repeatedly do not attend (DNA) initial scheduled appointments. This would provide insight into factors that differentiate parents who refuse vaccination compared to those who partially or completely comply with the schedule. Future studies could also utilise Q-methodology to explore whether parents in each decision group have shared or distinct beliefs that are fundamental to their decision-making. Identifying any difference in the hierarchy of parental views may highlight aspects of immunisation belief that could be addressed in future immunisation education programmes or intervention studies.

A further avenue for future research concerns the lack of longitudinal data from parents with a range of vaccine beliefs and varied decision outcomes (including immunisers, non-immunisers and partial immunisers). Whilst conducting studies to explore parental viewpoints both before and after specific immunisation procedures can allow inferences to be made about how immunisation experience might change parental viewpoints and uptake beliefs, longitudinal studies examining parental viewpoints across the first years of life would allow for the most stable beliefs to be established as well as identify if particular vaccines are associated with specific barriers (in addition to the existing evidence on MMR). Hence, future studies could utilise single-case Q-study designs, or utilise current Q-findings to construct a survey (known as Q-block design) [23], to investigate patterns of immunisation belief across early childhood.

The repository of existing videotape data could be utilised to further explore nuances in the prosody of care-giver speech and to identify key determinants in fast injection technique. In the cohort study (Chapter 4) the CAMPIS-IV [11] used categorical definitions to code care-giver behaviours. Care-giver vocalisations were coded based on the content of speech made towards the infant or others during the procedure (e.g. “It’s OK” is defined as a reassuring vocalisation). However, other aspects associated with the prosody of speech, such as its pitch and tone, may impact upon how it is perceived by the infant. The prosody of speech has been found to be an important communicative tool in infancy [24]. Hence, future research could examine the intonation of vocalisations coded in accordance with the CAMPIS-IV [11]. Comparing the pitch of care-giver vocalisations made during ‘pain’ phases (i.e. following needle insertion) with the pitch of voice during non-pain phases (i.e. rotavirus and pre-needle) could identify potential incongruences between the prosody and content of speech. Such an analysis could be used to provide a more detailed understanding of subtle displays of care-giver emotion on infant pain expression during the vaccination.

In addition, it was beyond the scope of the current thesis to examine factors that facilitated faster vaccine administration. Future research could design a novel coding scheme to focus on the preparatory steps taken by nurses before needle injection to identify factors that facilitate rapid injection.

# 7. Conclusions

The five empirical chapters in this thesis have highlighted that whilst care-givers (within a health-system advocating choice) determine immunisation uptake, their influence over infant pain expression is less clear. Although previous research and theoretical models of infant pain have tended to assume that care-giver behaviours have a causal role in infant pain expression, findings from this thesis suggest that this may not be the case. Instead, in the first immunisation procedure, the speed of vaccine administration might be an important predictor of infant pain expression. However, future research is needed before more concrete recommendations can be made regarding the use of a pacifier during injection phases. Results presented in the review articles and the two Q-methodology studies indicate that whilst parents have complex and divergent views about infant immunisation, the views of immunising parents are dominated by the notion that immunisation offers the best form of protection from disease - views that are supported by balanced accurate information about vaccines. Implications of these findings for clinical practice include the need to promote vaccine efficacy amongst parents, and the rapid administration of injections during the procedure.

# References

[1] Allan N, Harden J. Parental decision-making in uptake of the MMR vaccination: a systematic review of qualitative literature. J Public Health. 2014:fdu075.

[2] Brown, K.F. Kroll SJ, Hudson MJ, Ramsay M, Green J, Long SJ, Vincent CA, Fraser G, Sevdalis N. Factors underlying parental decisions about combination childhood vaccinations including MMR: a systematic review. Vaccine. 2010;28:4235-4248.

[3] Nagaraj A. Does qualitative synthesis of anecdotal evidence with that from scientific research help in understanding public health issues: a review of low MMR uptake. The Eur J Public Health. 2006;16:85-88.

[4] Roberts KA, Dixon-Woods M, Fitzpatrick R, Abrams KR, Jones DR. Factors affecting uptake of childhood immunisation: a Bayesian synthesis of qualitative and quantitative evidence. Lancet. 2002;360:1596-1599.

[5] Mills E, Jadad AR, Ross C, Wilson K. Systematic review of qualitative studies exploring parental beliefs and attitudes toward childhood vaccination identifies common barriers to vaccination. J clinical epidemiology. 2005;58:1081-88.

[6] Condon JT, Corkindale CJ. The assessment of parent-to-infant attachment: Development of a self-report questionnaire instrument. J Reprod Infant Psych. 1998; 16:57-76.

[7] Condon JT, Corkindale CJ, Boyce P. Assessment of postnatal paternal–infant attachment: Development of a questionnaire instrument. J Reprod Infant Psych. 2008;26:195-210.

[8] Lisi D, Campbell L, Pillai Riddell R, Garfield H, Greenberg S. Naturalistic parental pain management during immunizations during the first year of life: Observational norms from the OUCH cohort. Pain. 2013;154:1245-1253.

[9] Campbell L, Pillai Riddell R, Garfield H, Greenberg S. A cross-sectional examination of the relationships between caregiver proximal soothing and infant pain over the first year of life. Pain. 2013;154:813-823.

[10] Pillai Riddell R, Racine NM, Turcotte K, Uman LS, Horton RE, Osmun LD, Ahola Kohut S, J Hillgrove Stuart, Stevens B, Gerwitz-Stern A. Non-pharmacological management of infant and young child procedural pain. Cochrane Database Systematic Reviews. 2011;10.

[11] Blount RL, Devine KA, Cheng PS, Simons LE, Hayutin L. The impact of adult behaviors and vocalizations on infant distress during immunizations. J Pediatr Psychol. 2008;33:1163-1174.

[12] Shah PS, Aliwalas LL, Shah VS. Breastfeeding or breast milk for procedural pain in neonates. Cochrane Database Systematic Reviews. 2012;12.

[13] Sweet SD, McGrath PJ. Relative importance of mothers' versus medical staffs' behavior in the prediction of infant immunization pain behavior. J Pediatr Psychol. 1998;23:249-256.

[14] Racine NM, Pillai Riddell R, Flora D, Garfield H, Greenberg S. A Longitudinal Examination of Verbal Reassurance During Infant Immunization: Occurrence and Examination of Emotional Availability as a Potential Moderator. J Pediatr Psychol. 2012;37:935-944.

[15] Pillai Riddell R, Racine N, Craig K, Campbell L. Psychological theories and biopsychosocial models in paediatric pain. In: McGrath PJ, Stevens BJ, Walker SM, Zempsky WT, editors. *Oxford Textbook of Paediatric Pain.* Oxford: Oxford University Press; 2013, 85-94.

[16] Craig K. The social communication model of pain. Can psychol. 2009;50:22-32.

[17] Pillai Riddell R, Racine N. Assessing pain in infancy: the caregiver context. Pain Res Manag. 2009;14:27-32.

[18] Bernard R, Cohen LL. Parent Anxiety and Infant Pain During Pediatric Immunizations. J Clin Psychol Med S. 2006;13:282-287.

[19] Moscardino U, Axia G, Altoe G. The role of maternal depressed mood and behavioural soothing on infant response to routine vaccination. Acta Paediatr. 2006; 95:1680-1684.

[20] Grunau RV, Craig KD, Pain expression in neonates: facial action and cry. Pain. 1987;28:395-410.

[21] Taddio A, Ilersich AL, Ipp M, Kikuta A, Shah V. Physical interventions and injection techniques for reducing injection pain during routine childhood immunisations: Systematic review of randomized controlled trials and quasi-randomized controlled trials. Clin Ther. 2009:31: S48-S76.

[22] Bond L Nolan T, Lester R. Home vaccination for children behind in their immunisation schedule: a randomised controlled trial. Med J Australia. 1998;168:487-90.

[23] Baker RM, van Excel J, Mason H, Stricklin M. Connecting Q & surveys: Three methods to explore factor membership in large samples. Operant Subjectivity. 2010;34:38-58.

[24] Fernald A. Intonation and communicative intent in mothers' speech to infants: Is the melody the message? Child Dev. 1989:1497-1510.

# Appendix A: Studies excluded from the systematic review of interventions

Table A1. Studies excluded from the systematic review of parental uptake interventions

|  |  |  |
| --- | --- | --- |
| **Reference** | **Intervention focus** | **Reason for exclusion** |
| Ali et al. (2009) | Practice coverage | Study focus (practice uptake); Study design (cohort study) |
| Anjum et al. (2004) | Health education | Data not abstractable (group size used in analysis unclear; unclear data presentation) |
| Bartu et al. (2006) | RCT | Data not abstractable (specific outcome measure unclear) |
| Briss et al. (2010) | General interventions | Systematic Review |
| Cockman et al. (2011) | - | Study design (not an intervention) |
| Colombo et al. (1979) | Parental education by LHWs | Data not abstractable (data in person-years) |
| Deivanayagam et al. (1995) | Missed opportunities | Study focus (objective not immunisation uptake) |
| Djibuti et al. (2009) | Supportive supervision | Study focus (not parental intervention) |
| Dunn et al. (1998) | Parental education | Study focus (objective not immunisation uptake) |
| Fairbrother et al. (1999) | Physician bonuses | Study focus (practice uptake) |
| Glenton et al. (2011) | Lay health Workers | Systematic Review |
| Gӧkçay et al. (1993) | Parental home visiting | Study design (cluster randomised trial) |
| Hughart et al. (1998) | Missed opportunities | Study focus (objective not immunisation uptake) |
| Iroh Tam et al. (1998) | Missed opportunities | Study focus (objective not immunisation uptake) |
| Jacobson & Szilagyi (2005) | Recall and reminder systems | Systematic Review |
| Kendrick et al. (2003) | Home visiting programs | Systematic Review |
| Kauffman et al. (2013) | Face-to-face interventions | Systematic Review |
| Kempe et al. (2001) | Postal reminder | Data not abstractable (group size not stated per age-group; control group data unclear) |
| Kitzman et al. (1997) | Multi-faceted intervention | Multiple interventions within 1 study design |
| Linkins et al. (1994) | Telephone reminder | Data not abstractable |
| Morris et al. (2004) | Monetary incentives | Data not abstractable (absolute number of events in each arm unclear) |
| Oyo-Ita et al. (2011) | Low & middle income countries | Systematic Review |
| Pandey et al. (2007) | Community-based service information | Data not abstractable (group size used in analysis unclear) |
| Samuels et al. (2008) | Home vaccination | Study focus (too diffuse) |
| Slora et al. (2008) | Quality Improvement | Ineligible. Intervention aimed at practice |
| Soljak et al. (1987) | Postal reminder and practice list | Study design (multi-faceted intervention) |
| Takayama et al. (1999) | Hospital policy | Study focus (not parental intervention) |
| Vannice et al. (2011) | Parental education | Study focus (objective not immunisation uptake) |
| Waterman et al. 1996) | Community intervention | Study design (cohort study); study focus (too diffuse) |
| Whittaker et al. (2002) | Lay health Workers | Systematic Review |
| Williams et al. (2011) | Primary care strategies | Systematic Review |
| Zúñiga de Nuncio (2003) | Pre-natal education | Data not abstractable (group size used in analysis unclear) |

# Appendix B: Risk of bias judgments for studies included in the meta-analysis

Table A2. Risk of bias judgements for studies included in the meta-analysis

|  | **Sequence generation** | | **Allocation concealment** | | **Blinding** | | **Incomplete outcome data addressed** | | **Free of selective reporting** | | **Free of other bias** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Judgement** | **Support** | **Judgement** | **Support** | **Judgement** | **Support** | **Judgement** | **Support** | **Judgement** | **Support** | **Judgement** | **Support** |
| Abramson et al. (1995) | Unclear | Random approach stated but method unclear | Unclear | Insufficient information | Unclear | Insufficient information | Low | Low attrition rate as 4 children lost to follow up. The immunisation status of 11 children who moved out of study practices were obtained and included in the analysis on an ITT basis | Unclear | Insufficient information | Unclear | Families in the intervention group received additional contact to those in the control group such as contact with study co-ordinator and pre-appointment reminder. The independent effect of this is not stated in the report |
| Barnes et al. (1999) | Low | Computer-generated random number list | Low | Assignment generated using number list. Pairs assigned group before enrolment therefore could not foresee assignment | Unclear | Insufficient information | High | Of the 434 pairs randomised, only 164 (37.5%) consented to participate in the study and therefore provide outcome data. | Unclear | Insufficient information | Low | - |
| Bjornson et al. (1999) | Low | Alphabetised database randomised in balanced blocks of 10 | Unclear | Names assigned randomly but method used to do so unclear | Unclear | Insufficient information | Unclear | Complete outcome data reported. High rate of attrition (~27%) due to non-delivery of cards and loss to follow-up. | Unclear | Insufficient information | Low | - |
| Bolam et al. (1998) | Low | Restricted randomisation of numbers in blocks of 20. 0-4, 5-9, 10-14, 15-19 assigned to groups A, B, C and Control respectively. | Low | Concealed envelopes with appropriate safeguards used. Generator of assignment not involved in execution of allocation. | High | Mothers and health educators not blind to group assignment. 3 and 6 month outcome assessors blind. | High | High overall rate of attrition 25-27% at 3-6 month follow up. Reasons for attrition stated (cultural and still birth). Intention to treat analysis reported in method but those lost to follow up excluded from analysis. | Unclear | Insufficient information | Low | - |
| Brugha & Kevany (1996) | Unclear | Insufficient information | Unclear | Insufficient information | Low/ unclear | Insufficient information. Authors note that control group clusters had no knowledge of intervention occurring in neighbouring households. | Unclear | Insufficient information | Unclear | Insufficient information |  | - |
| Campbell et al. (1994) | Unclear | Random method stated but insufficient information about method given | Unclear | Insufficient information | Low | Medical providers blind to study group. No information about parent or outcome assessor blinding. | Low | Complete outcome data reported. 6% attrition rate due to infants no longer being enrolled at the clinic by 7 months | Unclear | Insufficient information | Low | - |
| Dini et al. (2000) | Unclear | Random method stated but insufficient information about method given | Unclear | Insufficient information | Unclear | Insufficient information | Low | Complete outcome data reported. Only 70% sample followed to 24 months due to recruitment difficulties. Of those who completed the follow-up, ~15% had moved practices. Receipt analysis conducted | Unclear | Insufficient information | Unclear | Pre-appointment reminders were only sent to families in the combination and telephone only groups, not the letter only group. The effect of this factor on uptake is unclear. |
| Hawe et al. (1998) | Unclear | Random method stated but insufficient information about method given | Unclear | Insufficient information | Unclear/ Low | Insufficient information about blinding of parents/ staff responsible for postage. Admin assistant recording uptake unaware of group allocation. | Low | Low rate of attrition (19 cards returned/ not posted; 0.73%) and reasons given. Included in analysis as numerator as Intention to treat analysis used. | Unclear | Insufficient information | Low | - |
| Irigoyen et al. (2000) | High | Non-random approach. Sequence generated sequentially according to appointment book | High | Allocation could be foreseen as a rotation method used. Groups were assigned upon sequence in appointment book | Unclear | Parents not blind to group allocation due to nature of intervention. Medical staff blind to group assignment. Unclear whether outcome assessors were blind. | Unclear | Insufficient information | Unclear | Insufficient information | High | Intervention not implemented in 6% postcard only, 46% telephone only and 53% of the combined groups. Coverage data was only abstracted from records for every third child who kept their appointment. The impact repeated reminders on the same child and family was not assessed. |
| Irigoyen et al. (2006) | Low | Random approach. Computer used to identify eligible children and select a random sample of eligible children to be assigned groups | Low | Central allocation used. Computer system randomly assigned sample selected to one of three groups. | Unclear | Insufficient information | Low | Complete data reported | Unclear | Insufficient information | Unclear | 345 children enrolled in one 2 week period were excluded from the study. Postcards were returned for 13.6% of children. |
| Johnson et al. (1993) | Low | Random number table used; odd numbers for intervention, even for control group allocation. | Low/ Unclear | Sequentially marked sealed envelopes used to allocate groups. Unclear whether envelopes were opaque. | High | No attempt at blinding. Participant and outcome assessor (family development nurse) aware of group allocation | Low | Complete outcome data reported. 11% attrition through families moving away, children taken into care, drop out, maternal death and child illness | Unclear | Insufficient information | Low | - |
| LeBaron et al. (2004) | Low | Computer generated random number list | Unclear | Insufficient information | Low | No attempt at blinding made. However, LHWs not responsible for collecting data related to outcome measure | Low | Complete data reported | Unclear | Insufficient information | Unclear | Outreach visits by LHWs only attempted in 42% of cases and were only completed in 26% of participants in outreach and combined groups. |
| Lieu et al. (1997) | Unclear | Random method stated but insufficient information about method given | Unclear | Insufficient information | Unclear | Insufficient information | Unclear | Insufficient information | Unclear | Insufficient information | Unclear | - |
| Mason & Donnelly (2000) | Low | Computer generated random number list | Unclear | Insufficient information | Unclear | Insufficient information | Low | Complete outcome data reported. ~5% attrition rate due to follow-up issues and some children already being immunised | Unclear | Insufficient information | Low | - |
| Morgan & Evans (1998) | Low | Computer generated random number list used | Unclear | Insufficient information | Low | Parents and Health Visitor blind to trial. | Unclear | No missing outcome data reported. Data regarding receipt of intervention not reported. | Unclear | Data regarding parental response to postal questionnaire not reported | Low | - |
| Morris et al. (2004) | Low | Random method used. Randomisation at the municipality level stratified on the basis of childhood malnutrition using coloured balls drawn from bag. | Low | Allocation determined by asking a child to draw a coloured ball from a box. The child could not see the balls after they had placed their arm through the aperture in the box. Balls were not placed back into the box. | Low | No attempt at blinding participants was made although measures were in place to prevent group contamination. Outcome assessors were independent and blind to study aim and group allocation | Low | Complete outcome data reported. 2.9-4.6% attrition/ group due unavailability of family and study withdrawal | Unclear | Insufficient information | Unclear | Groups different at baseline with respect to DTP/ pentavalent uptake. Lower level of uptake in the combined group. Additionally, the service-level intervention not fully implemented due to issues transferring funds from government to community teams (only17% transfers made). |
| Norr et al. (2003) | Unclear | Insufficient information | Unclear | Insufficient information | Unclear | Insufficient information | Low | Complete outcome data reported. 19% data lost to follow-up. | Unclear | Insufficient information | Unclear | Background characteristics of A-A and M-A different at baseline. |
| Owais et al (2011) | Low | Computer-randomised list stratified for each of the 5 enrolment sites | High | CWH's provided with computer-random list. Mother-infant pairs assigned to group through block randomisation in accordance with list | High | No blinding measures used due to educational nature of intervention. Outcome assessor blind to group allocation | Low | Low rate off attrition in intervention (2.1%) and control (2.7%) groups due to loss to follow up and infant death | Unclear | Insufficient information | Low | - |
| Porter-Jones et al. (2009) | High | Sequence generated by week of birth | Low | Health visitor enrolling participants couldn't foresee assignment as allocation printed on form provided | High | Neither HV or parents blind to study group. Blinding of outcome assessors unclear | High | The authors state a number of children were excluded from the analysis due to lack of documented consent. Specific numbers are not given. | Unclear | Insufficient information | Unclear | Insufficient information |
| Quinlivan et al. (2003) | Low | Computer generated random number list concealed in opaque envelopes | Low | Allocation concealed in numbered sealed opaque envelopes conducted by an independent midwife | Unclear | Blinding of outcome assessor but unable to blind participants into groups | Unclear | Complete outcome data reported. 11 cases lost to follow up/ adverse circumstances. 3x more participants lost in control group compared to intervention. Unclear whether this was influenced by the intervention | Unclear | Insufficient information | Unclear/ High | Governmental financial incentive scheme run alongside trial aimed at improving immunisation rates to parents and medical practices. Rates in pilot 5-8%, therefore increase in uptake not due to intervention alone. |
| Saitoh et al. (2013) | Low | Computer-randomised list stratified based on 3 enrolment sites upon consent | Low | Participant identification number entered into computer to determine allocation, therefore assignment concealed to ppts and investigators | High | Blinding attempted at baseline. Participants and study staff aware of allocation to intervention after completion of baseline questionnaire and group allocation | Unclear | Higher attrition rate from randomisation to post-test (n = 9). Reasons for attrition not discussed in detail | Low | Pre-specified outcomes reported in protocol reported in paper | High | (1) Temporary budget for all vaccines assessed introduced 2 months pre-intervention and increased availability of Hib and PCV7 during study period. |
| Shourie et al. (2013) | Low | Computer-generated random list to randomise GP practices on 1:1:1 basis | Low | Allocation of GP practices assigned by an independent researcher with no contact to participants | High | Blinding attempted at baseline. Participants and study staff aware of allocation to intervention after completion of baseline questionnaire and group allocation | Low | Low rate of attrition for questionnaire (11%) and MMR uptake (8%) data. Reasons for attrition/ differences in rates not stated. | Low | All primary and secondary outcomes of interest are reported in the study protocol. | Low | - |
| Stille et al. (2001) | High | Week in which family seen used to generate sequence | Low | Physician enrolling participants could not foresee assignment as appropriate packet placed inside infant's chart by investigator | Unclear | Insufficient information | Low | Complete outcome data reported. ~2%children excluded due to card not being administered or child found to be ineligible after review of medical records | Unclear | Insufficient information | Low | - |
| Usman et al. (2009) | Low | Computer-generated random list given to each enrolment centre | High | Random list indicated study group against study ID. Study ID given by data collector enrolling mothers, therefore allocation not adequately concealed. | High | No attempt at blinding. Participants and data collector aware of participation in intervention | Low | Complete outcome data reported. No cases lost to follow-up as cases not returning were assumed to have an incomplete immunisation status. | Unclear | Insufficient information | Unclear | Insufficient information |
| Usman et al. (2011) | Low | Computer-generated random list given to each enrolment centre | High | Random list indicated study group against study ID. Study ID given by data collector enrolling mothers, therefore allocation not adequately concealed. | High | No attempt at blinding. Participants and data collector aware of participation in intervention | Low | Complete outcome data reported. No cases lost to follow-up as cases not returning were assumed to have an incomplete immunisation status. | Unclear | Insufficient information | Unclear | Insufficient information |
| Vivier et al. (2000) | Low | Random number generator used to develop sequence | Unclear | Random number stated but details of allocation unclear | Unclear | Insufficient information | Low | Complete outcome data reported | Unclear | Insufficient information | Low | Intervention not completed in ~60% of total sample (46-73%). This factor is assessed by the use of receipt analysis. |
| Williams et al. (2013) | Low | Random selection of sites determined by coin flip | High | Participants allocated based on attendance at intervention or control study site, therefore data collectors could foresee assignment. But only 2 sites | Unclear | Insufficient information | Low | Complete outcome data reported. Reasons for attrition/ exclusion not given. | Low | Pre-specified outcomes reported in protocol reported in paper | High | Study not powered to detect difference in on-time receipt of 2 month vaccinations |
| Young et al. (1980) | Unclear | Computer generated list used to generate sample of high risk children. Method of randomisation used unclear | Unclear | Insufficient information | Unclear | Insufficient information | Unclear | 70% response rate to questionnaires and outcomes based on 60% of responding sample who were not fully immunised when the letter was sent | Unclear | Insufficient information | Low | - |

# Appendix C: Studies excluded from the qualitative systematic review

Table A1. Studies excluded from the qualitative systematic review

|  |  |
| --- | --- |
| **Reference** | **Reason for exclusion** |
| Bosu et al. (1997) | Data analysis (quantitative methods used) |
| Chantler et al. (2006) | Study focus (heal professional views) |
| Gazmararian et al. (2010) | Study focus (flu vaccine) |
| Keller (2008) | Study focus (not infant immunisation) |
| Leask et al. (2006) | Study focus (not infant immunisation) |
| Rainey et al. (2011) | Systematic review |
| Sampson et al. (2011) | Study focus (flu vaccine) |
| Samad et al. (2006) | Study design (cohort study) |
| Strobino et al. (1996) | Data analysis (quantitative methods used) |
| Whyte et al. (2011) | Data analysis (quantitative methods used) |

# Appendix D: CASP judgements for studies included in the qualitative systematic review

Table A4. CASP judgements of study quality for studies included in the qualitative systematic review

| **Ref** | **Clear statement of aims** | | **Appropriate methodology** | | **Design appropriate to aims** | | **Recruitment strategy appropriate** | | **Data collection** | | **Researcher-participant relationship** | | **Ethical issues considered** | | **Rigorous analysis** | | **Statement of findings** | | **Value** | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **0/1** | **Reason** | **0/1** | **Reason** | **0/1** | **Reason** | **0/1** | **Reason** | **0/1** | **Reason** | **0/1** | **Reason** | **0/1** | **Reason** | **0/1** | **Reason** | **0/1** | **Reason** | **0/1** | **Reason** |
| Austin (2011) | 1 | To explore parental experiences regarding child immunisation | 1 | Aim to describe immunisation experiences therefore qualitative method appropriate | 1 | Phenomenological research method to highlight parental experiences through interviews | 1 | Purposeful sampling of parents of recently immunised children | 1 | Semi-structured interviews. Form of data clear (audiotapes). Saturation of data not discussed | 0 | Insufficient information to determine potential biases in researcher involvement | 1 | Approval sought from ethics committee. Consent gained from practice managers, GPs and parents | 0 | Sufficient data to support findings, contradictory data presented but analysis process not discussed in-depth | 1 | There is a clear statement of findings in terms of the aims of the study | 1 | Implications for policy and immunisation protocols regarding the timing of information are discussed |
| Austvoll-Dahlgren & Helseth (2010) | 1 | To identify decision-making processes and barriers and facilitators to information | 1 | Aim to identify decision-making processes therefore qualitative method appropriate | 1 | Grounded theory to explore relationships between decision-making and information seeking through interviews | 1 | Strategic sampling to include parents with characteristics known to influence information seeking | 1 | Semi-structured interviews. Form of data clear (audiotapes). Data collected until theoretical saturation reached | 0 | Data collection and analysis carried out by primary author. Biases in researcher involvement not discussed | 1 | Approval sought from ethics boards and parents | 1 | Description of process of data analysis and member-checking stated | 1 | There is a clear statement of findings in terms of the aims of the study | 1 | Implications for public health nurses and recommendations for them to give more balance information, particularly to parents of new-born children are given |
| Benin et al. (2006) | 1 | To describe the full-range of mothers' attitudes about vaccinating their children and the promoters and inhibitors of vaccines | 1 | Aim to describe immunisation attitudes therefore qualitative method appropriate | 1 | Grounded theory to explore the relationships between the themes present in the mothers' comments through interviews | 1 | Purposeful sampling with random component until theoretical saturation reached. 15 mothers selected randomly, black mothers and non-vaccinators purposefully sampled | 1 | 2 open-ended interviews conducted pre- and post-scheduled immunisation | 0 | Data collection carried out by primary author. Biases in researcher involvement not discussed | 1 | Appropriate ethical approval sought. Informed consent gained. | 1 | Data analysis conducted independently by 2 members of the research team. Validity of coding checked by recoding transcripts using the main subset of codes. Final codes decided together | 1 | Findings discussed in relation to aims. Transcripts independently coded according to initial coding structure | 1 | Implications for paediatricians offering vaccine advice discussed |
| Bond et al. (1998) | 1 | To explore similarities and differences in parental perceptions of risk amongst complete, incomplete and non-immunising parents | 1 | Aim to explore similarities and differences in risk perception therefore qualitative methodology appropriate | 1 | Semi-structured interviews used to allow concepts to be explored in a flexible manner. | 1 | Stratified purposeful sampling to obtain sufficient numbers. | 0 | Semi-structured interviews conducted by the primary author in the home. Interviews audio-taped. Saturation not discussed in results section. Discussion comments that saturation was not reached for partial immunisers. | 0 | Data collection carried out by primary author. Biases in researcher involvement not discussed | 1 | Appropriate ethical approval sought. Informed consent gained. | 0 | Method of data analysis not discussed. No clear, in-depth description of the analytic process. Role of researcher in analysis and selection of data not discussed. | 1 | Clear statement of findings in terms of aims for all groups of immunising parents | 1 | Implications for vaccine providers and medical professionals giving vaccine advice are discussed |
| Bond & Nolan (2011) | 1 | To provide a detailed explanation about the differences between immunisers and non-immunisers regarding perceptions of severity, susceptibility to disease and the benefits of vaccination | 1 | Aim to explain similarities and differences in risk perception and susceptibility therefore qualitative method appropriate | 1 | Semi-structured interviews used as aim of study was to explore experiences in decision-making | 1 | Stratified purposeful sampling to obtain sufficient numbers. | 1 | Semi-structured interviews conducted by the primary author in the home. Interviews audio-taped. Interviews used rather than a focus group to facilitate exploration of individual experience rather than a group discussion about the pros and cons of immunisation | 1 | Data collection carried out by primary author. Author comments that the interviewer did not have a dual relationship with the participants. | 1 | Appropriate ethical approval sought. Informed consent gained. | 0 | Thematic analysis used. No clear, in-depth description of the analytic process given. | 1 | Clear statement of findings in terms of aims for all groups of immunising parents | 1 | Implications addressing issues of trust and the communication of risk information are made for public health practitioners |
| Braka et al. (2012) | 1 | Aim to examine sources of information, care-giver knowledge and concerns about vaccination and how these influence decision-making | 1 | Aim to identify sources of information and describe the influence of concerns on decision-making therefore qualitative method appropriate | 1 | Focus group discussions using a semi-structured interview guide | 1 | Care-givers purposefully selected from systematic list of all caretakers in selected study villages based on stating they were very or somewhat concerned by vaccine safety. | 1 | Focus group discussions fol0ing a semi-structured interview guide conducted within the caretakers' home environments to enhance freedom and spontaneity within the discussion | 0 | Experienced qualitative researchers conducted interviews. It is 1 if these interviewers were part of the research team and/ or were responsible for research question formulation and participant recruitment | 1 | WHO, National and University ethics granted. Informed consent gained from participants. | 1 | Raw data translated into English and transcribed. Content analysis conducted by 2 people using descriptive summaries and quotes to represent major themes | 1 | Clear statement of findings in terms of aims | 1 | Implications addressing the need for caretaker education regarding misconceptions about immunisation in a respectful and forthcoming manner. The need to target such education to rural communities was also emphasised |
| Brown et al. (2012) | 1 | Aim to obtain a comprehensive picture of general factors underlying parental decision-making about the 1st dose of MMR (MMR1) | 1 | Aim to describe factors underlying MMR decisions therefore qualitative methods appropriate | 1 | Semi-structured interviews using literature informed guide used to discuss parental decision-making | 1 | Purposeful sampling used to select a range intended MMR1 decisions. | 0 | Interviews conducted at a location convenient to the parents in person or by telephone. The consequence of this factor on the data is discussed. Data collected until saturation reached. | 1 | Impact of different methods of data collection on data discussed due to potential non-verbal cues provided by the interviewer. The authors also discuss the potential influence of knowledge gained from the literature search on data analysis as the search was conducted prior to analysis. | 1 | Ethical permission granted and informed consent gained. | 1 | In-depth discussion of the analysis process and steps taken to validate it presented via seeking out contradictory evidence and member checking etc. presented | 1 | Clear statement of findings in terms of aims | 1 | Implications for the importance of trust in health professionals and vaccine policy and potential steps to minimise parental anticipated regret are discussed. |
| Brunson (2013) | 1 | Aim to examine parents' vaccination decision-making processes | 1 | Aim to understand parental decision-making processes therefore qualitative links appropriate | 1 | Grounded theory used to inform data collection and analysis. Interviews used to explore parents' decision-making | 1 | Purposeful sampling used to select a group of parents who had made all types of immunisation decisions. Theoretical sampling was then used to interview participants who could address specific questions identified from initial analysis | 1 | Appropriate method used. Reasons for open-ended and semi-structured interviews stated to al0 a general and specific examination of the decision-making process. Data collection collected until questions from the emergent analysis were answered and the theoretical model fully developed. | 0 | All interviews and data analysis were conducted by the author. It is 1 from the report whether the researcher has addressed potential biases in their own role. | 0 | Insufficient information to permit judgement | 1 | In-depth discussion of the analysis given. Initial coding used to generate preliminary categories before theoretical sampling and coding used to develop the theoretical model, and further define codes. Validity was maintained by member checking from participants and parents blind to the study aims. | 1 | Clear statement of findings in terms of aims | 1 | Implications for interventions discussed. Interventions must maintain a general pro-vaccination social norm and incorporate the views of all people who parents find trustworthy sources of information. Intervention materials for parents should allow for the critical evaluation of information. |
| Casiday (2007) | 1 | Aim to explore the full range of parental perspectives regarding MMR vaccination | 1 | Aim to explore parental perspectives about MMR therefore qualitative method appropriate | 1 | Focus groups and interviews used to explore parents' decision-making | 1 | Purposeful and snowball sampling used to select a sample of parents that gave the full range of MMR views | 0 | Appropriate method used. Semi-structured format allowed parents to describe their decision-making experiences. The form of the data is not clear from the report. The author dies not discuss saturation of data. | 0 | Insufficient information to determine potential biases in researcher involvement | 1 | Ethical permission granted and informed consent gained. | 0 | The description of the analysis process is 1 as specific techniques are not stated. The extent to which contradictory data were taken into account is 1 and potential biases in the researcher's involvement in the analysis are not discussed. | 1 | Clear statement of findings in terms of aims | 1 | Implications for risk theory and vaccine information discussed. Information should account for the interplay between individual- and population-level risk, the need for individual to have the 'right to choose' and the difficulty parents face making a decision on behalf of their child. |
| Condon (2002) | 0 | Aim to explore attitudes mothers from 3 ethnicities regarding preschool immunisations. The focus of the study was widened to include all pre-school immunisations as opposed to MMR because it became apparent during data collection that MMR was not a contentious issue. | 1 | Aim to explore parental attitudes about preschool immunisations therefore qualitative method appropriate | 1 | Focus groups and semi-structured interviews appropriate as chosen to illuminate both individual and group opinions | 1 | Participants recruited by Link workers (members of community groups employed as interpreters and advocates) based on the likelihood that they would participate in a focus group. Reasons for refusal given. | 1 | Appropriate method used. Focus group and interview format al0ed individual and group attitudes to be expressed. Reasons for conducting interviews as a method of improving recruitment uptake were discussed. Data saturation not discussed. | 0 | Insufficient information to determine potential biases in researcher involvement | 1 | Ethical permission granted. | 0 | The description of the analysis process is 1 as an in-depth description is not given. The extent to which contradictory data were taken into account is 1. Potential biases in the unanimous nature of the results are discussed. | 1 | Clear statement of findings in terms of aims | 1 | The study provides an insight into the immunisation attitudes of a previously understudied group. The finding that immunisations were unanimously seen as important suggests that uptake interventions do not need to target ethnic minorities in general. However, information could be more targeted and translated to increase parental understanding |
| Evans et al. (2001) | 1 | Aim to investigate factors that influenced MMR decision-making in light of the controversy | 1 | Aim to investigate influencing factors therefore qualitative method appropriate | 1 | Focus groups used to explore parents' decision-making process | 1 | Purposeful sampling of parents who had accepted or refused MMR, with a range of histories for vaccines other than MMR. | 1 | Appropriate method used. Focus groups (3 accepted, 3 refused MMR) were held in order to investigate parental decision-making. Groups were held in a location convenient for parents and were led by a moderator using an open-ended question based guide to facilitate discussion. Data tape-recorded and fully transcribed. Data collection and analysis occurred simultaneously until saturation occurred. | 0 | Insufficient information to determine potential biases in researcher involvement | 1 | Ethical permission granted from several location research ethics committees | 0 | A description of the analysis is provided. Initial themes and sub-themes were identified before a coding index developed. Remaining transcripts were then coding according to the coding index by 3 independent members of the research team until a 2 level of agreement was reached. The extent to which contradictory data were taken into account is 1. | 1 | Clear statement of findings in terms of aims | 1 | Implications regarding the relationship between parents and healthcare professionals are discussed. The need for professionals to support and discuss decision-making in an open manner was also discussed. Implications for additional training for professionals to assist with this were also discussed. |
| Gardener et al. (2010) | 1 | Aim to extract parental beliefs about MMR through a discussion about potential MMR promotion interventions | 1 | Aim to investigate parental beliefs therefore qualitative method appropriate | 1 | Focus groups used to explore parental beliefs | 0 | Parent-toddler groups were selected randomly from 5 different Primary Care Trusts where MMR uptake was be0 95%. Parents were recruited based on their attendance at a regular group session at which the focus group had been advertised. | 1 | Appropriate method used. Focus groups held in order to investigate parental beliefs. Groups were conducted with minimal facilitator involvement, unless prompts regarding specific topics were needed. Discussions were recorded and transcribed verbatim. Saturation of data was not discussed. | 0 | Insufficient information to determine potential biases in researcher involvement | 1 | Ethical permission granted. | 1 | A description of the analysis is provided. Conceptual labels were applied to topics that emerged from the transcripts. These labels were then refined into 5 discrete themes. Transcripts coded by 1 author with regular colleague discussion. | 1 | Clear statement of findings in terms of aims | 1 | Implications were discussed in terms of immunisation information and the government. Further research regarding the effectiveness of independent information, not endorsed by government, is needed. Further implications for policy makers were discussed in terms of the need to marry balanced information with parental bias towards negative consequences. |
| Glanz et al. (2013) | 1 | Aim to explore themes related to vaccine decision-making in vaccine hesitant parents | 1 | Aim to investigate parental beliefs therefore qualitative method appropriate | 1 | Focus groups used to facilitate discussion and encourage parents to express their thoughts, concerns and beliefs openly. | 1 | Purposeful sampling of sub-sample of randomly selected parents who had refused or delayed vaccination for non-medical reasons | 1 | Appropriate method used. 7 focus groups (4 delayed) were held in order to investigate parental beliefs. Small groups chosen to al0 in-depth conversations to develop. Data recorded by audio recorder and note taker in focus group. Data transcribed fol0ing each session for theme identification. Data collection and analysis continued until saturation occurred. | 0 | Insufficient information to determine potential biases in researcher involvement | 1 | Ethical permission granted by health plan review board and informed consent gained | 1 | A description of the analysis is provided. Themes identified after each focus group independently by each member of the research team. After initial coding, themes refined until saturation was reached. An independent review of each transcript was then carried out by 2 reviewers to establish reliability. Discrepancies were resolved by discussion | 0 | Clear statement of findings in terms of aims. The authors present little discussion of evidence against their argument. | 1 | Authors discuss the contribution of the study in terms of the importance of information timing and frequency in addition to its content. The authors suggest that interventions to increase vaccine uptake will be more effective if they are applied early and contain balance information |
| Guillion et al. (2008) | 1 | Aim to explore the ideology of parents who made a conscious choice to refuse childhood vaccines | 1 | Aim to explore parental ideology therefore qualitative method appropriate | 1 | In-depth interviews using open-ended questions purposefully used to allow parents to share their views. | 1 | Targeted and snowball sampling used. Parents known to researchers and visited specific locations believed to attract potential participants were targeted. From here, snowball sampling was used to recruit additional participants. This method was chosen to allow access to hard to reach groups and as a method of gaining data on potentially stigmatised behaviour. Biases in targeted recruitment strategies were discussed. Recruitment strategy altered to only include parents who had refused vaccines for philosophical reasons due to difficulties in recruiting parents who had opted out for religious reasons. Reasons for this difficulty are not discussed | 1 | Interviews conducted in participants own environments. Interviews chosen deliberately to encourage parents to share their ideologies. Authors discuss the piloting of the interview questions and subsequent modifications in wording made. Interviews were digitally recorded and transcribed verbatim. Saturation of data during collection is not discussed. | 0 | The researcher discusses their involvement in prompting participants during the interview and during interview piloting. The authors do not comment on how changes in the recruitment strategy to only include parents who objected to vaccinations because of philosophical reasons | 1 | Ethical permission granted. | 0 | Method of data analysis not discussed. No clear, in-depth description of the analytic process. Role of researcher in analysis and selection of data not discussed. Limited data is presented to support the findings in terms of how the data presented was selected. Little contradictory evidence is presented. | 0 | Whilst the discussion of themes identified in the transcripts is clear, the authors do not present evidence contrary to the arguments they posit. | 1 | The authors discuss implications for the treatment of parents with concerns about childhood vaccines by healthcare professionals. The authors state that such parents must be treated as educated consumers who are reliant on scientific evidence. Future interventions could focus on parental strategies for seeking out and evaluating scientific information, particularly searching for balanced information that includes both sides of an argument. |
| Hilton et al. (2006a) | 1 | Aim to explore parental concerns about immune overload and their impact on immunisation decisions | 1 | Aim to explore parental concerns therefore qualitative method appropriate | 1 | Focus groups chosen as it offered scope for participants to set the gender for discussion and develop the discussion around important topics | 1 | Purposive sampling to ensure maximum variation in participants | 1 | Focus groups conducted in person using a topic guide. Method chosen to facilitate discussion and al0 parents enough time to voice their opinions. Group steered by topic guide, recorded and transcribed in full. Parents encouraged to lead the discussion with limited prompts from author | 0 | Insufficient information to determine potential biases in researcher involvement | 1 | Ethical permission granted. | 1 | In-depth description of the analysis given. Brief discussion of how a sub-set of relevant themes was derived before a coding frame was developed. Contradictory data were explicitly examined but no mention of data saturation was made | 1 | Clear statement of findings in terms of aims | 1 | Authors discuss the need for immunisation advice to cover gaps in parental knowledge surrounding immunisation overload so that concerns about combined vaccines don’t guide views about the complete schedule. |
| Hilton et al. (2006b) | 1 | Aim to explore parental understandings of vaccine-preventable diseases | 1 | Aim to explore parental understandings therefore qualitative method appropriate | 1 | Focus groups used to explore parental understandings overall and individual group understandings | 1 | Targeted strategy using appropriate gatekeepers to purposefully select participants based on maximum variability; affluent and deprived postcodes, different family circumstance and parental experiences. 1 focus group conducted for single MMR, MMR refusal, total refusal, parents of children with ASD and who were immuno-compromised following chemotherapy | 1 | Focus groups conducted in person. Focus groups chosen, recorded and transcribed verbatim. Group steered by topic guide. Saturation of data during collection was not discussed. | 0 | Insufficient information to determine potential biases in researcher involvement | 1 | Ethical permission granted. | 0 | No in-depth description is provided. Authors refer the reader to a PhD thesis. Sufficient data is presented to support research findings and the categorisation of themes is clear. | 1 | Clear statement of findings in terms of aims | 1 | Authors discussed the gaps in understanding among parents and potential challenges to overcome with regards to parental decision-making and immunisation policy, particularly public health information |
| Hilton et al. (2007) | 1 | Aim to explore parental perceptions about the credibility of sources of evidence about MMR safety | 1 | Aim to explore parental views therefore qualitative method appropriate | 1 | Focus groups to al0 parents enough time to express their views and opinions | 1 | Participants purposefully selected to give a diverse sample (see above) | 1 | Focus groups were conducted in person, recorded and transcribed verbatim. Focus group method chosen to facilitate parental expression. Saturation of the data during collection was not discussed. | 0 | Insufficient information to determine potential biases in researcher involvement | 1 | Ethical permission granted. | 1 | In-depth description of the analysis given. Methods of theme development and selection of data are briefly described. Deviant or contradictory cases were purposefully selected and sufficient information given to support findings | 1 | Clear statement of findings in terms of aims | 1 | Authors discuss implications of the research in terms of the need for a) mindfulness from GPs regarding parental perceptions of vaccination targets, b) education campaigns to be aware of presenting unbiased information and c) measures need to be taken to combat a lack of parental trust in the medical profession |
| Keane et al. (1993) | 1 | Aims to discuss parental perceptions about vaccines and their efficacy | 1 | Aim to discuss parental viewpoints therefore qualitative method appropriate | 1 | Focus groups to generate hypotheses for survey study and to explore parental views | 1 | Participants selected from 3 sites. Recruitment based on mutual availability. Discuss why some people not contacted | 0 | Focus groups used due to views explored for hypothesis generation. Methods for focus groups and balance between word generation and questioning 1. Saturation of data not discussed. | 0 | Insufficient information to determine potential biases in researcher involvement | 0 | Ethical permission not discussed | 0 | No in-depth description is provided. | 1 | Clear statement of findings in terms of aims | 0 | Authors only discuss implications of findings in terms of whether or not they will be replicated by the resultant survey. Authors discuss implications for local educational strategies, the need to increase understandings about the notion of vaccine-preventable diseases and why vaccines fail. |
| Lannon et al. (1995) | 1 | To understand the attitudes of socially disadvantaged mothers about health care systems | 1 | Aims to understand maternal attitudes therefor qualitative method appropriate | 1 | Focus-groups with open-ended questions | 1 | Purposeful sampling of mothers who were uninsured or using Medicaid | 1 | Focus groups conducted by 2 RAs using topic guide. Whilst number of focus groups was chosen, saturation was re-evaluated at the end of data collection | 1 | Insufficient information to determine potential biases in researcher involvement | 0 | Ethical permission granted. | 0 | No in-depth description is provided. | 1 | Clear statement of findings in terms of aims | 1 | Authors discuss the implications of study findings in terms of the careful management of existing organisation resources and develop a checklist for practitioners to assess the organisational barriers faced by mothers |
| Leask et al. (2006) | 1 | Aims to discuss parental responses to anti-vaccination messages | 1 | Aim to discuss parental responses to anti-vaccination messages therefore qualitative method appropriate | 1 | Focus groups used to study audience reception of media messages and understanding social communication processes. | 1 | Participants purposefully selected from well-child clinics. Women unable to speak English and those clearly opposed to vaccinations were excluded owing to concerns about group conflict. | 0 | Setting for the focus groups is 1, although methods are justified. Saturation of data not discussed. | 0 | Insufficient information to determine potential biases in researcher involvement | 1 | Ethical permission granted. | 0 | In-depth description of analysis given with clear categorisation of themes. Limited data is presented to support findings. | 1 | Clear statement of findings in terms of aims | 1 | Authors discuss implications of the findings in terms of the need for stories about people who have contracted vaccine-preventable diseases to re-entre the public discourse in order for confidence in immunisations to be maintained. |
| Luthy et al. (2010) | 1 | Aim to determine concerns about immunising in hesitant parents | 1 | Aim to determine parental concerns therefore qualitative method appropriate | 1 | Open-ended questions al0 hesitant parents to state reasons why they did not vaccinate their children | 1 | Participants purposefully selected if their child was 6 months overdue for < 1 vaccines, therefore denoting vaccine hesitancy | 0 | Questionnaires distributed to eligible parents. Open-ended questions were used to identify parental concerns. It is 1 where questionnaires took place and how participants were debriefed. Saturation of data not discussed. | 0 | Insufficient information to determine potential biases in researcher involvement | 1 | Ethical permission granted. | 0 | No in-depth account of data analysis is given regarding the establishment of codes. Data selection is not explained and limited data is provided to support findings. | 1 | Clear statement of findings in terms of aims | 1 | Authors discuss implications of the findings in terms of the need for balanced information regarding the safety of vaccines themselves and for the child's immune system in order to avoid self-scheduling among vaccine-hesitant parents. Further, authors comment on the value for in-depth discussion of vaccine concerns and the need for the individualisation of cases to promote timely vaccination. |
| Marshell and Hal Swerissen (1999) | 1 | Aim to examine parents' vaccination decision-making processes | 1 | Aim to examine parental decision-making therefore qualitative method appropriate | 0 | Semi-structured interviews used but method not justified | 1 | Snowball sampling used as the aim of the study was to contribute to theory development rather than testing | 0 | Semi-structured interviews conducted in private setting. Interview methods described although not justified. Data was transcribed. Saturation of data not discussed. | 0 | Insufficient information to determine potential biases in researcher involvement | 1 | Ethical permission granted. | 0 | No rigorous account of data analysis given. 1 how themes derived from data and insufficient data presented to support findings. Use of contradictory data 1. | 0 | The findings are explicit however the authors do not discuss contradictory data. | 1 | Authors discuss the need for interventions to support parental decision-making to be continuous and provide a supportive environment to encourage immunisation compliance. |
| McCormick et al. (1997) | 1 | Aim to explore parental barriers to immunisation | 1 | Aim to explore parental attitudes and beliefs therefore qualitative method appropriate | 1 | Focus groups chosen to solicit detailed information about parental immunisation beliefs that were not influenced by researcher opinions. Hence, focus groups al0ed peer interaction and identified barriers (and potential ethical differences) in the language of the target population | 1 | Purposeful sampling to al0 for collection of information by sub-group. | 1 | Semi-structured interviews conducted in a variety of settings. Justification of method stated. Form of data clear - audio-taped and transcribed verbatim. Methods explicit and role of researcher discussed. Saturation of data not discussed. | 1 | Researcher examines their role in data collection and analysis. Focus groups chosen to limit potential bias caused by researcher views. | 1 | Ethical permission granted. | 1 | Analysis process discussed, although limited details as to the use of Ethnography software are given. Role of the researcher involved in data collection discussed in terms of the analysis. The use of contradictory data was not discussed. | 1 | Clear statement of findings in terms of aims | 1 | Authors discuss the implications of the research in terms of parental education. Authors state that parental education needs to go beyond traditional strategies regarding the immunisation schedule, to personalise and make salient childhood immunisations to parents in order to change behaviour. |
| Miller et al. (2008) | 1 | Aim to give insight into parental need for immunisation information and to examine whether current information meets parental needs | 1 | Aim to gain insight into parental perspective therefore qualitative method appropriate | 1 | Semi-structured interviews used owing to the exploratory nature of the study | 1 | Suitable parents identified by Public Health nurses. Parents interested in the study returned stamped-addressed envelope and were contacted by the PI. No fathers returned slips. Authors attribute this to fathers not attending classes or clinics. | 1 | Semi-structured interviews conducted, although location 1. Method of data collection justified by exploratory nature of study. Methods of interview explicit and copy of interview guide given. Authors discuss limited modifications to interview guide made before saturation reached. | 0 | PI responsible for participant recruitment, data collection and analysis. The impact of their role is not discussed, although methods to safeguard the credibility and quality of the data are mentioned. | 1 | Ethical permission granted. | 0 | No in-depth account of data analysis is provided. It is 1 how the data presented links/ represents the analysis process and the themes derived. Whilst data is presented to support the derived themes, little contradictory data has been taken into account. | 1 | Clear statement of findings in terms of aims | 1 | Authors discuss the implications of the study findings in terms of the need for immunisation information to be unbiased and equally address parental concerns. The authors also state the importance of parental needs to be considered individually, particularly in terms of the presentation, availability and timing of information. |
| New and Senior (1991) | 1 | To explore the impact of physical constraints on childhood immunisation attendance by women | 1 | The hypotheses presented suggest that a quantitative design was intended and are mentioned at the start of the paper. However quantitative findings were explored further using the qualitative data subsequently presented | 1 | Interviews used to illuminate participant views from questionnaire | 1 | Parents of young children chosen at random from clinic lists. Unimmunised infants were deliberately sought out to allow parents' views to be sought. | 1 | Structured interviews. Data saturation is not discussed. | 0 | Insufficient information to determine potential biases in researcher involvement | 0 | Insufficient information to determine potential biases in researcher involvement | 0 | Insufficient information to determine potential biases in researcher involvement | 1 | Clear statement of findings in terms of aims | 1 | Authors discuss the competing demands of parents when it comes to immunisation, particularly on mothers and how barriers can impact on uptake. |
| Niederhauser & Markowitz (2007) | 1 | To explore the barriers to immunisations in parents whose children are unimmunised by 2 years | 1 | Qualitative method appropriate as aim to explore views | 1 | Design justified. Focus groups to explore barriers to immunisation | 1 | Clear 4-pronged recruitment strategy via purposive sampling from several sources. | 1 | Clear description of method of data collection. Focus groups used and an indication of how groups were constructed given. Data recorded and transcribed verbatim. Notes also made by moderator during sessions. Saturation of data was not discussed. | 1 | Researcher examined own role. Whilst involved in data collection, comments that tried to remain neutral throughout. Together with 2 other convenors of focus groups, researcher made notes about each session and discussed the findings together | 1 | Ethical permission granted. | 1 | Clear method of data analysis presented as well as measures taken to ensure internal and external validity (question order maintained, transcribing; discussion of findings, researcher impartiality) | 1 | Clear statement of findings in terms of aims | 1 | Authors discuss the need for more specific identification of immunisation barriers within intervention strategies, public policy, and in the identification of families at risk of non-compliance. |
| Raithatha et al. (2003) | 1 | To asses parental vaccine risk perceptions and thereby strategies to prevent uptake deterioration | 1 | Qualitative method appropriate as aim to gain an understanding of vaccine risk perceptions | 1 | Design justified. Semi-structured interviews performed to establish parental perceptions | 0 | Convenience sampling of parents from 1 rural and 1 urban nursery used. Authors do not discuss why this method of sampling was used | 0 | Too little information to permit judgement. The authors do not discuss interview setting, format, conduct etc. Saturation of data is not discussed. | 0 | Insufficient information to permit judgement. The authors do not comment on their own role within the study | 0 | Insufficient information to permit judgement | 0 | Clear description of the analysis however, little data is presented to support the findings. The extent to which contradictory data was considered is 1. | 1 | Clear statement of findings in terms of aims | 1 | Authors consider the need for immunisation information to be balanced, for health professionals to listen to parental concerns about vaccines, for GP incentives to be revaluated and for information to be disseminated at a local level. |
| Sporton & Francis (2001) | 1 | To explore the decision-making process of parents who have chosen not to immunise their children | 1 | Qualitative method appropriate as authors sought to explore parental decision-making | 0 | Insufficient information to permit judgement | 1 | Clear recruitment strategy. Non-immunising parents selected through immunisation co-ordinators and health visitors. Parents then telephoned using a screening questionnaire and a selection of parents with a range of backgrounds chosen for interview | 0 | Setting justified and method of collection clear. Little information given regarding explicit methods used to collect data. Data and analysis occurred simultaneously (although saturation is not explicitly mentioned). Interviews recorded and transcribed verbatim. | 0 | Insufficient information to permit judgement. The same author conducted, transcribed and analysed all interviews. However, little information about any steps taken to prevent bias is mentioned. | 1 | Ethical permission granted. | 0 | No in-depth description of the analysis given. Sufficient data is given to support the findings but the extent to which contradictory information was examined is 1. | 1 | Clear statement of findings in terms of aims | 1 | Authors consider the implications for understanding parental decision-making about childhood immunisations, the importance of balanced information and parental access to it. |
| Tarrant & Gregory (2001) | 1 | To explore parental beliefs about immunisation, childhood diseases and their impact on child health in First Nations communities | 1 | Qualitative method appropriate as aim to explore parental beliefs | 0 | Insufficient information to permit judgement | 1 | Purposeful sampling used to identify children <5 years-old from community birth records. | 0 | Whilst the method of data collection is clear, it is 1 where interviews were carried out, and if any modifications were made. Data was recoded and transcribed verbatim. Saturation of data is not discussed. | 0 | Insufficient information to permit judgement. The same author recruited and conducted. It is 1 which researcher conducted data analysis. However, little information about any steps taken to prevent bias is mentioned. | 0 | Insufficient information to permit judgement | 0 | No in-depth description of the analysis given. Some data is given to support the findings but the extent to which contradictory information was examined is 1. | 1 | Clear statement of findings in terms of aims | 1 | Authors discuss the implications of findings in terms of investigating culturally-appropriate educational interventions and for the behaviour of health professionals. |
| Tarrant & Gregory (2002) | 1 | To explore First Nations parents' belief about childhood immunisation and to examine factors influencing its uptake | 1 | Qualitative method appropriate as aim to explore parental beliefs | 1 | Design justified. Qualitative descriptive design chosen to give comprehensive summary of everyday experience that is relevant to practitioners (Sande0ski, 2000) | 1 | Purposeful sampling used to identify children <5 years-old from community birth records. 49 parents contacted, 28 participated. Reasons for non-participation discussed. | 1 | Setting justified and method of collection clear. Methods chosen and interview format used were clearly justified. Data recorded and transcribed verbatim. Data collected and analysed simultaneously until saturation had been reached. | 0 | Insufficient information to permit judgement | 1 | Ethical permission granted. | 1 | In-depth description of the methods used and steps taken to ensure methodological rigour. Sufficient data is provided to support the findings stated and contradictory information within themes is discussed. | 1 | Clear statement of findings in terms of aims | 1 |  |
| Tarrant and Thompson (2008) | 1 | To explore perceptions of childhood immunisations in a group of parents from a population with 2 vaccination coverage and to identify factors which might encourage uptake in other countries | 1 | Qualitative method appropriate as aim to explore parental perceptions | 1 | Design justified. Person-centred interviews chosen in order to engage the participant as both an informant and a respondent due to their knowledge about the behaviour under study. | 0 | Sub-sample of participants from a larger study of health beliefs and immunisations. It is 1 how/ why participants recruited into the interview study were chosen. | 1 | Setting justified. Methods and location of interviews was clear and provision for translation made explicit. Interviews used a topic guide and were audio-taped before being transcribed verbatim. | 0 | Insufficient information to permit judgement | 1 | Ethical permission granted. | 0 | Although a description of the method of data analysis is given, there is little detail about how the content analysis was conducted. Limited data are presented to support the findings and the extent to which contradictory data are taken into account is 1. | 1 | Clear statement of findings in terms of aims | 1 | Authors discuss implications for the study in terms of Hong Kong and more generally to other countries with a 2 level of immunisation uptake. The authors maintain the importance of utilising multiple strategies that have been shown to be effective in increasing immunisation uptake and comment how these factors were cited by parents in the study as contributing factors in decision-making. |
| Tickner et al. (2007) | 1 | To explore parental attitudes towards the 5-in-1 vaccine, including how parents make vaccine decisions for young babies | 1 | Qualitative method appropriate as aim to explore parental attitudes and aspects of decision-making | 0 | Insufficient information to permit judgement | 1 | Purposeful recruitment of parents whose child was due to receive the first 5-in-1 vaccine by the HV. Participants selected form a range of socio-economic backgrounds and with different views on immunisation. | 1 | Data collected in parents' home at a time convenient to them. Semi-structured interviews were used with a flexible schedule of open-ended questions fol0ed by probing questions when necessary. Interviews were tape-recorded and transcribed verbatim. Saturation of data is discussed; data collection and analysis occurred simultaneously in an iterative approach. | 0 | Insufficient information to permit judgement | 1 | Ethical permission granted. | 1 | A clear account of the analysis and the derivation of themes are given. Sufficient data are presented to support the findings and the extent to which contradictory information was taken into account is mentioned. Biases were limited by the independent coding of a selection of interviews by 2 authors. | 1 | Clear statement of findings in terms of aims | 1 |  |
| Tickner et al. (2009) | 1 | To identify possible reasons for 0er uptake of pre-school immunisations compared with the primary course. | 1 | Qualitative method appropriate as aim to parental reasons for 0er uptake of pre-school immunisations | 0 | Insufficient information to permit judgement | 0 | Participants selected from 9 nurseries chosen to include a wide diversity of parents. Parents were sent an information pack to which interested parents could reply before being contacted by the primary author. No discussion is given as to whether or not this sample was reflective of a range of immunisation views, socioeconomic backgrounds etc. | 1 | Data collected in parents' homes. Semi-structured interviews were used with an open-ended question schedule. The authors comment on why modifications were made to the interviews and that these were necessary to clarify themes. Data was tape-recorded and transcribed verbatim. Data collection and analysis occurred simultaneously, saturation of data is not discussed explicitly. | 0 | Insufficient information to permit judgement | 1 | Ethical permission granted. | 1 | A clear account of the analysis and the derivation of themes are given. Sufficient data are presented to support the findings. However, the extent to which contradictory information was taken into account is not mentioned. Biases were limited by the independent coding of a selection of interviews by 2 authors. | 1 | Clear statement of findings in terms of aims | 1 | Authors discuss the importance of timely information in relation to pre-school booster injections owing to parental uncertainties and time-constraints. Authors comment on the value of play-group and pre-school involvement in the communication of the immunisation schedule. |
| Tomlinson & Redwood (2013) | 1 | To understand views of immunisation of Somali women living in UK | 1 | Qualitative methods appropriate as aim to examine understandings | 1 | Design justified - ideographic approach to describing individual accounts | 1 | Snowball sampling due to hard to reach population within purposefully chosen group. | 1 | Interviews using topic guide. Collection and analysis occurred concurrently to inform sampling and to indicate when saturation had been reached. | 0 | Insufficient information to permit judgement | 1 | Ethical permission granted. | 1 | In depth description provided. Interviews read, initial codes identified from sub-set. All interviews coded according to codes. Codes grouped. | 1 | Clear statement of findings in terms of aims | 1 | Authors discuss how women's perception of risk is a key factor in their decision making and that these are typically mediated by peers rather than medical professionals. Information in the Somali community must be targeted to address the unique risks of this population. |
| Topuzoglu et al. (2007) | 1 | To explore immunisation views of socio-economically disadvantaged mothers | 1 | Qualitative methods appropriate as aims to understand views | 1 | focus groups to used | 1 | mothers purposefully selected from slums until saturation had been reached | 1 | Focus groups using topic guide. Groups conducted until saturation reached. | 0 | Insufficient information to permit judgement | 0 | Insufficient information to permit judgement | 1 | Insufficient information. Themes identified using coding frame. Reliability ensured by independent coding of transcripts by 2 coders. | 1 | Clear statement of findings in terms of aims | 1 | Information should be tailored to Turkish community |
| Watson et al. (2007) | 1 | To describe parental decision making about Men B | 1 | Qualitative method appropriate as sought to describe views | 1 | interviews to explore parental views | 1 | Purposeful sampling of parents with range of vaccine outcomes | 1 | Interviews conducted at location convenient to parents, audiotaped. Interviews conducted with topic guide. Data saturation not discussed. | 0 | Insufficient information to permit judgement | 1 | Ethical permission granted. | 1 | Transcripts coded line-by-line. Themes derived by constant comparative method by 3 authors. Codes compared between immunising groups to examine similarities and differences in viewpoint. | 1 | Clear statement of findings in terms of aims | 1 | Authors discuss the need for balanced information in terms of the Men B vaccine and the need for individual as well as population risks to be acknowledged. |
| White and Thomson (1995) | 1 | To explore beliefs about childhood disease and immunisations and to offer some explanations to low uptake | 1 | Qualitative method appropriate as aim to explore views | 0 | Insufficient information to permit judgement | 1 | purposive sampling of care-givers representative of major socio-economic backgrounds | 1 | Data collection at local group or individually at GP surgery. Sessions were structured using a set of open-ended questions or rating scales. | 0 | Insufficient information to permit judgement | 0 | Insufficient information to permit judgement | 0 | No in-depth description is provided. | 1 | Clear statement of findings in terms of aims | 1 | Authors discuss the merit of personalised immunisation programs for mothers (who take on most responsibility associated with vaccination) with additional barriers in addition to standard services. |
| Wilson (2000) | 1 | To assess rural parents' perceptions of immunisation and the services they are offered. | 1 | Qualitative method appropriate as sought to describe parental views | 1 | interviews chosen to allow participant's feelings and experiences to be obtained | 1 | Participants purposefully selected for having young child and residing in a rural setting | 1 | Data collection at allocation convenient for participants by 1/4 RAs. Questions revised after consultation with nurse and PI. Field notes taken and interviews tape recorded. Data collected until saturation reached. | 0 | Insufficient information to permit judgement | 1 | Ethical permission granted. | 1 | Grounded theory Constant Comparative Method used. Initial codes identified by each RA who transcribed and coded 1 initial interview. Codes shared with PI and updated accordingly. PI also examined similarities and differences between categories and reduced the number of codes based on similarities. | 1 | Clear statement of findings in terms of aims | 1 | It is important to develop a strong relationship between parents and health care professionals in rural settings to maintain vaccine uptake. |

1. The following chapter should be cited as Harvey, H., Reissland, N., & Mason, J. (2015). Parental reminder, recall and educational interventions to improve early childhood immunisation uptake: A systematic review and meta-analysis. *Vaccine*, *33*(25), 2862-2880. [↑](#footnote-ref-1)
2. The following chapter should be cited as: Harvey, H., Good, J., Mason, J and Reissland, N. (2013). A Q-methodology study of parental understandings of infant immunization: implications for health-care and advice. *Journal of Health Psychology,* 1359105313513622. [↑](#footnote-ref-2)