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**Early screening for failure to thrive in
infancy.**

Pauline McDougall.

Submitted for the degree of Doctor of Philosophy

19/11/2005

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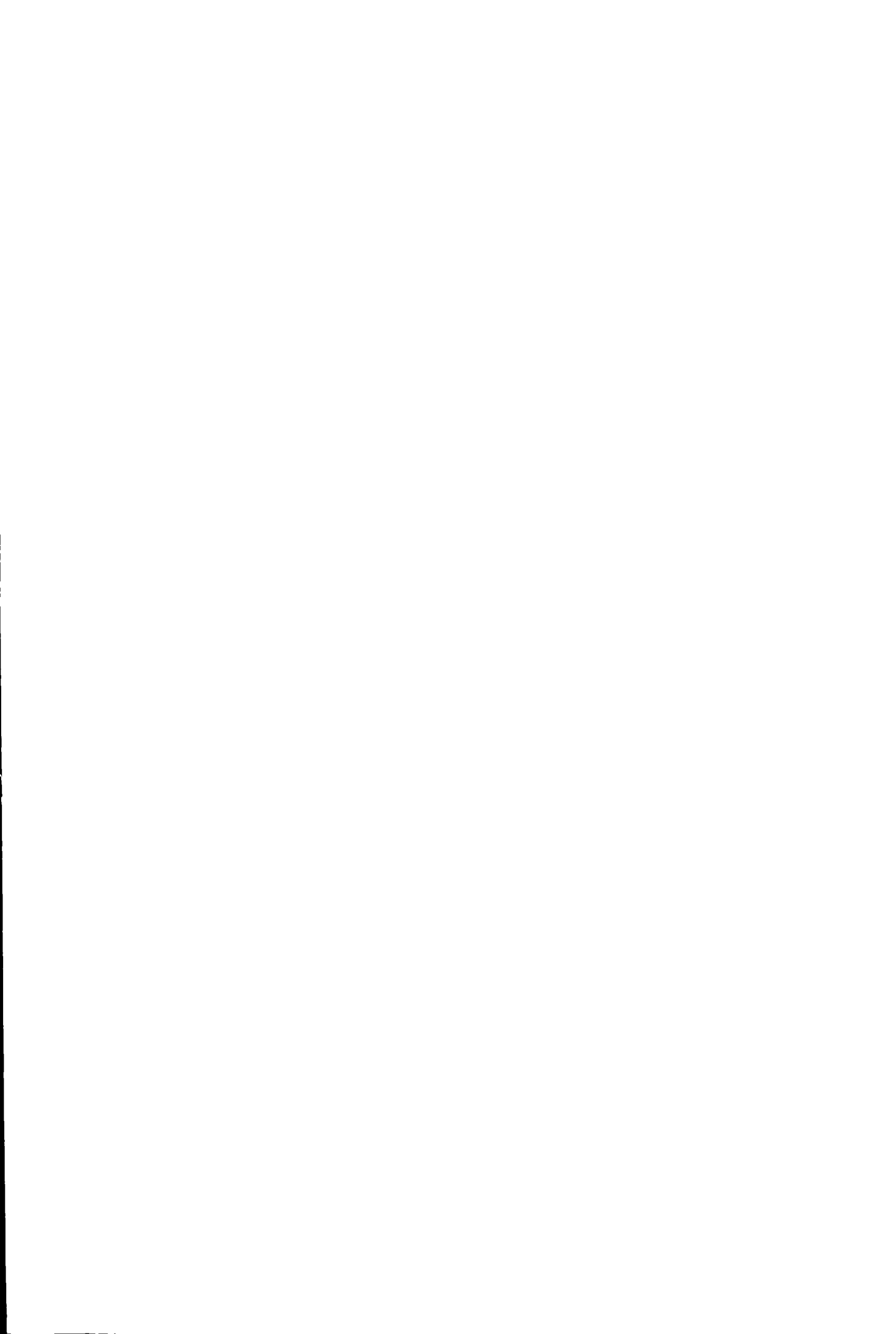
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Early screening for failure to thrive in infancy. Pauline McDougall

Abstract

The detection of failure to thrive in infancy is an important goal in routine surveillance of children. Failure to thrive is normally identified by slow weight gain, but is associated with feeding problems, and may lead to developmental delay and enduring intellectual defects. The prevention of these consequences is likely to depend on earlier detection of the condition than is currently achieved using traditional methods.

An experimental computer based early screening method for the detection of failure to thrive was implemented in a two-year birth cohort (1,966 infants) in 18 general practices in the Easington area. The methods utilised an ACCESS database incorporating the British 1995 growth reference, which was used to convert the infant's weight to a z score (conditional on age and sex). A 'thrive index' (a z score for weight gain conditional on age, sex and birth weight) was then calculated for the period from birth to the six to eight to week check and the infants in the slowest growing 5% automatically identified.

The projected number of births in the 18 practices over the period 1 April 2001 to 31 March 2003 was 1800, and the actual number identified from health visitors' birth registers was 1966. For the 1966 infants, records of both a birth weight and a six to eight week weight were identified for 1880 infants. One hundred and twenty one infants met the criteria for FTT over this period (thrive index ≤ -1.17) and of these,



102 term singletons were eligible to be recruited to the study. Those who participated had their development and weight gain followed to one year of age.

Infants were tested at four months and again at nine months using the Bayley Scales of Infant Development (2nd ed). Mental development index (MDI) scores and psychomotor development index (PDI) scores of case infants and controls were compared and a mean difference was found between cases and controls in MDI scores at four months of 3.52 which was statistically significant. The mean difference in PDI scores at four months was 3.59, which was also statistically significant. At nine months the mean difference in MDI scores was 2.26 and the mean difference in PDI scores at nine months was 2.25, which was not statistically significant in either case.

Information about demographic characteristics, health and feeding behaviour was obtained by using a structured questionnaire with the mothers. There were no statistically significant differences between families of case and control infants in indicators of affluence such as home or car ownership, nor were there any statistically significant differences between their mothers in their levels of educational achievement. There were no statistically significant differences between cases and controls in whether infants had ever been breast fed. Case group infants, however, were significantly more likely to be slow feeders than controls, and were more likely to take only small quantities and to be weak suckers. They were also more likely to be described by their mothers as having feeding problems.

The screening method described provides a practical procedure for weight screening at the six to eight week check that allows identification of children who fail to thrive in the early weeks of life.

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Declaration

The research contained in this thesis was carried out by the author between 2000 and 2005 whilst a postgraduate student in the Department of Psychology and the Centre for Integrated Health Care Research at the University of Durham. None of the work contained in this thesis has been submitted in candidature for any other degree.

Statement of Copyright

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

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Chapter One

Introduction

There is evidence from a randomised controlled trial (Wright et al., 1998) that the adverse growth outcomes of failure to thrive can be partly ameliorated by a structured health visitor intervention with limited specialist support. But the intervention was rather late, averaging 16 months and never earlier than seven months. Raynor et al. (1999) carried out a randomised controlled trial to determine whether home based intervention by a specialist health visitor would improve outcomes for children with failure to thrive compared with those who received conventional management. The mean age of infants in the study was 14.3 months. The study failed to find any significant benefits of health visitor intervention for children with failure to thrive.

Earlier intervention is likely to be more effective, in particular at preventing the developmental delay, but earlier intervention requires earlier detection. The earliest practical time for this would be at six to eight weeks when a weight is available for virtually all infants from the six to eight week check. Population based studies show that failure to thrive often has a very early onset. In an entire one-year birth cohort in Newcastle upon Tyne infants who failed to thrive in the first 18 months generally showed poor weight gain from birth (Drewett et al., 1999). This is consistent with results of a major prospective study in the USA (Altemeir et al., 1985) in which 60% of cases failed to thrive by one month and 87% by three months.

Failure to thrive in the early months cannot be identified using traditional screening criteria (weight below the 3rd or 5th centile) by comparing an infant's weight with population centiles using 'growth charts', as a low weight in the early months is likely to reflect a low birth weight, rather than poor weight gain after birth. Nor can it be identified by an infant's weight falling downwards across centiles on a growth chart,

since this does not take into account 'regression to the mean'. This is the tendency for infants with a low birth weight to gain weight relatively quickly early in life, and for infants born heavy to gain weight relatively slowly (Cole, 1995; Wright et al., 1998; Wright et al., 1994). What is needed is a comparison of the child's weight gain with that of other children of the same birth weight. This comparison can be made using a weight standard which is conditional on birth weight; the appropriate procedures are available in a mathematical form for research purposes and in a graphical form for routine clinical use (Cole, 1995; Wright et al., 1998; Wright et al., 1994). The procedure involves comparing an infant's weight with that of children of the same age, sex and birth weight, from an appropriate reference population. This gives a 'thrive index', which is a z score reflecting the difference between the infant's actual weight and expected weight (their average later weight given their birth weight). The recent development of these procedures, together with the widespread use of accurate electronic balances makes early screening for failure to thrive a realistic possibility. It has been recently established that screening as early as six to eight weeks of age is practical (Molkenboer, 2000). The procedures used do not require an additional measurement; they require only that the data collected at birth and at the six to eight week check are used in a more appropriate way.

The study reported in this thesis examined the extent to which cases detected using these procedures at the six to eight week check go on to show the developmental delay and poor weight gain classically associated with failure to thrive as detected later in infancy. Also reported are details of the feeding behaviour of infants identified as cases at the six to eight week check. Studies of children who fail to

thrive later have show that they are more likely to have feeding problems than infants who are growing normally (Mathisen et al., 1989; Skuse et al., 1994; Wright et al., 2000) and that these problems tend to start early and persist over time (Ramsay et al., 1993; Raynor et al., 1996; Wilensky et al., 1996). The demographic characteristics of the children were also investigated.

Monitoring of growth and development is provided for all infants in the United Kingdom and a procedure that improved its effectiveness, even to a limited extent, would help target health visitor services where they are most needed. Developmental delay is a consistently reported psychological consequence of failure to thrive and earlier detection of infants at risk of developing developmental delay associated with failure to thrive would allow earlier treatment interventions which might be more effective.

The following chapter (chapter 2) presents a review of the literature relevant to the study from a historical perspective followed by a discussion about growth charts, links between failure to thrive and health, feeding problems, socio-economic circumstances, abuse and neglect, and infant behaviour and temperament. The impact of failure to thrive on cognitive outcomes in infants and the effectiveness of interventions for failure to thrive are also discussed. Chapter 3 presents the aims of the study, describes the design and gives information about the characteristics of the study location. The data collection methods used in the study are described in detail. Chapter 4 presents the results of the study, including information about the population screened, the sample selected and case control comparisons of those who participated in the study. Chapter 5 discusses the study's findings in relation to the original aims

of the study and concludes with recommendations for training, practice and further research. A flow chart of the study showing timescales and research activity is shown in Figure 1.

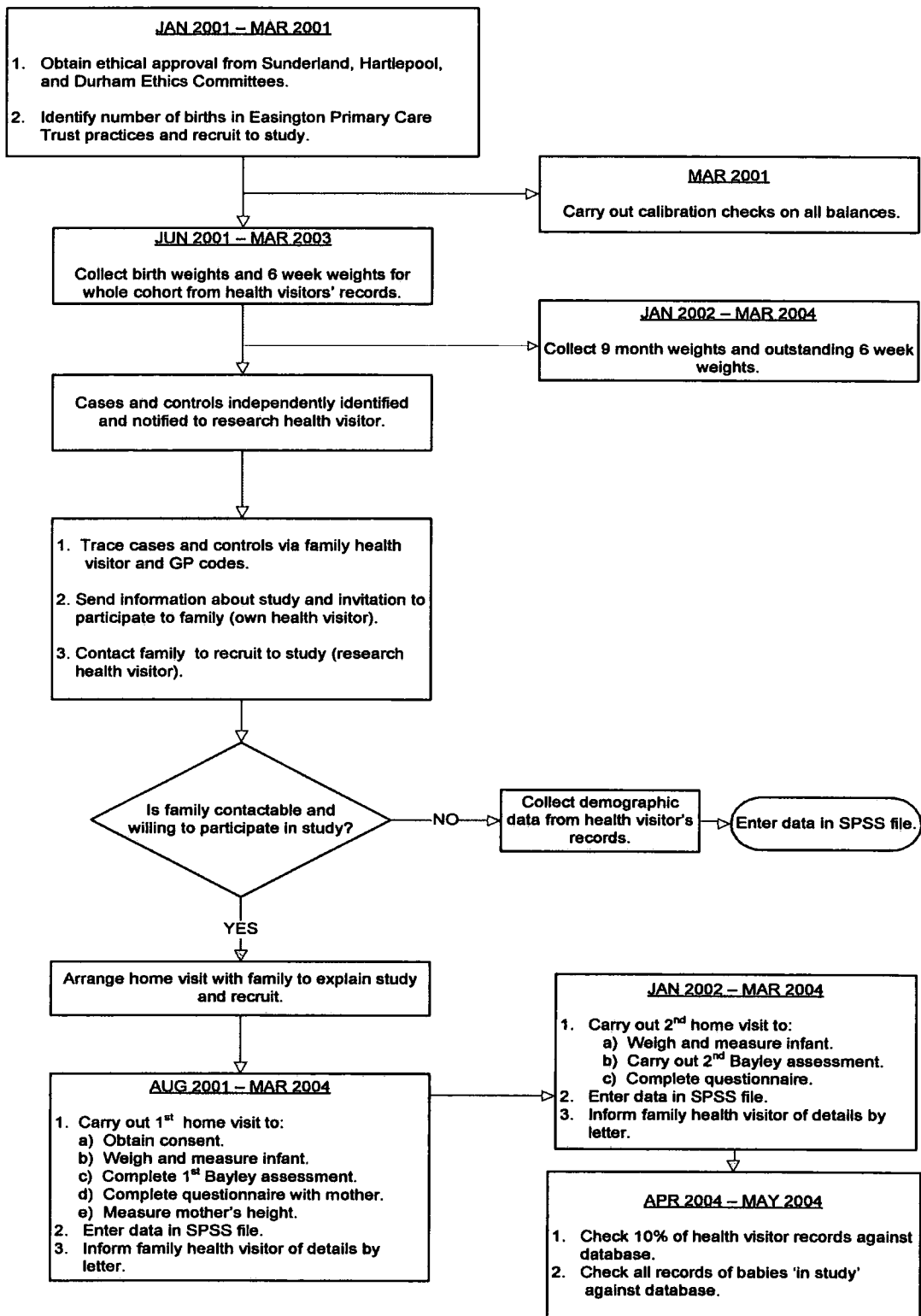


Figure 1. Flowchart of study

Chapter Two

Literature Review

Chapter 2: Literature review

2.1 Historical perspective

Throughout history there have been children who have failed to thrive, although in the developed world the reasons for this and the consequences have changed over time.

An early reference to the condition is to be found in the writings of Strolbelberger in 1629 (Still, 1939). He describes it as “a sort of consumption of the body, which leads to an unnatural falling away or thinness”. He stated that causes for the condition may be worms, fever, flux of the bowel, lack of nourishment or food disorder, or that it may be of congenital origin. Strolbelberger advocated various remedies, such as bathing the child in goats’ milk, or in a broth made from beer in which three sheeps’ heads had been boiled. Daniel Sennert, writing in 1632 (cited in Still 1933) on the feeding and management of infants, refers to faulty food and the presence of worms as causes of wasting. He also discusses bewitchment in all its forms as a cause of weight loss or poor weight gain in infants.

Dick (1987) has described how it was once believed that babies could be exchanged by the fairies for one of their own, and that these could be recognised by their hard bloated stomachs and failure to thrive. The commonly held belief was that to cure the baby, it must be tormented, in the hope that the fairies would take pity on it and return the human child in its place. In the Highlands of Scotland, these children were left on the shore at low tide and rescued when the tide came in and they stopped crying.

These superstitions persisted as late as 1840, when a man was sent to trial for abandoning his baby, whom he thought to be a changeling, in a tree on Christmas day.

According to folklore, a child was said not to thrive until it has been baptised. Before

baptism was performed, the child was prone to the influences of fairies and other evil spirits. The evil was said to manifest itself in the child becoming thin and wasted and it was common practice for various rites and customs to be carried out in order to help the child to thrive (Thompson, 1932).

An early reference to clinical signs of failure to thrive can be found in a text published over a century ago:

“The history in severe cases is strikingly uniform. The following story is the most frequently told. ‘At birth the baby was plump and well nourished and continued to thrive for a month or six weeks while the mother was nursing him; at the end of that period circumstances made weaning necessary. From that time on the child ceased to thrive. He began to lose weight and strength, at first slowly then rapidly, in spite of the fact that every known infant food was tried’. As a last resort the child, wasted to a skeleton, is brought to the hospital” (Holt, 1897).

Failure to thrive was traditionally described as either organic (with a known cause such as illness) or non-organic which was thought to be due to emotional or maternal deprivation. It was thought that infants with organic failure to thrive would not gain weight if admitted to hospital and that those with non-organic failure to thrive would gain weight if they were separated from inadequate parents (Bithoney et al., 1989). A study by Bithoney et al. (1989) tested this hypothesis and found that both non-organic and organic failure to thrive infants grew equally well given sufficient calories.

Berwick et al. (1982) reviewed hospital records of 122 infants, aged between one and 25 months, who were admitted to hospital with the diagnosis of failure to thrive but without an obvious underlying disease. Some of the infants with organic disease gained weight whilst some of those separated from ‘inadequate’ parents lost weight.

On average about 40 laboratory tests and x-rays were performed for each infant, but only 0.8% of all tests showed an abnormality which contributed to the diagnosis of the cause of failure to thrive.

Studies of children living in institutions had shown that they were at risk of failure to thrive (Spitz, 1945). Radbill (1987) referred to the plight of children living in institutions; the terms hospitalism, and institutional syndrome were used to describe these children who failed to grow normally. According to Talbot et al. (1947) anaclitic depression in children occurred due to the absence of a mothering figure in institutionalized infants which caused a neuro-endocrine disturbance. The hypothesis that these children received adequate energy yet failed to thrive due to lack of care and attention, was challenged when findings from a study by Whitten et al. (1969) confirmed that the infants in their study failed to thrive because of inadequate energy intake. Following on from Whitten's study, Frank and Zeizal (1988) found that in cases of failure to thrive associated with abuse or neglect, it was also likely to be due to inadequate energy intake rather than emotional deprivation that these children failed to thrive.

Despite the acknowledgement that lack of food was responsible for failure to thrive, the view that maternal deprivation and neglect was the primary cause persisted and much of the research into failure to thrive continued with this in mind. Helfer and Kempe (1968) for example described failure to thrive as a form of child neglect and they classified parents of children who failed to thrive alongside those who abused their children. A text by Hobbs et al. (1993) about child abuse and neglect dedicates a whole chapter to the subject of failure to thrive.

Up until the mid eighties much of the research carried out into failure to thrive was based on clinical referred samples, which were heavily biased towards children with a variety of problems; either feeding problems, psychological problems, socio-economic problems, or parent-child interaction problems. More recently researchers have taken a broader view and carried out research using unreferred samples from community settings. This avoids the problems associated with referred samples which are not representative of all children with failure to thrive, as demonstrated by Wright et al., (2000).

2.2 Growth charts

The report, Present Day Practices in Infant Feeding (Department of Health and Social Security, 1988) recommends that;

'Regular assessment of nutritional status should be an essential part of health surveillance of all infants. Clinical inspection of the baby remains the most important means of assessing the nutritional status and general well being. Serial weight measurements, ideally without clothes, will provide a good general means of assessing an infant's nutritional progress. If serial observations are plotted on standard weight charts early indication of failure to thrive or obesity may be picked up'. (Page 50).

Routine growth monitoring however, has been criticised on the grounds that it has not been adequately evaluated (Garner et al., 2000) and an appraisal of the clinic practice of weighing babies to monitor their physical well being, showed that these weighing practices are often inadequate due to poor weighing techniques, insufficient use of centile charts and a lack of understanding of normal variations in early weight gain (Davies et al., 1983).

In research or in clinical work, failure to thrive is defined by the use of an anthropometric indicator with a clear cut off point. If an infants growth falls below this point it may be classified as failing to thrive. In Britain, most research on failure to thrive in infants has made use of the Tanner-Whitehouse charts (Tanner et al., 1966). The Tanner growth standards are based on a cohort of only 80 boys and 80 girls measured at three month intervals between 1952 and 1954. The Gairdner-Pearson charts range from pre term to two years and were based on weight data from a small number of babies in local authority nurseries in London in the 1940's (Gairdner et al., 1971). These are a variation of the Tanner Whitehouse charts. The data used to produce the charts were based on weights of children living in the South East of England and were not therefore nationally representative. In addition, since these charts were published there has been a trend for children to mature earlier and attain greater adult size (Chinn et al., 1984; Voss et al., 1989). Changes in rates of breast feeding and timing of the introduction of solids (Weigley, 1990) may have also had an effect on the rate of weight gain in infants. Breast fed babies may have a higher risk of failure to thrive as there may be a delay in the introduction of solid food (Weston et al., 1987). Breast fed infants have been found to grow more rapidly in the first few weeks than bottle fed babies but were on average 650g lighter by one year of age (Dewey et al., 1992). There has been an increase in the proportion of infants who are breastfed, the introduction of solids has been delayed and the composition of formula milk has changed to resemble breast milk more closely (Whitehead et al., 1984).

The UK 1990 growth reference charts (Freeman et al. 1995) were produced in response to these concerns. Data for these charts were obtained from seven studies

which provided a nationally representative sample of over 25,000 infants between 1978 and 1990 (Freeman et al., 1995). The UK 1990 charts were revised (Preece et al., 1996) following a study by Wright et al. (1996) which compared a longitudinal dataset of weights collected routinely between birth and 24 months from a birth cohort of 3418 term infants born between 1987 and 1988 in Newcastle upon Tyne (Wright et al., 1994) with the U.K. 1990 standards and the Tanner and Whitehouse standards. The cohort showed a mean difference in standard deviation scores of 0.42 between boys and girls ($P < 0.0001$) when compared with the 1990 standards. There should be no difference, since the SD scores are sex standardised. Two and a half times as many girls as boys had weights below the 3rd centile during the first year, with an equivalent excess of boys above the 97th centile ($P < 0.0001$). Similar results were found with Tanner and Whitehouse standards. These differences could result in substantial sex bias in the identification of poor growth in early childhood.

In addition to the above there are other growth references in occasional use in the general population. These include various versions of the US growth references (Hammill et al. 1977; Kuczmarski et al. 2000) and what is known as the Sheffield or CONI chart (Carpenter/ Emery, unpublished). A new "Euro-reference" has recently been constructed and is used in some specialist computerised growth programmes. None of these are at present recommended for general use in the United Kingdom.

Growth charts are a vital tool in measuring and monitoring infants' weights. The Joint Working party on Child Health Surveillance recommended the use of the 1990 nine centile charts (Freeman et al., 1995; Preece et al., 1996) which are cross sectional charts based on the UK 1990 growth reference data. They have been constructed to show the 0.4 and 99.6 centiles; only 1 in 250 children are outside these limits

(Freeman et al., 1995). The growth charts show centile lines with weights in kilos on the vertical axes and age in weeks on the horizontal axes. The lines are based on weight for age of infants in a normal population. The 50th centile represents the weight which 50% of infants have a weight below and 50% have a weight above. Twenty five percent of infants have a weight below the 25th centile and 75% have a weight above. For an infant who has a number of recorded weights over a period of time it is possible to join these points to show a weight trajectory and to compare the infant's weight gain with those in a reference population.

Whitehead and Paul (1984) reviewed the other growth charts available. The National Centre for Health Statistics growth (NCHS; Hamill, 1979) is based on a sample of infants in the United States recruited between 1929 and 1975. The Harvard growth standards (Stuart et al., 1959) are based on a sample of 228 infants recruited between 1929 and 1939. Both charts have been widely used in research on failure to thrive in the USA. The reference populations which both of these charts are based on are from 50 years ago and in the case of the Harvard standards based on a small sample. Since these charts were introduced changes in infant feeding have occurred.

Guo et al. (1991) advocate evaluating increments in length and weight rather than evaluation of growth using reference standards, especially for infants with growth failure; a comparison with average attained weight of infants in a reference population is in their opinion inferior to the use of increments to evaluate weight gain. In research on failure to thrive (poor weight gain) the assessment of growth is crucial and Peterson et al. (1985) indicate that a measure of gain is more sensitive than a measure of attained weight at a certain time. Velocity standards can differentiate

infants who are small from infants who are failing to grow.

Another important issue in evaluating weight gain in infancy is regression to the mean, which means that weights become less extreme on average. The amount of regression to the mean depends on the correlations between the weights at the two time points (Cole, 1995). This issue is important since 'regression to the mean' means that infants born heavy generally move closer to the mean (50th centile) as they grow and this should not be interpreted as poor weight gain.

Wright et al. (1994) carried out a population survey of weight gain in infancy, to explore the availability of routine weight data and the variation in weight gain in infancy. In addition, the study questioned the commonly used definition of failure to thrive (falling below a pre-determined centile, usually the third). A one year cohort of children was identified using the child health computer system. The health records of all term infants were reviewed to collect medical information and weights; these were transformed into SD scores using the Cambridge growth standards. The infants' SD scores were calculated from weights at two separate points; the difference between the attained SD score and predicted SD score given an earlier SD score is referred to as the 'thrive index'. It takes into account the tendency of infants with a birth-weight above the mean to move downwards to the mean, and those with a birth-weight below the mean to move upwards towards the mean.

After pre term babies were excluded, there were 3,418 infants aged between 18 and 30 months. A birth weight was available for 89% of the children and 92% had at least one clinic weight. There was a recorded weight between nine and 24 months for 79% of the infants; which meant that the growth data were a mixed longitudinal and cross-

sectional set. Children with a high SD score at six weeks showed a tendency to decrease in SD score whilst those with a low SD score increased, demonstrating the tendency of regression to the mean. Results showed that 97% of infants would be expected to have a thrive index of above -1.69 and 95% above -1.48. Seventy three infants had a thrive index below the 3% threshold and 122 below the 5% threshold. Of those with weight gain below the 3% threshold, 40% had not fallen below the 3rd centile; therefore a large proportion of infants with poor growth will not be identified if the third centile is used.

As part of the Davis Area Research on Lactation, Infant Nutrition and Growth (DARLING) study (Heinig et al., 1993), anthropometric data were collected monthly from birth to 18 months and infants who were either breast-fed or formula-fed during the first 12 months were followed. The two cohorts were matched for parental socioeconomic status, education, ethnic group, anthropometric characteristics, and for infant sex and birth weight. Neither group was given solid foods before four months. While mean weight of formula fed infants remained at or above the National Centre for Health Statistics median throughout the first 18 months, mean weight of breast-fed infants dropped below the median beginning at six to eight months and was significantly lower than that of the formula-fed group between six and 18 months. In contrast, length and head circumference values were similar between groups. Weight for length z scores were significantly different between four and 18 months, suggesting that breast fed infants were leaner. The groups had similar weight gain during the first three months but breast-fed infants gained less rapidly during the remainder of the first year; cumulative weight gain in the first 12 months was 0.65 kg less in the breast-fed group. Length gain was similar between groups. These results

indicate that weight patterns of breast-fed infants, even in a population of high socioeconomic status, differ from current reference data and from those of formula-fed infants. The authors concluded that new growth charts based on breast-fed infants were needed.

The Child Growth Foundation published the first weight reference charts specifically designed for the breast-fed infant (Fry, 2003). Based on a sample of 120 long-term British breast-fed babies, the charts demonstrate the particular growth pattern of breast-fed babies. This differs from formula-fed infants in that breast fed babies initially gain weight more rapidly, but from two to three months of age their weight gain decreases and they begin to move downwards across centiles. At present in the study area, breast fed babies are measured against the standard British 1990, revised Preece et al. (1996) weight reference chart rather than one that reflects the pattern of the long-term breast-fed baby. Although 'Breast from birth' charts are available as inserts for the parent held child health record, they are not routinely used by all health visitors.

There is a clear lack of consensus in both clinical and research work about which anthropometric indicator and cut off value should define failure to thrive (Raynor et al., 2000; Wilcox et al., 1989; Wright et al., 1994). This limits the generalisability of research findings and may mean that some infants who fail to thrive might not be identified, depending on the sensitivity and specificity of the indicator used (Steward et al., 2003).

2.3 Early feeding problems and failure to thrive

Population based studies

A prospective study of non-organic failure to thrive carried out in a primary care setting aimed to identify antecedents of growth failure (Altemeir et al., 1985). The study found that during the nursery hospitalisation period, mothers of infants who failed to thrive were more likely to have problems feeding their infant. Half of the mothers did not wish to feed their infant, or presented sufficient problems for the nurses to decide to do most of the feeding.

Pollit et al. (1978) observed 40 normal mother-infant pairs during feeding at between 20 and 36 hours old. The aim was to test the proposition that selected behaviours of both mother and infant are predictors of weight gain during the first month of life. Aggregate scores of four specific maternal and infant behaviours accounted for over 32% of the variance in total weight gain. The number of times the mother replaced the teat cover on the bottle positively correlated with weight gain, but cleaning activities were negatively associated with weight gain. A positive correlation was found between the number of times the infant's eyes opened and weight gain and a negative correlation between the number of times the infant refused the bottle and weight gain. These findings indicate that the availability of nutrients is not in itself a sufficient condition to meet the infant's nutritional needs. The authors conclude that infants at risk of failure-to-thrive can be identified and measures to prevent this syndrome can be introduced.

A community-based study (Wilensky et al., 1996) examined the epidemiological characteristics of a non-referred sample of failure to thrive children in Israel. The authors carried out a retrospective review of community child health records in three neighbourhoods in Jerusalem and the total population of Beit Shemesh. The study population reflected upper, mixed and lower socio economic levels. Records were

reviewed after the infants had reached 15 months of age; all weight, height and head circumference measurements were recorded for each child, as well as demographic details, paediatric examinations and medical history. The total cohort numbered 1452 births and failure to thrive was defined as falling below the third centile for duration of three months. Infants whose birth weight was below 2500 g or born before 37 weeks gestation were excluded, as were those infants whose weight to height ratio was above 10%. Fifty-five cases were identified and matched with a control from the same health clinic born in the same month. Three children with significant medical causes for failure to thrive were excluded to avoid confounding medical variables, one had moved out of the area, and one refused to participate. None of the controls refused to participate. This was a very high recruitment percentage.

As part of the study a feeding questionnaire was administered and results showed no significant differences between the two groups in the percentages of children who were breast-fed. The duration of breast-feeding in infants who failed to thrive was longer (15.3 v 11.4 weeks) though not significantly longer. The average length of breast feed was significantly longer in the group who failed to thrive (19.5 v 12.9 min; $p < 0.05$). This group also differed significantly in feeding history, falling asleep while breast feeding more often, sleeping through feed times, refusing solids more often, and still showing feeding related difficulties at 25 months of age.

A study by Ramsay and Gisel (1996) found an association between neonatal and later sucking ability, clinical signs of feeding ability and maternal feeding practices. Forty nine infants were followed to a mean age of six weeks; 20 had feeding problems based on changes in feeding practices by their mothers, and 29 did not. Results showed that many of these infants were feeding less efficiently from birth and the

authors suggest that even among healthy infants there may be more with problematic feeding abilities than have been previously recognised. The authors also concluded that mothers are a reliable source of information about their infants' feeding abilities.

A study by Wright and Birks (2000) identified infants by population screening. It was carried out to identify whether there were differences between children who had failed to thrive and a group of normally growing controls in feeding behaviours. Wright et al. (1998) previously carried out a randomised controlled trial of community interventions as part of the Parkin service. Population screening had identified a group of children who had failed to thrive and field staff assessed these children.

When comparing initial breast-feeding rates, these were similar; 47% of cases and 50% of controls were breast-fed. Solids were reported by parents to be introduced later in the case group at mean age of 3.89 months compared with 3.04 months in the controls. This difference was highly significant. Cases were reported to be late starting finger foods, at a mean age of 7.15 months compared with controls at a mean age of 6.14 months. This difference was highly significant. When asked if their children had any feeding problems in infancy, 27 (28%) parents of case infants reported feeding problems compared with only two (7%) of controls. This difference was statistically significant. No association was found between early feeding problems and the age of introduction of solids. Parents of cases were more likely to describe their child as a variable eater (35.1%) than controls (17.9%) while parents of controls were more likely to describe their child as hungry (39.3%), compared with 13% of parents of cases. Twenty cases were excluded from this analysis as they chose more than one adjective to describe their child.

Parents were asked to rate their child's liking for different food groups on a five-point scale. There were no differences in preferences for high or low energy foods; however controls were rated as liking most foods more than cases. The difference in the total score for all foods was highly significant. The results from the study suggest that children who fail to thrive have significantly different behaviours in relation to food.

Parkinson et al. (2004) directly observed feeding behaviour and food intake in children who failed to thrive. A cohort of 961 term infants was screened to identify children with weight gain below the 5th centile in the first year. Two lunchtime meals were observed and video taped at 13-21 months, one consisted of finger foods and one of 'spoon foods'. The sample consisted of thirty children who failed to thrive and 57 controls. The video tapes were coded for feeding behaviour using a behavioural coding inventory which distinguishes between children feeding themselves and responding to being fed by their mother.

Differences in feeding behaviour were found between meal types, with mothers feeding their child more often at meals with 'spoon foods' and children feeding themselves more often at meals comprising finger foods. By weight, more food was consumed at the spoon food meals, but energy intake was no higher, showing that the children compensated for the differing energy yields of the foods. Children who failed to thrive took in less energy than controls, and were less likely to sit in a highchair throughout the meal, but there were no clear differences in other feeding behaviour. The authors concluded that food type is an important variable when studying mealtime behaviour. Children who fail to thrive take in less energy than controls of the same age, despite there being no major differences in mealtime feeding

behaviour. When asked if their children had any feeding problems in infancy, 27 (28%) parents of case infants reported feeding problems compared with only two (7%) of controls. This difference was statistically significant.

A population based study by Heptinstall et al. (1987) identified a one year birth cohort of four year-olds from an inner city area, whose growth fell below the 10th centile for height and weight on the British Standard Growth Charts (Tanner et al., 1976). Of the 2,145 recorded live births, records were traced for 1,868 children. Mean parental heights were taken into account and the child's height had to be below the 10th centile relative to these; using the standards by Tanner et al. (1970). Only term Caucasian singletons and those with no known organic disease which may have affected growth were included in the study. There were 24 cases identified, and only one refused to participate. They were matched for age, sex, socioeconomic status, ordinal position and birth weight, with 23 normally growing children. None of the comparison group refused to participate.

There were no differences between groups in whether infants were breast or bottle fed, and although case group infants were introduced to solids later than comparisons the difference was not statistically significant. There were no differences noted between food intake or environmental factors between the two groups, however mealtime observations revealed considerably more negative attitudes and disorganisation in case group families. Retrospective information obtained at interview indicated that these factors had been ongoing since early infancy. A statistically significant difference was found between the groups in oral in-coordination, with 11 case children having oral in-coordination compared to one comparison. The authors concluded that the role of family dysfunction should be

considered in relation to studies of child nutrition. The number of children in the study was relatively small and only included children from a socio economically deprived inner city area of London. These children may have characteristics which differ from the population in general.

Six months is the recommended age to introduce solid foods for all normal healthy Infants (Department of Health, 2003). The Infant feeding survey (Department of Health, 2000) found that 24% of mothers had introduced solids before three months. The majority (85%) had introduced solids by the age of four months and by six months; virtually all babies had been introduced to solid food. A prospective population based study by Wright et al. (2004) examined factors that predicted the age infants were introduced to solid food, and the relationship between weaning, weight gain and morbidity. The study sample was parents 923 term infants recruited shortly after birth, who were born in a defined geographical area. Postal questionnaires, weaning diaries, and routinely collected weights provided the data (707 parents returned data on weaning). The median age infants were first introduced to solids was 3.5 months, with 21% commencing before three months and only 6% after four months of age. Infants progressed quickly to regular solids with few difficulties, even when weaned early. Most parents did not perceive professional advice or written information to be a major influence on their decision to wean. The strongest independent predictors of earlier weaning were rapid weight gain up to six weeks, lower socioeconomic status, the parents' perception that the infant was hungry and the method of feeding. There was no relationship between weight gain after six weeks and age of weaning. Infants weaned before three months had an increased risk of diarrhoea compared to those weaned after four months. Social factors had some

influence on when solids were introduced, but the most infants were established on solids before the previously recommended age of four months without difficulty. Earlier weaning was associated with an increased rate of minor morbidity.

A prospective whole population survey by Skuse et al. (1994) monitored a one year birth cohort of 1558 full-term singletons, and 47 infants with failure to thrive (but otherwise healthy) in the first year were recruited. Nutritional histories of 47 infants with failure to thrive and 47 controls were recorded from semi structured interviews with mothers and from direct observation of the infants in a standardised feeding situation. Calorie intakes were measured by direct observations at mealtimes and were found to be lower by approximately 25% in the infants with failure to thrive. Oral motor abnormality scores were measured using the Schedule for Oral Motor Assessment, a specifically developed instrument for rating skills in children. Abnormality scores for infants' oral motor skills showed that case infants had significantly higher scores in respect of puree, semi-solids, crackers and drinking from a trainer cup (but not from a bottle).

Case comparison studies

Wright et al. (2000) described a study of dietary intake and eating behaviour in infants with failure to thrive who had been referred to an intervention programme. The family health visitor had made the decision as to whether the child was referred to the programme or not. Normally growing infants were recruited for comparison. Cases were found to have poorer appetite, delay in starting solid foods and ate fewer foods than controls. No significant differences were found in energy intake, even after allowing for body composition and other confounding variables.

Drewett et al. (2003) identified 28 one-year-old children who failed to thrive in infancy through a specialist clinical service using a conditional weight gain criterion which identified the slowest gaining 5%. Twenty eight control children of the same age and sex were recruited from the same area. The food intake and feeding behaviour of the groups was compared using a detailed observational micro-analysis of a lunchtime meal, using a behavioural coding scheme developed for use over the weaning period.

Food and drink intake were significantly lower in the cases than in the controls, the difference being due to differences in the quantities taken. The cases consumed slightly less energy dense foods, but this difference was not statistically significant. The mean duration of the meal was significantly shorter in the case group and both food and fluid intake were significantly lower in the children who failed to thrive than in the controls. Behaviour counts recorded at the meal showed that mothers of the children who failed to thrive fed them as much as, or more than the control mothers fed their children. The children who failed to thrive tended to refuse the offered food more and also fed themselves significantly less often than the controls. These behavioural differences during the meal accounted for about one third of the difference in energy intake between the groups.

Feldman et al. (2004) examined touch patterns between mothers and infants with feeding disorders. Twenty infants aged between nine and 34 months, referred to a community based clinic, were diagnosed with feeding disorders and other primary disorders. These were matched with 47 controls, and mother-child play and feeding were observed, touch patterns, response to partner's touch, proximity at play and relational behaviours were coded during feeding. The home environment was also

assessed.

Compared with infants with other primary disorders and matched controls, less maternal affectionate, proprioceptive, and unintentional touch was observed in those with feeding disorders. Children with feeding disorders displayed less affectionate touch, more negative touch and more rejection of the mother's touch. More practical and rejecting maternal responses to the child's touch were observed, and children were positioned more often out of reach of the mothers' arms. Children with feeding disorders showed more withdrawal during feeding and the home environment was less optimal. Feeding efficacy was predicted by mother-child touch, reduced maternal depression and intrusiveness, easy infant temperament, and less child withdrawal, controlling for group membership. Proximity and touch were disturbed in the feeding disorders group, mothers touched their infants less, and the children demonstrated signs of touch aversion. The authors concluded that touch patterns may be risk indicators of potential growth failure.

Ammaniti et al. (2004) evaluated the effects of age and the presence of feeding problems on relationships in a sample of 333 mother and child pairs during meals. Two groups of children were compared in their first three years; two hundred and twenty one children had normal development and a clinical group of 122 children had a diagnosis of feeding disorder and failure to thrive. A sub group of 50 mother and child pairs were selected at random from the total clinical sample and were paired with a control group. All mother-child pairs in the sample were observed in twenty-minute video-recordings during a meal. The failure to thrive group showed interactional dysfunctional patterns during feeding and scored higher in symptomatic characteristics both of the mother and of the child in comparison to the normal

development group. There was an association among specific symptomatic characteristics of the mothers (dysfunctional eating attitudes, anxiety, depression, hostility) and of their children, in particular, anxiety and depression, somatic complaints, aggressive behaviour, and dysfunctional relationships during feeding. The authors conclude that in order to establish a valid diagnostic methodology and formulate strategies for targeted and effective intervention, it is important that when assessing children with feeding problems, the individual characteristics of the mother and child and their relationship during the development of feeding patterns in the first three years of life are considered.

Mathisen et al. (1989) carried out a study which aimed to find out whether there was an association between infants with non-organic failure to thrive from a socio-economically deprived inner-city area, and abnormal oral-motor functioning and aspects of social adversity; such as disorganised meal-times. A Feeding Assessment Schedule was devised to rate oral-motor behaviour which was used to test nine pairs of case and comparison children while they were being fed at home. Video-recordings were made of the feeding sessions and these were analysed later. The case infants were found to have immature and abnormal oral-motor development and were less successful feeders. Temperamentally they were more 'difficult' than the comparison infants and they were less adept at signalling their needs during meal-times. The case infants were fed in inappropriate positions for their age, with more distractions and less suitable utensils.

Polan et al. (1991) assessed positive and negative affects in 28 infants with failure to thrive and 14 normally growing infants in both feeding and non feeding situations. The infants were aged between six months and three years. Infants with failure to

thrive were found to express less positive affect in both feeding and non feeding situations and more negative affect in feeding than normally growing infants. Among the infants with failure to thrive, the presence of both acute and chronic malnutrition was associated with heightened negative affect during feeding, but the degree of organic contribution had no effect.

Kotelchuck and Newberger (1983) carried out a study of familial characteristics of infants with failure to thrive. Structured interviews were carried out with mothers of 42 infants with failure to thrive and 42 matched controls. The infants with failure to thrive were significantly more likely to having poorer health and more feeding problems than control group infants.

Pollitt and Eichler (1976) studied the eating, sleeping, elimination, autoerotic and self-harming behaviour of 19 preschool children with failure to thrive, and their behaviour was compared to a group of 19 children normally growing children. Information was obtained by repeated home visits by public health nurses. The results of the study showed that children with failure to thrive had more feeding difficulties as infants. They had skimpier less regular meals, a poorer response to food when rated on a five-point scale and they had a lower energy intake.

Studies which used selected samples

A study by Tolia (1995) investigated the assessment, treatment and outcomes of seven infants with failure to thrive between the ages of 13 and 30 months at the time of presentation. The infants were referred to a paediatric gastroenterology clinic after a paediatrician had excluded the presence of chronic organic disease. All were born at term after normal pregnancies with birth weights and lengths between the 50th and

95th percentiles except in one. None had any history of peri-natal problems; however there was decreased milk intake almost immediately after birth, with lack of interest in feeding. At the time of referral a thorough history was taken which included an assessment of dietary intake, social history, family stresses and growth history of parents and siblings. A physical examination was carried out and all infants were below the fifth percentile for weight, all were below the fifth percentile for height except one and head circumference was within the normal range for five of the seven. Blood tests and other gastrointestinal investigations were performed on all the children. Interaction between parents and children during feeding was observed by a psychologist, and psychologic evaluation performed during an interview of both parents and children. All of the children were evaluated by a dietician and followed up regularly.

The evaluations performed did not reveal any specific aetiology for the decreased energy intake. None of the children had any developmental delay and there were no psychiatric conditions in their mothers. Changes in formulas or psychological intervention were unsuccessful in modifying feeding habits except in two infants. All were supplemented with enteral supplements, three did not consume enough orally and needed naso-gastric tube infusions with eventual placement of gastrostomy tubes in two, and the third one continued with naso-gastric infusions. A significant increase in caloric intake resulted in improved growth percentiles for height and weight, but head circumference measurements of two stayed at below the 5th percentile, despite nutritional rehabilitation. Attempts at weaning the children off the supplements resulted in all of the infants losing weight. The author suggests that there is a critical need for early, aggressive nutritional intervention in such infants who show a poor

feeding pattern almost from the beginning.

A study by Raynor and Rudolph (1996) looked at the characteristics of children enrolled in an intensive community intervention trial for failure to thrive. Mothers completed a four day diet diary and a sub-sample of these were analysed in detail by a research dietician for calorie and iron content. Few children attained the expected average calorie requirement and 35% were found to be anaemic. A self administered questionnaire was completed by mothers; this was designed to obtain information about maternal perceptions of the child's behaviour, particularly in relation to feeding. From the questionnaires completed by the mothers, 58% reported that feeding problems had started early; either from birth or as a baby. An adverse response to food was reported by 60% of the mothers; including repeatedly turning the head away from food, spitting food out and vomiting. Thirty percent felt that their child ate better for others than for themselves. These children were a referred sample with no controls which may bias the findings and results need to be considered with this in mind. Many children who fail to thrive are either not detected or are never referred (Dowdney et al., 1987; Wright et al., 1998). In this study; only infants who were referred for failure to thrive were included; there were no controls. It could be that these were the most severe cases, and therefore not representative of the population of infants who were failing to thrive. It is possible that they were not representative for other reasons, for example they might have been referred because the health visitor had additional concerns about the infant, or other aspects of the family. Results need to be considered with this in mind.

The studies reviewed indicate that infants who fail to thrive are more likely to have feeding problems and that these problems tend to start early and persist over time.

Infants who fail to thrive are more likely to refuse food, show less positive affect at mealtimes, take longer to feed, eat smaller meals and consume fewer calories. Other factors such as immature and abnormal oral motor development, negative parental attitudes and disorganised mealtimes were also shown to be associated with failure to thrive. It might be concluded that feeding problems might (at least partly) be a contributory factor to failure to thrive.

2.4 Failure to thrive and socio-economic circumstances

Population based studies

A study by Wright et al. (1994) used a cohort of 3418 full term children, aged 18 to 30 months born in Newcastle upon Tyne, to explore the association between weight gain and deprivation in the population. Data on birth weight, gestation, up to six subsequent weights between birth and eighteen months, and limited medical data were retrieved from their child health records. Children born before 37 weeks gestation were excluded. Weights were transformed into SD scores using the Cambridge Growth Standards (Cole, 1988; Cole et al., 1992). The thrive indices were calculated (Wright et al., 1994) and each child in the cohort was matched, using their post codes, to a neighbourhood. Neighbourhoods were defined as either extremely affluent or deprived following consultation with local workers, since geographical classification was imprecise due to the social mix. The level of deprivation of the neighbourhoods was calculated using the Townsend Score which summarises census data on home ownership, overcrowding and unemployment rates.

Of the 3653 children identified, 391 (10.7%) lived in the most affluent areas, 752 (20.6%) in the most deprived areas and the remaining 2510 (68.7%) in the

intermediate areas. Weights at birth were available for 89% of the children and at 12 months for 64%; 79% had a last recorded weight between nine and 24 months. No differences were found between different levels of deprivation and availability of weights. By 12 months there was a mean difference in weight equivalent to 290g between children in affluent and deprived areas. At six weeks of age a child from a deprived area was only slightly more likely to be below the third weight centile than a child from an affluent area but by 12 months this was three times more likely, which reflected slower weight gain in deprived areas. Twice as many children in deprived areas were below the screening threshold for failure to thrive (thrive index of <1.48) compared to the intermediate areas. Children in the affluent areas were more likely to be below the screening criteria compared to intermediate area children, although this was only just significant. Possible explanations for this are the higher rates of breast feeding in the more affluent areas of Newcastle (White et al., 1990). Breast fed babies may have a higher risk of failure to thrive as there may be a delay in the introduction of solid food (Weston et al., 1987); in addition breast fed infants have been found to grow more rapidly in the first few weeks than bottle fed babies but were on average 650g lighter by one year of age (Dewey et al., 1992).

The strong relationship between deprivation and low birth weight, which introduces the possibility of bias into previous studies of this type, has been avoided by the use of the thrive index method of case definition in Wright et al's study. The method of socio-economic classification may not be rigorous and some children may have been misclassified, however the authors' suggest that gradients in the rates of pre-maturity, low birth weight and similar gradients in weights throughout the first year from the least to the most deprived children suggest that the classification is sufficient to

demonstrate true differences. The main finding of the study was that the prevalence of failure to thrive is more evenly distributed across social classes than would be expected from previous studies.

Batchelor and Kerslake (1990) examined clinic cards and health visitors records to identify infants with weights below the third centile on a growth chart (which they used as a criterion for failure to thrive). They found that approximately one third of infants with failure to thrive went unrecognised by health visitors and infants with failure to thrive that were followed up were more likely to be infants with a greater degree of deprivation. They found that infants who were not from deprived families were less likely to be identified as failing to thrive and more likely to be described as 'small'.

Wright and Birks (2000) carried out a study which aimed to identify whether there were differences in demographic characteristics between children who had failed to thrive and a group of normally growing controls. Field health visitors collected data for each case using a proforma, which was usually completed at a home visit.

Information obtained included family information, the child's medical and dietary history and structured questions about the child's eating behaviour, food preferences and personality. A community paediatrician performed a medical examination, and where relevant, blood and urine screening tests were performed, except where the child was already under hospital management. Compliance by health visitors was not universal but 60% of the expected number of cases was identified.

Control infants included all children in those practices who were aged between 16 and 18 months, none of whom had met the screening criteria for failure to thrive at any

time. They were identified from three general practices considered to be representative of the area. Those who agreed to participate were all interviewed at home by one person using the same assessment proforma as used for the case infants; however the case group had been interviewed by different fieldworkers, which may introduce the possibility of bias.

One hundred and twenty cases were identified and 23 had recovered to above the screening threshold before identification. Of the remaining 97 children, 95 (98%) had received at least part of the standardised health visitor assessment. Of the 40 eligible control children, 28 (70%) mothers agreed to be interviewed. The control children were older than the cases at the time of interview (between 16 and 18 months) while the median age of the cases was 15.1 months at health visitor assessment. The spread of ages of cases was also wider ranging from seven to 28 months. There was no explanation about why cases and controls were not more closely matched and the control group was also considerably smaller than the case group. Seventeen (17.5%) of case infants had organic conditions although only four of these could be said to be the main reason for their failure to thrive, and all but two of these conditions were already recognised. None of the control infants had significant organic disease.

Demographic information for the families of cases was compared with that of the control group and also with census data for Newcastle. Very little difference was found between the groups. The families of 54.7% of cases were not homeowners, compared with 53.6% of controls and home ownership for families with children in Newcastle (obtained from census data) was 53.5%. Car ownership for cases and controls was 48% and 50% respectively compared with 49% of families with children in Newcastle. In the case group 41.5% had no employed parent compared with

46.4% of controls. The percentage from census data was 29.4%.

Blair et al. (2004) investigated the prenatal and socioeconomic factors associated with infants who failed to thrive. Failure to thrive was identified using standardised weight gain conditional on previous weight. The population cohort study identified 11718 infants born at term with no major congenital abnormalities in 1991-1992. A weight gain criterion conditional on birth weight to weight at six to eight weeks, six to eight weeks to nine months, and birth to nine months was used, and the slowest gaining 5% were identified. No association was found between failure to thrive and socioeconomic deprivation such as poor parental education or low occupational status. Parental height was significantly correlated with slow weight gain from birth to six to eight weeks, six to eight weeks to nine months, and birth to nine months. Eight times as many infants born to shorter parents showed slow weight gain as infants born to taller parents. Higher parity was also related to slow weight gain; infants born in the fourth or subsequent pregnancy were twice as likely to fail to thrive from birth to nine months as first-born infants. The authors recommended that future studies need to take account of parental height when calculating growth standards and look at why failure to thrive is more common, not in poorer families but in larger families.

A community based study (Wilensky et al., 1996) examined the epidemiological characteristics of a non-referred sample of failure to thrive children in Israel. The total cohort numbered 1452 births. Records were reviewed after the infants had reached 15 months of age, all weight, height and head circumference measurements were recorded for each child, as well as demographic details, paediatric examinations and medical history. Failure to thrive was defined as falling below the third centile for duration of three months. Infants whose birth weight was below 2.500 g or born

before 37 weeks gestation were excluded, as were those infants whose weight to height ratio was above 10%. Fifty-five cases were identified and each of these was matched with a control born in the same month from the same health clinic. Three children with significant medical causes for failure to thrive were excluded to avoid confounding medical variables, one had moved out of the area, and one refused to participate.

At 25 months a psychologist visited the families at home to collect data about the infant's feeding and medical history, the mother's psychiatric history and the mother's perceptions of the infant's temperament. The HOME assessment was performed to assess the home environment. Logistic regression was used to find independent associations between the variables birth weight and head circumference at birth, parity, maternal age, maternal years of education, paternal age and paternal years of education and the probability of failure to thrive. The only variable found to be significantly positively associated with failure to thrive ($p < 0.01$) was paternal age.

Edwards et al. (1994) carried out a case – control study to determine the socioeconomic differences between a group of children with failure to thrive and a group of normally growing controls in two economically deprived areas of Newcastle upon Tyne. Growth charts of 306 singleton children aged 12 to 24 months were reviewed and 63 were identified with poor growth. The criteria used to identify those with poor growth was a fall in weight across two major centiles (Gairdner Pearson growth charts) from the maximum centile achieved at four to eight weeks of age, for a period of a month or more. Five children whose poor growth could be caused by organic disease were excluded.

Each of the remaining 58 children selected was matched with the next normally growing child in the register, of the same sex and age, and from the same clinic. The mean age of cases and controls was 20.8 months. Children were classified according to the type of failure to thrive into four sub groups; early onset failure to thrive, late onset failure to thrive, temporary failure to thrive and recurrent failure to thrive. Mothers were interviewed on a number of topics, including socioeconomic variables additional information was provided by health visitors about the family, this involved grading the family on six aspects of the child's care. Statistically significant differences were found between the two groups of children for a number of variables. Cases were significantly more likely to have inadequate heating in their home, and average weekly expenditure on food was significantly less. There was no difference between the groups in whether parents were single, mothers' education, families with a social worker, or children registered as at 'risk' with the NSPCC.

When analysed in their subgroups according to type of failure to thrive, different characteristics were associated with the different sub groups. The 'recurrent' group was associated parenting difficulties and the 'late onset' group with adverse socioeconomic factors. The early onset group was not consistently associated with any adverse factors and the 'temporary' group was similar to the 'early onset' group. These sub groups were very small however and the results should be interpreted with this in mind.

Studies which used selected samples

Kotelchuck and Newberger (1983) carried out a controlled study of familial characteristics associated with failure to thrive in a sample of infants under the age of

four, who were admitted to a single hospital over a period of 18 months. Data were obtained retrospectively from a previous study (Newberger et al. 1977). The 42 case group infants comprised those whose weight and height fell below the third percentile and for whom no organic cause could be found for their poor growth. They were matched with a control group of 42 infants admitted to the same hospital with a short-term acute diagnosis. Cases and controls were matched on the basis of race, age (within three months) and socio-economic status. The mothers of all infants in the study were interviewed during their child's hospitalisation using a standardised pre-coded interview schedule. The interview focussed on stress related to family, environment and child development issues. Data were analysed by performing T tests or chi-square tests between case and control groups on an item-by-item basis.

Both groups had the same demographic characteristics, and demographic measures of family structure did not differentiate cases from comparisons. No educational differences were found between fathers, and although mothers of case children had slightly less education than control mothers; this difference was not statistically significant. No significant differences were found between the groups of mothers relating to their pregnancy or delivery and although slightly more separations between mother and child were found in the case group, this was not statistically significant. No differences were found between cases and controls in the age of the child at first separation, or in the person who initiated the separation. Separations were due mainly to the child's illness.

Mothers of case group infants were significantly more likely to perceive them as sickly than mothers of controls. Thirty eight percent of case children were perceived as being in poor health compared to 7% of controls, and 64% of controls were seen as

healthy compared with 14% of cases. More reported child-rearing problems (sleeping, feeding and discipline) were found in the families of children who failed to thrive (52%) than in the control group (38%), this difference was statistically significant and was due to the higher number of feeding problems in the control group. No statistically significant differences were found for sleeping or discipline problems between the groups. When considering variables associated with maternal stress such as financial, legal, housing or marital problems, no differences were found between the mothers of children who failed to thrive or comparison mothers. A composite measure of stress in childhood did show a difference, although this was not statistically significant.

Mothers of case group children perceived less support from family and neighbours than comparison mothers, and they reported seeing their relatives less often, despite both groups having similar numbers of relatives living nearby. In addition they were more likely to report their neighbourhood to be unfriendly and that they did not like it, than the comparison mothers. These differences were statistically significant. Both groups had similar levels of involvement with social services.

Stepwise regression was calculated on the two groups (cases and comparisons) which were defined as levels '1' and '0' of a binary variable. Three variables accounted for 46% of the differences between the failure to thrive families and comparison families. The case families were more likely to have children with ill health, live in an unfriendly neighbourhood and have a larger discrepancy in parent's education. The other variables were found to be highly correlated with these.

This study drew its sample from a large urban referral hospital and may be biased

towards more ill children. Children who failed to thrive but may have been managed in a community setting, and those who may have not been brought to the attention of health professionals or social workers, were not included in the study. They may have different characteristics from infants in the study and their mothers may also have different characteristics and family backgrounds.

The growth of children with failure to thrive who received aggressive management was evaluated by Casey et al. (1984). They examined the children managed in a secondary level ambulatory diagnostic and management clinic for children with failure to thrive. Information about growth outcomes after one year according to failure to thrive type, and socio demographic information was examined. Of 154 children referred to the clinic, 131 were identified with failure to thrive. After one year, 52% of the failure to thrive children had improved, 40% were stable and 9% were worse. Children placed in foster care were more likely to have improved.

Lower maternal income, lower maternal education, lone mother, lower family socioeconomic status and higher birth order; at the time of initial diagnosis were all variables that were significantly associated with children considered to have improved after one year.

A study by Raynor and Rudolph (1996) looked at the characteristics of children enrolled in an intensive community intervention trial for failure to thrive. All children aged between six months and two and a half years who were referred for failure to thrive were recruited. Basic demographic data were obtained from a questionnaire, which showed that while the children came from a variety of socio-economic backgrounds, the majority were from families living in poverty with over half in

receipt of income support.

These children were a selected sample and this may bias the findings. Many children who fail to thrive are either not detected or are never referred (Dowdney et al., 1987; Wright et al., 1998). In this study only infants who were referred for failure to thrive were included; there were no controls. It could be that these were the most severe cases, and therefore not representative of the population of infants who were failing to thrive. It is possible that they were not representative for other reasons, for example they might have been referred because the health visitor had additional concerns about the infant, or other aspects of the family. Results need to be considered with this in mind.

The studies reviewed conflict in their conclusions about the links between socioeconomic status and demographic characteristics of families and failure to thrive in infants. Studies which use referred samples are likely to include the most severe cases and exclude children who may not have been identified by health professionals but never the less have poor weight gain. In addition, children may not be identified as failing to thrive if there are no indicators of poverty and deprivation or organic disease, and health professionals may just diagnose them as small.

2.5 Failure to thrive, abuse and neglect

Population based studies

Wright et al. (1998) carried out a randomised controlled trial of community interventions as part of the Parkin service. Population screening had identified a group of children who had failed to thrive and these were assessed by field staff.

Twenty one (22%) of case families had received some social work input during the

period of follow up. Four children were registered as being at risk of abuse or neglect and of these; three had spent time in care. None of the control children had any social work input. The study concluded that the role of deprivation and neglect in failure to thrive has been overstated, the rates of proven abuse and neglect being 5% of all cases studied (Altemeir et al., 1985; Skuse et al., 1995; Wright et al., 2000).

Wright and Birks (2000) carried out a population based survey of risk factors for failure to thrive. The results suggest that the role of deprivation and neglect has been overstated and that undemanding behaviour, low appetite and poor feeding skills may contribute to the onset and persistence of failure to thrive. In a study by Edwards et al (1994) 19% of case group infants had an allocated social worker compared with 4% of controls, and 6% of cases were registered with the NSPCC as being 'at risk' compared with none of the controls. Neither of these variables however were statistically significant.

A prospective longitudinal study by Skuse et al. (1995) used a whole birth cohort of 2609 babies born in a single year (1986) to examine the relative importance of failure to thrive as a risk factor for later abuse or neglect. The area from which the birth cohort was taken was described by the authors as ethnically diverse, relatively homogenous in socio-economic terms, and severely disadvantaged. Growth and developmental data from the cohort were collected from clinic and health visitors' records and stored on a computerised database. Multiple births and babies born before 38 weeks gestation or after 41 weeks gestation were excluded from the study, as were babies who were born at or below the 3rd centile (allowing for gestation and maternal stature). Children who had failed to thrive were selected for the study if they had lived in the area until 12 months of age and had been weighed at least once.

Cases selected as failing to thrive had to have a weight for age SD score of at least -1.88 , having been attained by 12 months of age and sustained for three months or more. It is unclear as to how those babies who were only weighed once were classified, as it would be impossible to say whether or not a child's growth trajectory had been sustained for three months. If some children had only been weighed once, it would be impossible to know how many cases of failure to thrive had been missed, based on the selection criteria used to confirm cases. Of the 2609 births, there were 1554 potential subjects remaining following implementation of the exclusion criteria (Skuse et al., 1994). All children participating in the study were screened for the presence of organic disease. This included a standardised interview on relevant medical symptoms, a medical examination and a capillary sample of blood. Maternal heights were taken into account for cases and the comparisons and no significant differences were found. Two case families and three comparison families failed to complete the assessment procedure and were excluded from the analyses. The final sample comprised 47 infants identified as having non-organic failure to thrive by the age of one year and a comparison group comprising 47 infants, closely matched on the basis of age, gender, ethnic origin, birth weight (to within 300g), ordinal position and socio-economic status (Skuse et al., 1994).

The study's main outcome measures were registration on the child protection register or subject to investigation of suspected abuse or neglect without registration. In 1990 the authors gathered information on all children born in 1986 in the study area, who had ever been subjects of case conference, placed on a child protection register, received into care, on a place of safety order or subject to wardship proceedings. Names of the children at risk were cross-tabulated with names of children in the

original birth cohort. Although there had been a substantial population turnover in the study area, all but two of the original children with non-organic failure to thrive continued to live in the area at follow up. The two that had moved away had not subsequently been a cause for concern and were included in the analysis as not abused or neglected, as were other members of the cohort who had moved away and for whom no further information was available. At the end of 1990 all information obtained for the cohort was updated, by which time all would have been four years old. At the time of the original survey no child in either the non-organic failure to thrive or the comparison group had been the subject of an investigation of abuse or neglect. Over the period from 1986 to 1990, 64 children (2.5%) from the original birth cohort were placed on a child protection register in the area. A further 32 (1.2%) were subject to child protection conferences but not registered. In total, 96 (3.7%) of the cohort fell into one or other of these categories, including six (13%) of the original cases of non organic failure to thrive. Of these, four (9%) had their names placed on the child protection register and a further two (4%) had been subject to a child protection conference only. In none of the cases of non organic failure to thrive, was failure to thrive the sole reason for concern. Overall, the reasons for inclusion on the child protection register were; physical abuse 12 (19%); neglect 15 (23%); emotional abuse two (3%); sexual abuse three (5%); and grave concern 11 (34%).

Data relating to risk factors which might have been connected to their subsequent risk of abuse or neglect were available for a variable proportion of the original survey population. These included birth weight (92.3%), parity (86.3%), ethnic origin (91.3%), and maternal age (90.3%). Data were available for 2206 (84.6%) on all of these variables. Children who failed to thrive were four to five times more likely to

be at risk of abuse or neglect. This was a highly significant association. Those with a birth weight of less than 2500g were almost twice as likely to be abused or neglected. This reached marginal statistical significance. Those born earlier than 35 weeks gestation were more than three times as likely to be abused or neglected; this was statistically significant. Those born to mothers aged less than 20 years of age were twice as likely to be abused or neglected; this was statistically significant. Parity was not significantly associated with an increased risk of abuse or neglect, the relative risk being one and a half times. Significant correlations were found between birth weight and gestation and between maternal age and parity.

Other data that might be associated with increased risk of later entry onto a child protection register were collected on the original cohort. These included the sex of the child (data available on 100%), ethnic origin of parents (91.3%) and paternal age (40%). The authors also investigated the relevance of child health clinic attendance in the first postnatal year; about 1 in 5 (21%) of women never attended a child health clinic in this period. They found no evidence in their sample to suggest that boys, those with young fathers, certain ethnic minorities and clinic non-attenders were at greater risk of abuse and neglect.

The data from the study suggest that there is a greater risk of subsequent abuse or neglect among infants who have failed to thrive and who have no underlying organic disease or disorder. The increased degree of risk is four to five times higher than that of other full term infants. Infants who moved out of the area and for whom there was no further information were included in the analysis as falling into the category of not being abused or neglected; it would be impossible to say whether there was a bias toward 'at risk' families moving out of the area or staying. All but two of the original

children with non-organic failure to thrive remained in the study area, and the two who had moved away did not subsequently give cause for concern. Only one in eight of the original cases (of failure to thrive) had been subject to an investigation or intervention for this.

The authors' conclusions were that early non organic failure to thrive is a risk factor for later serious parenting deficiencies and that the risk was four or five times higher for infants who had failed to thrive than for other full term infants. However they concluded that previous studies had overstated the risks because their samples were referred cases. This study is different from the previous studies as it was a prospective longitudinal study carried out in a community setting. Previous studies have used selected populations, for example children referred to hospital or outpatients departments for weight loss (Benoit et al., 1989; McCann et al., 1994). This excludes those infants who are failing to thrive but have not been referred, thus leading to selection bias. Many infants may never get referred let alone admitted for hospital treatment (Dowdney et al., 1987). In a study carried out in Newcastle upon Tyne by Wright et al. (1998) it was found that up to 30% of cases of failure to thrive went unrecognised by the clinical team.

A prospective study of non-organic failure to thrive (Altemeir et al., 1985) aimed to identify antecedents of growth failure. The authors note that previous research in the field was mainly done retrospectively and based on children admitted to hospital with failure to thrive. Results from studies that used these subjects would have different outcomes from studies carried out in a primary care setting, as it is usually the most severe cases that are admitted to hospital. Previous studies had been unable to conclude whether certain maternal characteristics would predispose to having a child

that failed to thrive, or whether the child who failed to thrive influenced the characteristics of the mother. With this in mind, Altemeier's study was carried out prospectively in a primary care setting, thus avoiding the problems associated with previous studies. Recruitment for the study took place between 1975 and 1976 (although the paper was not published until 1985) at a time when failure to thrive was considered to result from child abuse or neglect and non-organic failure to thrive was a category for registration of children on a child protection register.

Out of a group of 1400 pregnant women, a random sample of 20% (274) were selected by computer. The authors felt that this would provide an adequate number of children with failure to thrive for their analysis, although they do not present a power analysis to justify this and the number who failed to thrive was actually quite small (no = 15). Although 21 met the criteria for failure to thrive, six had an organic condition that could explain poor growth and these were excluded from the study.

The study was biased towards low-income families living in an inner city area that had already been recruited to take part in a child abuse study, therefore results cannot be generalised to the population as a whole. The study concentrated on parental relationships, stress, attitudes to parenting and personality. Factors which would be considered important today such as infant temperament, resources, knowledge and the presence of a feeding disorder were not considered in relation to the failure of the child to thrive.

An interview was carried out with mothers to assess increased risk for child maltreatment and a life stress inventory was administered during the initial prenatal visit. There is no information about the interviewers other than they were female

research assistants. A thirty-five minute interview was conducted in the pre-natal period with the mother. The interview asked the mother about aspects of her own childhood, her views and philosophy of parenting, about her health, lifestyle and support. A life stress inventory was included to take into account maternal and paternal stresses. Answers were placed in pre-defined categories which had been previously tested on 200 women. Each pre-defined answer was assigned a score of +2 to -4, based on an estimate of its consequence. The 20% with the most negative scores were deemed at risk for child maltreatment and this was used for purposes of analysis. At the end of each interview the research assistants listed any subjective observations of their own which they felt would put a mother at risk of child maltreatment. These observations included whether they felt that the mother 'would be unable to care for her child because of drug addiction, mental retardation, emotional instability, or disturbances of nurture during childhood'. These subjective observations do not appear to be have been validated.

Studies which used referred samples

Ayoub and Milner (1985) clinically evaluated and followed 42 parents and their infants to determine if the type of failure to thrive was related to assessments of parental awareness, cooperation, subsequent failure to thrive outcome, and later neglect. The relationships between the parent's Child Abuse Potential Inventory scores and the clinical measures were determined. They found that the degree of parental awareness and cooperation was predictive of failure to thrive outcome, however, no relationships were found between failure to thrive type, parental awareness and cooperation, failure to thrive outcome and later neglect. In contrast, while the Child Abuse Potential scores were not related to failure to thrive type,

parental awareness, cooperation and failure to thrive outcome, they were predictive of later neglect.

A study by Taitz and King (1988) reported clinical details and statistical analysis of growth retardation in a cohort of 260 abused children. Seventy one children (26%) showed impaired growth for weight or height. Of 92 children who spent time in foster homes, 21 showed improved growth, but only five out of 168 who were never separated from their parent showed improvement in height or weight centiles. Out of 11 children placed in foster care who were more than 2 SD below the mean for height, 10 demonstrated significant catch up growth, compared with only four out of 28 children who remained in their own homes. Catch up growth among children who remained at home was generally less than that of children in foster homes. In 17 cases children with a non accidental injury had previously been diagnosed with poor growth. The authors concluded that growth retarded children in their natural homes showed poor growth and because of the relationship between poor growth and other parameters of development, children who show catch up growth in foster homes should probably not be 'rehabilitated' with their natural parents.

Dubowitz et al. (1989) tested the theory that the same causal factors were related to child abuse and failure to thrive. Their study compared individual, familial, and environmental conditions in cases of child abuse to cases of failure to thrive. An assessment was carried out of the mother's childhood home, support, current living situation, attitudes toward her child, and her child's characteristics (such as temperament, social maturity, and medical conditions). The results showed the groups to be remarkably alike, however a major significant difference was that although both groups were poor, the abuse group was even poorer and lived in more

crowded conditions than the children with failure to thrive. The authors suggest that these results indicate a common aetiology for child abuse and failure to thrive and that there is a need for a multidisciplinary approach to these problems.

Hufton and Oates, (1977) followed up 24 children at an average of six years and four months after they had first been admitted to hospital and diagnosed as having non-organic failure to thrive. Twenty one of the children in the original study were located. The physical progress and health of the children were reviewed; the personalities of 13 of the mothers were assessed, and the socio-economic circumstances of the child and family were assessed. Nine families were dependent on welfare benefits, and ten families described themselves as having financial difficulties. Twelve families lived in rented accommodation and six described their homes as inadequate. Five families had no family doctor and two were not covered by medical insurance. The authors concluded that children with non-organic failure to thrive are at risk in the areas of growth, personality development, and education. Three of the children from the original cohort had suffered physical abuse and two of those had died. The authors pointed out that many of the features of the families in this study are those found in abusing families.

This study only used children who had been admitted to hospital and diagnosed as having non-organic failure to thrive, therefore these children are likely to be the most severe cases. The study is not representative of all children who fail to thrive and it does not include children who may be failing to thrive but have not been referred, or have been managed in the community. In addition the number of children studied is relatively small.

While some of the studies reviewed suggest that infants who are abused and neglected are more likely to fail to thrive, these are a small proportion of the total number of infants who fail to thrive. In addition referral bias needs to be taken into account, as health professionals may be more likely to refer those who appear to be neglected or come from lower socio economic groups, than infants with slow weight gain from middle class families.

2.6 Cognitive outcomes of failure to thrive

Population based studies

A prospective cohort study with matched case-control study of outcomes examined the epidemiology, clinical characteristics, and outcomes for low birth weight infants with failure to thrive (Kelleher et al., 1993). Nine hundred and fourteen low birth weight infants were recruited from eight large university hospital sites throughout the United States. Of the 914 low birth weight infants meeting case criteria by thirty months, 180 (19.7%) were failing to thrive. These infants had lower developmental indices and at 36 months they had lower IQ scores and were much smaller than controls. More than 80% of the cases in the cohort did not have a chronic medical disorder, but several biological and environmental differences were found between cases and controls.

As part of a large population based study (Avon Longitudinal Study of Parents and Children) data on growth and development were collected and analysed by Drewett et al. (2005). Measurements used were those taken at birth, as near as possible to six weeks and nine months. Developmental data were obtained from postal questionnaires which were completed by parents when the child was 26 weeks and 18

Chapter 1: Introduction

Failure to thrive is a term used to describe infants whose weight gain is slower than would be expected. The term faltering growth is more recent, and is preferred by some as it has fewer negative connotations and fewer implications of failure by the parent or child (Miguel et al., 1990). Both terms are commonly used in clinical papers and in practice, sometimes exclusively and sometimes interchangeably. There is no universally agreed definition of failure to thrive, though a core criterion is a weight gain in the lowest 3 or 5%.

In a small number of children who fail to thrive, in the region of 5% (Wright et al., 1998) poor weight gain may be attributable to a major organic disease and is referred to as 'organic' failure to thrive. In the majority it is not, and the failure to thrive is referred to as 'non-organic'. Substantial numbers of cases are probably not detected: one third in Wright et al. (1998).

There is consistent evidence that failure to thrive is associated with delayed development in infancy (Black et al., 1994; Raynor et al., 1996; Skuse et al., 1994; Wilensky et al., 1996). It also has long term effects on growth: affected children are short at eight years of age, even in relation to the stature of their parents, and they are thin (Drewett et al., 1999). Several studies have also reported enduring adverse effect on intelligence, though the evidence on this is less consistent (Boddy et al., 2000; Corbett et al., 1996; Dowdney et al., 1998; Drewett et al., 1999; Hufton et al., 1977; Mackner et al., 2003; McPherson et al., 1997; Oates, 1984).

months old. The questions were from the Denver developmental screening test; they were adapted for parental report. In a sample of the study population the relationship between parental report scores and scores obtained from the Griffiths Scales of Mental Development (carried out by a psychologist) was examined and found to be significantly correlated.

Infants weights were converted to z scores using the 1995 growth reference (Freeman et al., 1995; Preece et al., 1996) and the slowest growing 5% were identified from birth to six weeks, from six weeks to nine months and from birth to nine months. Although developmental delay was found to be associated with slow weight gain in all categories, slow weight gain from birth to six weeks was most strongly correlated with later developmental delay and the authors concluded that slow weight gain over the period from birth to six weeks is a stronger predictor of developmental delay than poor weight gain over the rest of the year.

A one-year whole population cohort of term infants born in Newcastle-upon-Tyne was screened a for failure to thrive in infancy (Drewett et al., 1999). The children were identified using the Child Health Computer System, which holds information about children currently, or previously living in the city. Each baby clinic in the city was visited and each child's records reviewed to retrieve their birth weight and weights closest to one, two, three, six, nine, 12 and 18 months. The weights were converted to standard deviation scores using the UK 1990 standards and level of deprivation of the child's address given a code using census data matched to postcodes. Infants failing to thrive were identified using a conditional standard or thrive index, which identified those whose weight gain was in the slowest growing

5%.

The study aimed to find out if failure to thrive was associated with cognitive deficits at eight years of age. Children from the cohort were selected as cases for follow up if they had at least one weight available between birth and two months plus two subsequent weights, and a thrive index below the fifth percentile on two or more occasions between three and 18 months. For each case identified a control was selected. The same weight availability criterion applied; they had to be the same age plus or minus one month, with a thrive index above the 10th percentile, the same or nearby GP practice and same deprivation category.

Parents were sent a letter asking for written consent for anthropometric measurements and cognitive testing to be carried out in school. Anthropometric measurements of weight, height and head circumference was carried out by a research nurse.

Intelligence was assessed by a research psychologist using the Weschler Intelligence Scales 111 for children and reading skills were assessed using the WORD by two psychologists who did not know whether the children were cases or controls

Mothers were seen at home, their heights measured and father's height recorded as reported by mother. Mother's IQ was measured using the four subtest short form of the WAIS-R, and an interview completed to collect social and demographic and educational data. The medical history of the child was examined to find out if any organic illness might have caused the poor growth and if the child was reported to have a medical problem that might contribute to poor weight gain, the case notes were reviewed by a paediatrician who did not know whether the child was in the case or control group.

There were 3418 term children in the cohort; of these 2812 (82%) had an early weight and weights in at least two of the subsequent age bands. One hundred and thirty six children had thrive index values below the fifth percentile in two or more age bands. Allowing for those for whom consent could not be obtained, those who had moved out of the area or were not traceable, 107 (79%) of eligible case children, and 117 (87%) of controls were included. The higher number in the control group is accounted for by the fact that where a child had moved out of the area they were replaced with another control which was not possible with case children.

There was very little difference between the groups when a comparison was carried out on a range of variables. The only statistically significant differences were between the reported heights of fathers, where there was a mean difference of 2.8 cm with fathers of control group children being taller. There was a statistically significant difference in the proportion of mothers of case group children who reported feeding problems, 47% compared with 25% of controls.

On average the cases were significantly shorter and lighter than controls. They had smaller head circumferences and lower body mass indices. Parent's heights were slightly shorter in cases and this was taken into account in the analysis. The difference in heights between the groups was statistically significant. Of the 224 children studied, 222 were tested with the Weschler 111. The difference between the two groups was small and not statistically significant. When the mother's IQ and the presence of an organic condition that may have affected growth were taken into account in analysis of the relationship between the child's IQ and reading score, it was found that the child's IQ was strongly related to the mothers ($p < .0001$). Children with a history of an organic condition affecting growth had a lower IQ than those with

no organic condition although this is not statistically significant. Other covariates were examined, including family size and birth order, whether the mother smoked, and whether or not the child was breast fed. Incorporation of these into the analysis did not have any important effects on findings.

Boddy et al. (2000) carried out a follow up study using children from an original study by Skuse et al. (1994). This examined links between the timing of failure to thrive and subsequent child development, and investigated the hypothesis that severe non-organic failure to thrive predicted limited physical or cognitive development at six years. At the time of the original study only nine of the case group infants had been referred to hospital as a result of their poor weight gain. No differences in growth were found between these children and other case group children in terms of duration or severity of failure to thrive.

Forty two of the original case group children and 42 controls were available for follow up at six years. Data obtained at 15 months relating to physical growth in the first year, maternal IQ and education, maternal stature, and socio economic status were included as variables in the analysis. Routine measurements of children's heights and weights which had been recorded by school nurses were converted to centiles then to standard deviation scores and each child's body mass index was calculated and converted to centiles. Data on physical stature were missing or unavailable from school nurse records for seven children. Participating families were seen at home and a semi-structured interview carried out with the mother. The Osborn Social Index was used to assess socio-economic status at six years, as this method had been used at 15 months. Information was obtained about father's occupation, educational qualifications of parents, type of housing and housing tenure,

crowding, car ownership and phone ownership. Following this children were seen in school and the McCarthy Scales of Children's Abilities were used to examine the children's psychological development; these test four dimensions of cognitive functioning; memory, quantitative, verbal, and perceptual abilities. The tests, which were described as games and stories, were administered by a research psychologist trained in their use and children were tested at school in a quiet room away from the classroom. Assessments of psychological functioning at six years were carried out with 42 cases and 41 comparisons. One family did not give permission for their child to be tested.

There were very few differences between case and comparison children at 15 months and at six years in terms of general sample characteristics. Although there was evidence of less socio economic improvement between 15 months and six years for cases, overall there were no differences in social demography between 15 months and six years. Case children were significantly shorter and lighter than control children at six years of age. Control group children were on average almost 5cm taller and 4kg heavier than cases. There was no evidence to suggest that there were different anthropometric outcomes for children if they failed to thrive in the first six months or second six months of life. Regression methods were used to take into account potentially relevant co-variables. Although maternal IQ and birth weight were not related to anthropometry at six years, there were small significant associations between change in social index and height and weight z scores. Maternal height was strongly correlated with child height and weight. From the assessment at 15 months, data were available on maternal heights but only for limited numbers of paternal heights, therefore only maternal heights were taken into account when analysing

physical development at six years.

Mental development at 15 months was found to be related to BMI at six years, and weight, height and weight for height z scores at the time of the initial study were significantly correlated with child stature at six years. Failure to thrive status was the only significant predictor of weight z scores at six years although 15 month MDI scores predicted a small but significant amount of variance in BMI. Case children showed a non significant tendency to have lower General Cognitive Index scores than control group children although the average difference was less than four points. On the Memory and Quantitative subscales there was a statistically significant difference between scores; comparison children's scores were higher than those of cases. The timing of failure to thrive had no effect on cognitive abilities at six years, in contrast to findings at 15 months. No significant associations were found between physical stature and cognitive abilities at six years, and 15 month MDI and PDI scores were not related to performance on the McCarthy Scales at six years. The findings of the study are consistent with those of Drewett et al. (1999) who found that the adverse effects of failure to thrive on cognitive development appear to diminish over time although these children are shorter and thinner than control group children at between seven and nine years of age.

Wilensky et al. (1996) carried out a retrospective review of community child health records for a total cohort of 1452 births. Failure to thrive was defined as falling below the third centile for duration of three months. Infants whose birth weight was below 2.500 g or born before 37 weeks gestation were excluded, as were those infants whose weight to height ratio was above 10%. Fifty-five cases were identified and each of these matched with a control born in the same month from the same health clinic.

Three children with significant medical causes for failure to thrive were excluded to avoid confounding medical variables, one had moved out of the area, and one refused to participate. None of the controls refused to participate.

A developmental psychologist who was blind to which infants were cases and which were controls assessed the children using the Bayley Scales of Infant Development (Bayley, 1993) at a mean age of 20 months. Three fifths of the infants who failed to thrive were still below the third centile for weight at 20 months of age. The matched case control data showed significantly lower mental development scores in the cases when assessed with the Bayley scales (MDI 99.7 v 107.2; $p < 0.05$). More of the cases had a mental development quotient below 80 (11.5% v 4.6%). Multiple regression analysis on the total sample found mothers' education, the HOME score, and failure to thrive to be independently associated with the Bayley mental score at 20 months of age.

Black et al. (1994) studied the role of parenting style in mothers whose children failed to thrive in a primary care setting. The study tested the hypotheses that children of parents with a nurturant parenting style would demonstrate better social-cognitive development than children of authoritarian or neglecting parents; that the relationship between non nurturant parenting and child development would be exaggerated in children with failure to thrive, and finally that the more undernourished the child was, the poorer the social-cognitive development outcomes.

Cognitive development was measured by the Mental Scale of the Bayley Scales of Infant Development (Bayley, 1969) administered by psychologists. Adaptive behaviour during testing was measured during testing using the Infant Behaviour

Record. The children in the comparison group achieved higher MDI scores than case children, and there was a statistically significant difference in the effect of parenting style. Children of parents classified as authoritarian displayed more maladaptive behaviour during testing than children of parents classified as nurturant or neglecting.

When the effects of nutritional status on the relationship between parenting style and social cognitive development were examined, nurturant parenting style was found to be associated with better levels of interactive competence. When regression analysis was used to examine the relationship between a nurturant parenting style and children's cognitive development there was a statistically significant interaction between height for age and parenting style. Partial correlations examined the nurturant and neglecting groups to see if there was a relationship between height for age and cognitive development after the effects of chronological age, maternal education and weight for height were removed. In the nurturant group there was a positive slope, indicating that mild nutritional deprivation without stunting was associated with better cognitive development. This finding was statistically significant. In the neglecting group the slope was negative, indicating that chronic nutritional deprivation was not related to cognitive development, although this was not statistically significant.

A prospective study by Mackner et al. (2003) examined the cognitive development of a group of 226 infants from low income families, from infancy up to six years of age. All were of normal birth weight and with no perinatal complications, congenital problems, or chronic illness. The infants participating in the study were recruited from a paediatric primary care clinic and categorised as failing to thrive or not. The criteria for selection of the failure to thrive group was a decline from weight for age or

weight for height declined from what was appropriate for gestational age to below the fifth percentile growth charts (Hammill et al., 1977). One hundred and twenty eight children were classified as failing to thrive (mean age 12.6 months) and were treated in an interdisciplinary clinic. These infants were examined by a paediatrician and the medical charts of the ninety eight infants who were growing normally (mean age 15.36 months) were reviewed by a paediatrician to exclude organic disease which might affect growth. Eighty percent of the families of children with failure to thrive and 90% of the comparison group families agreed to participate in the study. Seventy two percent of the cases and 80% of the controls remained in the study at six years.

Baseline anthropometric and developmental assessments, interviews and videotaped observations of parent child interaction were carried out following recruitment by examiners who were blind as to the children's group status. Up to the age of three years cognitive development was assessed with the Mental Development Index of the Bayley Scales of Infant Development. At ages three and five the Stanford-Binet Fourth Edition composite index was used. The mean on these scales is 100 with a standard deviation of 16. The Battelle Developmental Inventory Screener Cognitive Score was used at age four, and at six a composite of the Vocabulary and Block Design subtests of the Weschler Preschool and Primary Scales of Intelligence. These scores were standardised with a mean of 100 and a standard deviation of 15.

Other factors taken into account in the analysis were maternal education and IQ, the home environment, parental mental health, maternal depression, child temperament and mother-child interaction. Using hierarchical linear modelling, child-centred home environment and small family size were related to better cognitive performance.

Cognitive development declined in both groups to 1.0 - 1.5 SD below the norm.

Children with failure to thrive had statistically significant lower cognitive scores than children with normal growth to the age of four, however by the ages five and six, there were no differences in cognitive scores based on the children's growth history. This may be due to the home intervention and clinical services that the children with failure to thrive had received, which may have influenced their growth and cognitive development.

Studies of selected samples

A retrospective study by Barker et al. (2005) looked at the birth weights and recorded weights at one year of infants born in Hertfordshire between 1911 and 1930. These were evaluated and the authors found that among 4,630 boys, irrespective of the social class at birth, those who slower growth in infancy had poor educational achievements and had lower incomes than those who grew more rapidly. The authors conclude that one possible interpretation of this is that biological processes linked to slow infant growth may lead to lifelong impairment of cognitive function.

Wolke et al. (1990) tested the hypothesis that infants with non-organic failure to thrive would have delayed mental and motor development. Health visitors were asked to nominate infants of one year of age, from a deprived inner city area, who were known to be failing to thrive, as subjects for the study. These were matched with comparison infants on age, race, sex, ordinal position, birth weight and gestation, maternal years of education and housing. The infants were assessed using the Bayley Scales of Infant Development. Case group infants had significantly lower Mental Developmental Index scores than comparisons. Case infants also tended to have lower Psychomotor Developmental Index scores than the comparisons, although the

difference was not statistically significant.

A study in Sydney Australia (Oates et al., 1971) which reviewed 24 out of 30 children admitted to hospital with non-organic failure to thrive over a two year period found that 50% of these children were below the 10th percentile for both height and weight. The index child was usually the youngest in the family and in 60% of cases had been born within 18 months of a sibling. Three of the children had been adopted and the parents of the children usually came from large disrupted families, half of the children were not fully immunised and 60% of the fathers were semi-skilled or unskilled workers. One third of the families had no family doctor, preferring to use hospital emergency departments.

A later study reviewed these same 24 children at an average of six years and four months after they had first been admitted to hospital and diagnosed as having non-organic failure to thrive (Hufton et al., 1977). Twenty one of the children in the original study were located and their physical progress and health reviewed. Five remained below the 10th percentile for weight and only one was below the 10th percentile for height after correcting for mid parental heights. Four children had been admitted to hospital with gastrointestinal problems, all the other children had been well. Two children had died, one as a result of convulsions and one from head injuries.

Educational progress was assessed by using the Weschsler Intelligence Scale for Children, a reading vocabulary test and reports from teachers. Two thirds of the children had a delayed reading age, one third had verbal scores significantly lower than their performance scores in intelligence testing, and ten of the children were

described by their teachers as functioning below average.

The sample size for this study is very small and included children previously admitted to hospital and classified as failing to thrive over a two-year period. This excludes those children who may have failed to thrive but were not admitted to hospital, or those who may have been treated in a community setting. This could introduce bias as the families included in the study may have different characteristics to those families who were not referred to hospital.

A later study by Oates et al. (1985) compared this same group of children (who had previously been admitted to hospital with non-organic failure to thrive) with a group of children who attended the same school and were matched on age, sex, ethnic group and social class. Less than half of the children hospitalised for non-organic failure to thrive had returned for hospital follow up. Twenty-one children had been reviewed as part of a previous study at an average age of seven years and 10 months after admission. The reviewers found that 48% of these children were average in their schoolwork, two thirds had a delayed reading age and 48% had behaviour problems (Hufton and Oates, 1977); no comparisons were reported. Fourteen of the children were traced at an average time 12.5 years from hospital admission to review, and all families agreed to take part in the study. Mean ages of children in the study and comparison groups were 13.8 years and 13.4 years respectively. There were eight boys and six girls in each group.

Children were weighed and measured, underwent a series of psychological tests and a test of reading ability. The children's teachers completed a behaviour questionnaire about each child. They did not know the reason for the study and were blind to which

were study group children and which were comparisons. Weights of all children but one in study group were greater than the third percentile, and the differences between study and comparison groups were not significant. However when the relationship between the weight ages and height ages was compared with their chronological age, a difference emerged. Six of the children who had previously failed to thrive were one or more years below their chronological age for height and weight in contrast to just one child in the comparison group ($p < 0.04$), a statistically significant difference.

The children's cognitive abilities were assessed and those who had failed to thrive scored significantly lower on the verbal scale of the Wechsler Intelligence Scale for Children – revised. They had a mean score of 90 compared with 102 for children in the comparison group. This difference was statistically significant however the difference between the two groups and full-scale scores did not reach statistical significance ($P < 0.06$). Lower verbal ability in the study group was shown by results on the verbal language development scale. The children had a lower mean quotient of 80 compared with 91 in the comparison group, which was a highly statistically significant difference. The reading ability of the children was tested and half of those in the comparison group had a reading age with one year of their chronological age. Only three of the study children were at this level and eight of the 14 were more than three years behind their chronological age in their reading ability.

The sample size for this study is very small and included children previously admitted to hospital and classified as failing to thrive over a two-year period. Around half of the children had failed to attend for review at around seven years and ten months after hospitalisation and these were excluded from the study group. The study also excludes those children who may have failed to thrive but were not admitted to

hospital, or those who may have been treated in a community setting. This could introduce bias as the families included in the study may have different characteristics to those families who had been referred to hospital.

Drotar and Sturm (1988) evaluated the cognitive development a group of children hospitalised for non organic failure to thrive during their first year of life who had received time limited outreach intervention. They also assessed the efficacy of a multivariate predictive model of cognitive development, including four domains: biologic factors (nutritional status), duration and age of onset of failure to thrive, intellectual competence as assessed by the Bayley Scales, and environmental factors such as maternal education and income.

The criteria used to identify non organic failure to thrive were: weight below the fifth percentile based on the National Center for Health Statistics norms, the absence of major organic disease that would affect the child's ability to gain weight, demonstration of weight gain in hospital, decreased rate of weight gain from birth to below the fifth percentile (a decline in centile position), physical growth within norms for gestational age at birth, and a birth weight of at least 1,500g. Additional criteria were, age between one and nine months, absence of physical abuse and within one hours distance of the hospital.

Children admitted to hospital for evaluation of their physical growth were recruited from seven area hospitals. Eighty eight families of children meeting the study criteria were invited to participate. The eight families who chose not to participate were not found to differ significantly from those who did, in terms of demographic characteristics. Of the remaining 80 children in the sample 16 were lost to follow up

at 36 months, as they had moved out of the area, could not be located or withdrew from the study. Five further children could not be located in time for the 36 month assessment. No significant differences in demographic characteristics were found between these families and those available for study at 36 months, nor were there any significant differences in physical growth characteristics or in cognitive development of the children at study intake. Of the initial sample of 80 children, 59 were available for assessment at 36 months. These included 39 males and 20 females, 25 white, 33 black and one Hispanic child.

During the time the children were in hospital when they were diagnosed as failing to thrive, they were randomly assigned to one of three interventions. Twenty two were assigned to family centred intervention involving family members in weekly home visits aimed at enhancing family coping skills, organising childcare routines, and supporting the child's mother. Seventeen children from the study sample received weekly parent centred intervention which focussed on improving the mother child interaction, relationship and nutritional management. Interventions lasted 12 months in both groups then were discontinued. A third group of 20 children were assigned to the advocacy group in which the child's mother was seen on six occasions, the focus being emotional support to help the mother stabilise the child's weight gain after hospitalisation, and to access economic and community resources. After six visits contact with the mother was maintained by telephone. In all groups the intervention was terminated after one year when the children were an average age of 18 months. The study was designed to test the relative efficacy of different types of intervention and did not include a no-treatment control group.

Previous research concerning psychological outcomes of non-organic failure to thrive

determined predictor variables. These included four domains: environmental (maternal education and family income), case characteristics (onset and duration of failure to thrive), psychological competence at the time of diagnosis (assessed with the Bayley Scales of Mental Development), and nutritional status. At 36 months of age the children's cognitive development was assessed with the Stanford-Binet Intelligence Scales by examiners who had no information about the children and were blind to their treatment assignment. The mean Stanford-Binet IQ score was 84.5; only 17% of the sample scored at or above 100, compared to standardisation norms of 50% and 14% scored below 70% compared with standardisation norms of 3%. Thirty two percent of the sample scored in the low average to average range, which was comparable to standardisation norms of 34.1%.

No statistically significant effects of type of intervention were found, with mean Stanford-Binet IQ scores of 80.6 for the family centred intervention group, 87.5 for the parent centred intervention group and 88.6 for the advocacy group. The study lacked a control group therefore there is no opportunity to compare these scores with children with the same demographic characteristics who were growing normally.

Predictor variables included age of onset of failure to thrive, the criterion for this was based on the age at which the child's weight reached or crossed below the 5th percentile. Duration, which was defined as the time between the child's weight reaching the 5th percentile and age at study intake, weight for height, Bayley Mental Development Index, and years of maternal education and income. There were no significant differences between any of the treatment groups on any of these variables.

When predictor variables were correlated to assess relationships, a statistically significant relationship between maternal education and family income was found. In

addition, age of onset of failure to thrive and Bayley MDI scores at study intake were correlated, however, nutritional status and age of onset and duration of failure to thrive were not related. The study demonstrates that the prediction of cognitive development in these children is enhanced by including environmental factors and characteristics of the child's condition.

Hierarchical regression was chosen to analyse the individual contributions of the predictor variables on IQ scores. Family income and maternal education were entered first, as they were expected to have the most significant influence; these were found to account for 22% in the variance on scores which is significant at the $p < .05$ level.

The addition of onset and duration of failure to thrive also resulted in a significant increment in variance. The addition of nutritional status and Bayley MDI scores at study intake did not show any significant increments in variance. Partial correlation coefficients were conducted to determine the influence of individual variables within each of the two variable sets, controlling for the other variable. Education correlated significantly with Stanford-Binet IQ scores, controlling for income, and income correlated significantly with Stanford-Binet IQ scores controlling for education. Onset correlated with IQ with duration controlled, although duration did not correlate with IQ with onset controlled.

Using the same predictor variables, a discriminant analysis was conducted to identify children with age appropriate versus below average intellectual development.

Children with IQs at or below 84 (1 or more standard deviations below the mean) were considered high risk. The 29 children in this group had a mean IQ of 74.4. The 29 children with IQs of more than 84 comprised the low risk group, their mean IQ was 96.79. Group membership was correctly predicted for 74.14 of the sample.

Correct classification of high risk scores was 75.9% compared with correct classification of low risk scores.

The study failed to show a differential effect on cognitive development from any of the interventions. The authors acknowledge that this might be due to the fact that intervention plans were sometimes difficult to implement as the majority of infants were from economically disadvantaged highly stressed families. In addition the lack of a no treatment group makes it impossible to assess whether there was an effect on cognitive development from the interventions. The sample size is relatively small and clearly lacking in statistical power. It included children admitted to hospital and classified as failing to thrive. Those children who may have failed to thrive but were not admitted to hospital, or those who may have been treated in a community setting were excluded. This could introduce bias as it is likely that those children admitted to hospital are the most severely affected and these families may have different characteristics to the rest of the population.

Mitchell et al. (1980) identified a cohort of 312 children from three rural primary care clinics, of whom 30 were identified as failing to thrive based on weight criteria and clinical examination. Growth data, social characteristics and illness were compared with a group of normally growing infants matched for age, sex and demographic details. Twelve cases and sixteen controls were available at three to six years for follow up examinations. They were assessed using the McCarthy Scales of Children's Abilities and when the sexes were combined, no significant differences in scores were found between the groups. Female cases however had significantly lower scores than female controls and females had significantly lower scores than males.

A study by Raynor and Rudolph (1996) looked at the characteristics of children enrolled in an intensive community intervention trial for failure to thrive. All children aged between six months and two and a half years who were referred for failure to thrive were recruited. Growth measurements were recorded; and of the 63 children enrolled in the study, 84% had a weight below the third percentile and 43% were classified as severely underweight with a SD score of < -2.5 . The study did not include a control group. The children were assessed with the Bayley Scales of Infant Development, and results showed that a large percentage of the sample suffered from developmental delay. The study included only infants who were referred for failure to thrive and there were no controls. It could be that these were the most severe cases and therefore not a representative sample. It is also possible that they were not representative for other reasons, for example they might have been referred because the health visitor had additional concerns about the infant or family and results need to be considered with this in mind.

As part of an intervention study (Raynor et al., 1999) the cognitive and motor developmental statuses of a referred sample of infants with failure to thrive were assessed with the Bayley Scales of Infant Development. The mean age of the infants was 14.3 months. Baseline mental and psychomotor development index scores were below the mean in both groups and although mean scores in both groups improved following intervention, no statistically significant differences were found between the groups and scores remained below the mean.

A prospective longitudinal study by Singer and Fagan (1984) compared the cognitive functioning of three groups of infants, 13 with organic failure to thrive, 13 with non organic failure to thrive and a group of 13 normally growing infants. Infants were

assessed in the first year with the Bayley Mental Development Index (MDI) Scale (Bayley, 1969) and again at 20 months. The Stanford-Binet Intelligence Scale was used at the final follow up at three years. All infants were recruited from a hospital setting. At the both the first and second assessments the infants in the failure to thrive groups scored significantly less well on the mental scale than did the control group. At three years only 25 children were available for follow up; these were tested using the Stanford-Binet Intelligence Scale. The infants in the failure to thrive groups scored significantly less well than the controls and Bayley scores at 20 months were found to be a reliable predictor of performance on the Stanford-Binet Scale at three years. The study demonstrates delayed development of infants who fail to thrive compared to a control group; however the number of infants included in the study is relatively small and as all infants were recruited from a hospital setting the sample is unlikely to be a representative and results should be interpreted with this in mind.

Findings from studies of cognitive outcomes in non organic failure to thrive have been inconsistent. Drewett and Corbett (2004) carried out a review and meta-analysis of 31 published papers, reporting 121 results of cognitive tests in children with non organic failure to thrive. The studies were classified by group ascertainment into those identified in primary care or by whole population screening, and those identified in hospitals or specialist clinics. Controlled studies where cases were identified in primary care were analysed and the overall estimate of the long term cognitive outcome for failure to thrive was obtained from IQ and McCarthy scale scores. The mean difference was equivalent to 4.2 IQ points (95% CI 2 to 6). The controlled studies which used cases and controls identified in primary care measured cognitive outcomes with the Bayley Scales. Wilensky et al. (1996) found a mean difference in

MDI scores of -7.5 ; the mean score for the control group was 107.2 and for the cases it was 99.7. Skuse et al. (1994) found a mean difference between cases and controls in MDI scores of -10.3 . The mean score for controls was 108.5 and for cases it was 98.2; a difference of -10.3 . The mean in PDI score for controls was 103.6 and for cases it was 96.7; a difference of -6.9 . In Black et al. (1994) controls had a mean MDI score of 101.9 and the mean score for cases was 94.7; a difference of -7.2 . Mackner et al. (1997) used the Bayley Scales to test infants in their study. The mean MDI score for control infants was 99.9 and for cases it was 94.1. The difference was -5.8 .

Drewett and Corbett concluded from their review that the evidence from the reasonably well controlled studies of subjects selected from primary care settings indicates that failure to thrive in infancy is associated with adverse intellectual outcomes large enough to be of importance at a population level.

2.7 Failure to Thrive and Infant Behaviour and Temperament

Population based studies

In a study by Wright and Birks (2000) parents were asked to describe their child in terms of happy / miserable, good behaviour/bad behaviour, demanding / undemanding, and sociable / shy on a three point Likert scale. Over 80% of both groups of parents described their child as happy, but case parents were less likely to describe their child as well behaved (66.3%) compared with 82.1% of controls which was not statistically significant. Control children were reported to be more sociable than cases (61.8% compared to 92.9%) this difference is highly significant. Case children (23.4%) were reported to be less demanding than controls (46.4%), this

difference is highly significant. Results from the study suggest that children who fail to thrive tend to be more shy and undemanding than children who grow normally.

As part of a community based study of failure to thrive (Wilensky et al., 1996) 55 infants with failure to thrive were compared with a group of controls. Mother's perceptions of their infant's temperament were studied. The HOME questionnaire showed that the homes of children with failure to thrive were significantly lower in the sub scales relating to emotional reactivity, active stimulation and family participation in encouraging development. Also behavioural observations at 20 months found children with failure to thrive to be less sociable and more afraid of the examiner than control group children; however when the Bates questionnaire was used to record mothers' perceptions of their infant's temperament, no significant difference was found in temperament between the groups.

Wolke et al. (1990) carried out a study which investigated whether mothers of infants with non-organic failure to thrive are less adequate in their social stimulation of the infant and express less positive affect during play interaction. The study also looked at the temperaments of the infants to see if they were more difficult, apathetic or undemanding, from observed interactions and maternal perceptions. The infants' mental and motor developments were assessed using the Bayley Scales of Infant Development to test the hypothesis that infants with non-organic failure to thrive would be delayed. The study was conducted within a larger project and the sample was drawn from a small pilot study in a deprived inner city area.

Health visitors were asked to nominate infants of one year of age who were known to be failing to thrive as subjects for the study. Criteria included full term delivery, no

severe intra-uterine growth retardation, no organic disease which might account for poor growth, and weight for age more than two SD below the mean, sustained for at least three months. Ten infants were identified; one family refused to participate.

The nine remaining infants were matched with comparison infants on age, race, sex, ordinal position, birth weight and gestation, maternal years of education and housing. Matching was achieved by studying birth and clinic records, and by interviewing health visitors. It was not possible to achieve a satisfactory match for birth weight, as cases were found to have been significantly lighter at birth. This is inevitable if you use their criterion, as weight in infancy correlates with birth weight.

Families participating in the study were visited at least twice in their own home by two different investigators who were blind as to which infants were cases and which were controls. During the first home visit a detailed history of feeding, development and an assessment of oral-motor function were carried out. Play sessions with five different toys were videotaped and these were viewed repeatedly in order for detailed notes of the observed behaviour to be made. Maternal and infant behaviour was rated on a variety of scales scored from the video recordings by a medical psychologist. The psychologist was blind as to which infants were cases and which were controls.

The child's developmental status was assessed using the Bayley Scales of Infant Development, and behaviour assessed using a rating scale known as Tester's Rating of Infant Behaviour. These were completed by an examiner and videotaped. A psychologist rated the infant behaviour from the video, and significant inter-rater reliability was established for all but one of the scales which were subsequently excluded from the analysis.

The Infant Characteristic Questionnaire and the Temperament Impression Scale were administered to parents. The Infant Characteristic Questionnaire is a parent report scale of infant temperament, and the Temperament Impression scale asks the mother to rate her infant's temperament on visual analogue scales; this included specific behaviour styles during mealtimes. Group comparisons of maternal, infant and joint behaviour were made using rating scores from the play sessions. Mothers of case infants were found to express significantly more negative emotions during play interactions and tended to have less physical contact than comparison mothers, although this difference was not statistically significant. Case infants were significantly less likely than comparison infants to vocalise and used fussing and whining as communication signals. They were also less task orientated and less persistent in trying to solve tasks than controls, spent less time initiating social interaction and frequently avoided contact with their mothers. These differences were statistically significant. The degree to which mothers and infants jointly oriented and coordinated their communication and actions was significantly lower among case infants and mothers.

When the differences in scores from the Testers Rating of Infant behaviour were compared for the two groups, 12 of the 15 comparisons were statistically significant. The case infants were rated as being more fussy, unhappy, less adaptable, more difficult and demanding and less socially attractive. They were found on the whole to be less cooperative and more difficult to distract. There were no group differences in the rating of maternal sensitive cooperation during Bayley assessments. These findings were supported by the results of the mothers' ratings on the Infant Characteristics Questionnaire and the Temperament Impressions Scale. Case infants were described

as more difficult and demanding and less sociable. They were also perceived to be more changeable in their moods and less cuddly than comparisons. Surprisingly, mothers' ratings of infants' mealtime behaviour did not differ between the groups and most regarded mealtimes as the easiest part of the day. Both groups were described as active, happy, adaptable to new foods and tastes and moderately regular in their hunger demands.

The authors concluded that there were relatively few differences in maternal behaviour between the groups, but there was a pattern of less sociable and more difficult and demanding behaviour among the sample of infants with failure to thrive. The sample size of nine cases and nine controls was very small. It would be not be possible to generalise findings and results should be interpreted with caution.

Steward et al., (2001) investigated the idea that failure to thrive results from a problematic infant-mother interaction, with the infant making a significant contribution to the process. The study examined the relationships between behavioural responsiveness, heart rate variability as a marker of autonomic nervous system activity, and nutritional status in infants with failure to thrive. Fourteen infants with failure to thrive were matched with 14 normally growing infants. Results indicated that infants with failure to thrive exhibited considerably more negative behaviours and exhibited low heart rate variability. The authors concluded that there may be a physiologic basis to the behaviours that are exhibited by infants with failure to thrive and recommended further prospective research to look at this relationship more closely.

Studies of selected samples

Polan et al. (1991) investigated the relationship between failure to thrive and affect. Criteria for inclusion were; born at 35 weeks gestation or later with normal birth weight, and a fall in weight to below the fifth percentile, or deceleration in weight gain after 6 months crossing down two or more percentiles. Subjects were aged between six months and three years. Case and control groups were recruited from children attending primary care and hospital appointments for treatments and investigations. Controls were children whose weights and heights were on or above the 10th percentiles.

Twenty eight children with failure to thrive and 14 normally growing children were studied. All mothers of failure to thrive children agreed to participate but 37% of mothers of normally growing children either refused or failed to attend the initial appointment. Each child with failure to thrive was assessed by a paediatrician to confirm diagnosis and rate the severity of the contribution of organic problems using Woolston's (1983) scale. This gives a score of one to five, with one and two representing no organic factor or only mild secondary complications of malnutrition; and scores of three, four, and five representing cases with organic contributions to growth failure. Acute and chronic malnutrition were rated separately using Waterlow's criteria (Waterlow, 1972). Children were observed in a playroom with their mothers. The session, which was recorded with a video camera, consisted of a mid-day meal followed by three social activities. The children's' affect expressions were scored on 11 affects, including four positive affects, and seven negative affects. The videotapes were coded by trained observers who were blinded as to the group status of the children.

Results of the study indicate that failure to thrive children had significantly less

positive affect in the feeding and non feeding activities and significantly more negative affect in feeding than the comparison group. In addition, greater severity of both acute and chronic malnutrition was associated with expression of negative affect during feeding among those with failure to thrive, and the severity of the organic contribution failure to thrive was not related to affect. The studies limitations are the small sample size and recruitment of both cases and controls from a pre selected population who were attending appointments. This excludes those children in the population who are failing to thrive but have not been recognised and referred, and also those normally growing children who are well and not attending hospital or primary care appointments, and is therefore not a representative sample.

As part of a study by Raynor and Rudolph (1996) a self administered questionnaire was completed by mothers; this was designed to obtain information about maternal perceptions of the child's behaviour, particularly in relation to feeding. There were also levels of behavioural difficulties, including problems related to sleep and behaviour management. Mothers' perceptions of their infant's behaviour were also more negative among infants who failed to thrive. The children were a selected sample and which may have biased the findings.

Pollitt and Eichler (1976) reported more developmental disturbances in children with growth failure compared with normal growing comparison children. Nineteen pre school case children and 19 controls were recruited from a paediatric clinic. Children attended this clinic for reasons other than growth failure, including ear and upper respiratory tract infections. In a few cases they attended for poor growth. Children were selected to take part in the study if their weight fell below the third percentile on the growth chart; controls were selected on the basis of weight and height being on or

above the 25th percentile. Other selection criteria included; birth weight of 2500 g or more, singleton birth, gestation of 36 weeks or more and no evidence of organic disease which might cause poor growth.

Data for the study were collected during home visits using interviews, informal conversations and direct observation. A behavioural laboratory was also used and areas studied were eating, sleeping, elimination, autoerotic and self harming behaviour. Of these; differences in eating behaviour were the most pronounced between the two groups of children. Mothers of case group children reported significantly more feeding difficulties than mothers of control group children; these included; poor appetite, poor suck, vomiting after feeds, crying during feeds and difficulty in progressing from liquids to solid food. Mothers of case group infants were significantly more likely to perceive them as sickly than mothers of controls. Thirty eight percent of case children were perceived as being in poor health compared to 7% of controls, and 64% of controls were seen as healthy compared with 14% of cases. Based on mothers' reports, case children slept for an average of 11 hours compared with 11.5 hours for control children and there were no noticeable differences in the number of children who woke up frequently in the night. Behavioural differences were only significant when pooled together; the combined data on sleeping, elimination, autoerotic and self harming behaviour produced a significant difference between children with failure to thrive and normal growing children.

Although some of the studies reviewed used small samples and their selection criteria varied; they indicate nevertheless that infants who fail to thrive have different behaviour from normally growing infants and their behaviour is generally more

negative and unattractive.

2.8 Impact of early failure to thrive on health

Environmental influences that impair growth and development in early life may be risk factors for ischaemic heart disease. To test this hypothesis, 5654 men born between 1911 and 1930 were traced (Barker et al., 1989). They were born in six districts of Hertfordshire, and their weights in infancy were recorded; 92.4% were breast fed. Men with the lowest weights at birth and at one year had the highest death rates from ischaemic heart disease. The standardised mortality ratios fell from 111 in men who weighed 18 pounds (8.2 kg) or less at one year, to 42 in those who weighed 27 pounds (12.3 kg) or more. Measures that promote prenatal and postnatal growth may reduce deaths from ischaemic heart disease and promotion of postnatal growth may be especially important in boys who weigh below 7.5 pounds (3.4 kg) at birth.

A study was carried out using the Hertfordshire data to determine whether the link suggested between growth in utero and during infancy and death from cardiovascular disease in men, is also present in women (Osmond et al., 1993). Five thousand, five hundred and eighty five women and 10,141 men born between 1911 and 1930, whose birth weight and weight at one year of age had been recorded were followed up.

Among women and men death rates from cardiovascular disease fell progressively between the low and high birth weights groups. Deaths from cardiovascular disease in men but not women were also strongly related to weight at one year, falling progressively between the low and high weight groups. The highest cardiovascular death rates in women were among those with below average birth weight but above average weight at one year. In men the highest rates were among those with below

average birth weight and below average weight at one year. The study concluded that the relationship between cardiovascular disease and birth weight is similar in men and women, and that cardiovascular disease is also related to weight gain in infancy in men.

Cheung et al. (2000) examined the association of foetal growth, birth weight, and early postnatal growth on blood pressure in Chinese adults. One hundred twenty-two subjects born in Hong Kong in 1967 were followed from birth to age 30 years. Multiple linear regression was used to analyze the association between size at birth, postnatal changes in body size and systolic and diastolic blood pressure at age 30 years. After adjusting for potential confounding variables they found that birth length standard deviation score, ponderal index at birth, and postnatal changes in ponderal index from age six months to 18 months were significantly inversely associated with systolic blood pressure. Other anthropometric variables were not associated with diastolic blood pressure. The results of this study support the hypotheses that both foetal growth and early postnatal growth may have a long-term impact on blood pressure in adults.

Eriksson et al. (2003) examined the relation of obesity in adult life to growth and living conditions during childhood. A birth cohort of 4515 people who were born at Helsinki University Central Hospital between 1934 and 1944, who attended child welfare clinics and were still resident in Finland in the year 2000 were studied. The incidence of obesity was based upon lifetime maximum body mass index which was obtained from a postal questionnaire. The main explanatory measurements were size at birth, childhood growth, and socioeconomic status in childhood and in adult life.

The incidence of obesity was 33.8% in men and 32.4% in women with the incidence

rising with increasing birth weight. From birth the mean weight and BMI of people who later became obese exceeded the average and remained above average at a statistically significant level at all ages from six months to 12 years. Childhood body mass index was a stronger predictor of adult obesity than body size at birth. A higher maternal body mass index in pregnancy was associated with more rapid childhood growth and an increased risk of obesity in adult life and higher socioeconomic status and better educational attainment were associated with a lower prevalence of obesity.

Birth weight and weight gain in infancy in relation to long term health outcomes was investigated by Barker et al. (1995). The birth weights and recorded weights at one year of 15,500 men and women born in Hertfordshire between 1911 and 1930 were evaluated. A relationship was found between weight gain in the first year and suicide in later life. Each kilogram decrease in weight gain between birth and one year was associated with an increase in the risk of suicide of 45% for men and 31% for women.

From large scale studies that have been carried out it appears that weight gain in the first year of life is related to future health outcomes. Links between weights in infancy and suicide, cardiovascular disease and ischaemic heart disease have been reported. The early detection of slow weight gain and subsequent early intervention may help to reduce morbidity and mortality related to these diseases.

2.9 Intervention Studies

Controlled intervention studies

Black et al. (1995) carried out a randomised clinical trial to evaluate a home-based intervention on the growth and development of children with failure to thrive. The sample included 130 children who were all younger than 25 months (with a mean

age of 12.7 months), recruited from urban paediatric primary care clinics serving low income families. Eligibility criteria included; weight for age below the fifth percentile (based on the National Centre for Health Statistics Growth Charts), gestational age of at least 36 weeks, birth weight appropriate for gestational age, and no significant history of perinatal complications, congenital disorders, chronic illnesses, or developmental disabilities. Children were allocated at random to one of two groups, 64 to the clinic plus home intervention group, and 66 to the clinic only group. There were no group differences between the children's age, gender, race, growth, or in demographic details. Eighty-nine percent of the families (116 out of 130) completed the one year evaluation.

All children received services in a multidisciplinary growth and nutrition clinic, which included a comprehensive clinical evaluation from a multi disciplinary team. Data were collected prior to the start of interventions and repeated one year after recruitment. Anthropometric and developmental assessments and a video recording of the child and parents during a mealtime were carried out. A researcher, who was blind as to the intervention status of the child, visited the family at home to observe the child and family together 18 months after recruitment. A community based agency provided the home intervention and families in the home intervention group were scheduled to receive weekly home visits for one year by lay home visitors, supervised by a community health nurse. The interventions were individualised and negotiated between parents and those providing the interventions. They included maternal support, promoting parenting, child development, use of informal and formal resources, and parent advocacy. Both groups received nutrition intervention from the clinic.

Growth was measured by standard procedures and converted to z scores for weight for height and height for age. Cognitive and motor development was measured with the Bayley Scales of Infant Development; and language development was measured by the Receptive/Expressive Emergent Language Scale which was administered at recruitment and at the 12 month follow up. Parent-child interaction was measured by observing mothers and children during feeding sessions, both at recruitment and at the 12 month follow up. The quality of the home was measured by the Home Observation Measure of the Environment 18 months after recruitment.

Children's weight for age, weight for height, and height for age improved significantly during the 12 month study period, regardless of intervention status. Children in the home intervention group had better receptive language over time and more child-oriented home environments than children in the clinic only group. There was a significant decline in cognitive development over the year, but younger children in the home intervention group showed less of a decline than younger children in the clinic only group. The differences between the older children were not significant and there were no changes in motor development associated with intervention status. During the study period the children gained skills in interactive competence during feeding and their parents became more controlling during feeding, but differences were not associated with intervention status. The authors conclude that early home intervention can promote a nurturant home environment and reduce the developmental delays often experienced by low income, urban infants with failure to thrive; although results should be interpreted bearing in mind that among the older children there were no differences between the groups in cognitive development.

A prospective randomised clinical trial by Casey et al. (1994) investigated whether the

incidence of failure to thrive in a sample of pre term children with low birth weights could be decreased by providing an intensive multi-faceted three year intervention programme. In addition they tested the hypothesis that the interventions would make a difference to the health, growth, behaviour status and three year intelligence of the children. The sample of 985 pre term infants with low birth weights was selected from eight American hospitals. The criterion used to identify cases was based on weight velocity (when children did not maintain the expected weight gain over time). After exclusion of infants unavailable for follow up 914 infants remained, of these 180 met the criteria for failure to thrive and 581 of the sample were growing normally.

Infants were visited weekly during the first year and twice weekly between one and three years of age by home visitors who provided family support and programmes which encouraged cognitive, language and social development for the infant. The parents were also encouraged to bring their child to a development centre five days a week from the age of one to three years for early childhood educational intervention. Although the incidence of failure to thrive did not differ between the treatment and control groups and there was no difference on any of the outcome variables, when compliance with interventions was taken into account during the analysis, those from the high compliance group had significantly higher scores than the low compliance group.

Hutcheson et al. (1997) carried out a randomized clinical trial to examine the moderating effects of risk status on the impact of home intervention in a follow-up study of children with failure to thrive. Two types of risk (demographic and maternal negative affectivity) and two levels of intervention were examined. All children

received services in a multidisciplinary growth and nutrition clinic, and half the children also received home visits from a lay home visitor for one year. There were no effects of demographic risk, maternal negative affectivity, or intervention status on child outcome at the close of the home intervention. However, at age four, more than one year after the home intervention ended, there were effects of the home intervention on motor development among all children and on cognitive development and behaviour during play among children of mothers who reported low levels of negative affectivity. Results highlight the importance of conducting follow-up assessments in the evaluation of home intervention services, and suggest that among low socio economic status families of children with failure to thrive; home intervention may be most useful among mothers with low negative affectivity.

Bithoney et al. (1989) undertook a study to determine whether children with organic failure to thrive could grow at similar rates as children with non-organic failure to thrive when treated by a specialised multidisciplinary team. Eighty-six children who were referred to an outpatient failure to thrive clinic were recruited. Sixty four had non-organic failure to thrive and 22 had organic failure to thrive. Growth quotient analysis was used to determine growth outcomes over a six month follow up period. Children in both groups grew extremely well. Results indicated that weight gain alone cannot reliably differentiate organic failure to thrive from non-organic failure to thrive. The authors suggest that children with failure to thrive should have maximum calorie intake and that a multidisciplinary team consisting of a paediatrician, child psychiatrist, nutritionist, nurse clinician, and social worker may be successful in managing failure to thrive children.

Bithony et al. (1991) investigated the effect of a multidisciplinary team approach on

weight gain between two groups of children with failure to thrive. Selection criteria included weight and height below the 5th centile on the National Centre for Growth Statistics growth charts, or weight loss of two or more standard deviations in a six month period. Children with organic illness which may have caused the poor weight gain were excluded. The two groups of children were followed for at least six months following diagnosis; the case group were treated in a growth nutrition clinic and the comparison group in a primary care clinic. Both services were offered in the same institution.

Fifty three case infants were selected from the growth nutrition clinic. This clinic used a multidisciplinary team consisting of a paediatrician, nutritionist, developmental specialist, nurse practitioner, child psychiatrist and social worker to treat failure to thrive. The children had a detailed history taken and interventions were provided based on assessment of the child's needs. These might include social, developmental, psychological or dietary input from the team. Most of the children had laboratory investigations of blood, stools and sweat tests and all of the children had a case manager, intensive follow up and were sent reminders about appointments.

One hundred and seven comparison children were identified retrospectively from an existing primary care clinic. The comparison children were treated by a staff physician or a nurse practitioner, and laboratory investigations were carried out at their discretion. These children received significantly fewer home visits and were less likely to see a nutritionist or to be referred to food assistance programs.

There were no significant differences between the groups in terms of demographic characteristics. The degree of failure to thrive was classified as severe, moderate or

mild, and it was found that children in the growth nutrition clinic group were more severely malnourished. Findings from the study show that the children in the growth nutrition clinic who received intensive support from the multidisciplinary team showed a significant increase in growth compared to those attending the primary care clinic. The study uses samples of children referred to specialist centres for failure to thrive and can not therefore be said to be representative. It does however demonstrate the benefits of a multidisciplinary approach on weight gain as shown by significant differences between the groups although developmental outcomes were not tested

A randomised controlled trial to evaluate the effectiveness of Health Visitor intervention for failure to thrive in children under two years (Wright et al., 1998) was carried out in Newcastle upon Tyne. The service was part of a multidisciplinary group, the Parkin project. Children were identified by population screening, which required a minimum of two weights to be entered on the child health computer for each child; usually the weight obtained by Health Visitor at the six to eight week check and a further weight from the Health Visitor at between nine and 18 months old. If the weight standard deviation score had fallen by 1.26 or more, after adjustment for regression to the mean using the 'thrive index' (Wright et al., 1994) then the child was classified as failing to thrive. Over a two year period 229 children in the area were identified as failing to thrive. Children identified as failing to thrive in 20 of the 38 primary care teams in Newcastle were randomly allocated to take part in the intervention and the remaining identified children were the controls.

Exclusions were children whose weight had recovered to above the screening threshold by the time of identification and second twins where both had screened in.

In the intervention practices there were 120 cases of failure to thrive, 23 of these

received no input because their weight gain prior to identification was above the screening threshold. Ninety five of the remaining 97 children received a standardised health visitor assessment and subsequent input was provided if recommended by the health visitor and if the family were agreeable. Health visitors in the intervention practices received extra training, and a programme involving dietetic, paediatric and social work input was available to the intervention families. There were 109 children in control practices, these received routine health visitor input and were referred via conventional means if the health visitor had any concerns.

A year after the close of recruitment all children were traced and offered a home visit by a research nurse at three years of age. The children were weighed and measured and basic demographic and medical information collected. A structured questionnaire was used to obtain parents' opinions and clinic, primary care records and hospital notes reviewed to extract medical information and recorded weights. At follow up beyond three years, records were reviewed for 79% of children in the intervention group and 84% of controls. Both groups had shown early onset of failure to thrive, controls having fewer weights recorded, and 16% having none after the screening weight, five of whom had severe failure to thrive when last weighed. Ten cases of major organic disease were found, five in the intervention group and five controls, and 15 children in the intervention group and 12 controls had minor but possibly contributory conditions. Anthropometry at the visit showed that both groups had caught up with their weight, but the intervention group were nearer their expected weight and were significantly taller, although this did not reach significance when adjustments were made for parental height. When the last available weights were compared these showed a significant effect of intervention, even after adjusting for



severity and length of follow up. At the last follow up, 91 (76%) of children in the intervention group had recovered to above the screening threshold compared with 60 (55%) of controls. This difference was statistically significant. The authors concluded that a treatment programme for failure to thrive delivered by health visitors using strict diagnostic criteria and assessment protocols with limited specialist support, results in a weight gain of around half an inter-centile space, using UK 1990 reference charts (Freeman et al., 1995; Preece et al., 1996), equivalent to about 550 g.

Raynor et al. (1999) carried out a randomised controlled trial to determine whether home based intervention by a specialist health visitor, would improve outcomes for children with failure to thrive compared with those who received conventional management. Assessors were blind as to the intervention given to the children.

Subjects were recruited from all children referred for failure to thrive between April 1994 and February 1996 in the Leeds area. Inclusion criteria were age between four and 30 months and weight below the third centile, or deceleration in weight gain over two centile channels, in the absence of organic disease. Children of all birth weights and maturity were included; main carers whose first language was not English were excluded due to lack of availability of interpreters. Eighty four children met the inclusion criteria; of these 83 were enrolled in the study. The percentage of families in the sample who were unemployed, living in local authority housing and in receipt of income support was higher than the national average. Eighty one percent of the sample was of normal birth weight, although the mean weight SD score was -1SD lower than the mean height SD score. The majority of the sample was white, with three children of Asian decent.

Outcome measures included growth, cognitive and motor development, dietary

analysis, behavioural questionnaire, maternal mental assessment and referral to support services. Research assistants who were blind as to the child's intervention status collected the data. Nurses collected anthropometric measurements; an independent health visitor collected the developmental assessment, behavioural questionnaire and maternal mental state assessment, and inspected the family health visitor notes. A research dietician collected the dietary assessment and a research assistant checked the hospital notes for attendance and referrals.

Children were assigned to groups according to age (above and below 12 months) and by birth weight (above and below the third centile at birth) using a blocked randomisation table. Eighty four children met the inclusion criteria of whom 83 were recruited to the study. Baseline and follow up growth measurements were obtained on these children, however eight children in the control group and one in the intervention group failed to attend for non growth baseline measurements. This difference was statistically significant ($p = 0.014$).

Both groups of children attended the consultant led out-patient clinic. Those in the intervention group also received intensive home visiting from a specialist health visitor, who was trained in the management of eating problems, assessment of parent-child interactions, counselling and nutrition. She visited for one year, in collaboration with the family health visitor. Children's growth was charted on the child growth foundation charts and converted to z scores. Both groups showed highly significant improvements in weight but not height. The difference between the two groups was not statistically significant.

The infants' cognitive and motor developmental statuses were assessed with the

Bayley Scales of Infant Development (2nd edition). Mean baseline mental and psychomotor development index scores were low in both groups and although mean scores in both groups improved following intervention, no statistically significant differences were found between the groups. The researchers developed their own behavioural questionnaire for the study which focussed on the child's behaviour generally and in relation to eating and drinking, based on mother's views. The questionnaire was piloted on families at a health visitor clinic and adjustments made. Pre and post study questionnaires were completed for 37 and 27 children in the intervention and control groups respectively. Scores between the groups were similar at pre study; however there was a significant post study difference between groups in perceptions about feeding in favour of the intervention group.

Four day food diaries were used to obtain a nutritional assessment. This was followed by an interview at home by a research dietician to clarify what had been eaten. These assessments were discontinued after the first 36 as data collection was resulting in unacceptable delays in management. After the study both groups showed an increase in energy intake although it is not clear whether the increase was statistically significant.

The main caregiver's mental state was assessed using the self administered hospital anxiety and depression scale. Baseline measures of depression scores were similar in both groups although a higher proportion of mothers in the intervention group had higher scores for anxiety. Although 11 of the 17 anxious mothers in the intervention group had reduced their scores to the non anxious range compared with none of the nine anxious mothers in the control group, this was not a statistically significant

difference.

At the end of the study, levels of support services provided to children in both groups were compared. Hospital notes for attendances and non attendances at failure to thrive clinics, admissions to hospital and referrals to other agencies were compared. In the control group more children were referred to social services although a significance level is not given. There were more referrals to a community dietician in the control group and the difference between the groups were statistically significant ($p < 0.001$). More children in the control group than the intervention group were admitted to hospital, which was a statistically significant difference. Both groups of children had similar numbers of outpatient appointments although the control group were more likely to miss appointments ($p = 0.017$). A random sample of 25 sets of health visitor notes were examined for the number of home visits carried out and the number of unproductive visits. Family health visitors carried out more than double the number of home visits for the control group than the intervention group. In addition they had more than 10 times the number of unproductive visits for the control group, being significantly more likely to have two or more unproductive visits ($p = 0.015$). Using multiple regression analysis, initial weight SD score, length of time in study, intervention status, age at allocation and income support status were entered in the equation, to determine predictors of final weight SD score. The only strong predictor was initial weight SD score. Employment status, educational status, and intrauterine growth retardation, were substituted for income support status in the regression model and these failed to show a significant effect on weight outcome.

~~The study failed to measure any significant benefits of health visitor intervention in~~
failure to thrive, for the child. Informal feedback about the service from families and

professionals was positive, and the authors found significant benefits in terms of reduction in hospital admission, fewer referrals to other professionals and more compliance with clinic appointments and health visitor visits. The study was underpowered in terms of initial calculations, and not all participants completed all parts of the study. Pre term and intrauterine growth retarded infants were included in the study; it may be that the inclusion of these could bias the results as their lower birth weight is likely to influence their subsequent weight gain (Fergusson et al., 1980).

Uncontrolled intervention studies

A Children's Society Infant Support Project which consisted of health visitors, nursery nurses and social workers was evaluated by Hampton (1996). The multidisciplinary team worked on a domiciliary basis with families of children with failure to thrive who were under three years of age; using working practices founded on social learning theory. One team member was allocated to a family and they were able to consult with other members of the multi disciplinary team. A number of assessment visits were made, parents completed a food diary and a video recording was made of two meals. The family worker discussed findings from the assessment with the parents and an agreement was made which included suggestions for work on nutrition and psychosocial factors, positive reinforcement and planned ignoring of unwanted behaviour. Evaluation took place when the course of work was completed and again six months after that. Of the 108 children referred to the project 68% made satisfactory progress in terms of growth. The study was an evaluation of a project for children identified with failure to thrive and there was no control group to compare

outcomes with.

Hobbs and Hanks (1996) set up a multidisciplinary team for the treatment and management of infants and children with failure to thrive. The mean age of the children referred was 42.2 months, the most frequent age of referral being between 10 and 30 months. A dietician visited the family at home and took a full feeding history. A mealtime video recording was taken and the family were then seen in a clinic where two professionals were assigned to work with the family while others observed. Behavioural interventions were used and feeding and dietary advice and support were given. The outcomes reported were for 47 children with failure to thrive, who had attended for more than one appointment. Of these only eight deteriorated in terms of weight, the rest showed an improvement from a mean z score of -2.17 to one of -1.87 . The study evaluated a service for children with failure to thrive and their families, with weight gain as the outcome measure. There was no control group with which outcomes could be compared.

Powell and Reid (1994) reported the outcomes of the work of a multidisciplinary feeding disorders team. Twenty children aged up to 30 months with failure to thrive were referred to the team by a consultant paediatrician and outcomes were assessed on standardised scores of weight on referral to the team and at discharge and paired tests carried out. The results were highly significant, however the sample is small and it consisted of a sample of children with feeding difficulties severe enough for them to be referred by a consultant paediatrician. In addition five of the sample were preterm and weighed less than 2500g at birth. The authors acknowledge that due to difficulties around identification of failure to thrive by both professionals and parents, the service was being used by only a very small proportion of children who might

benefit from it.

The assessment and intervention consisted of a home visit by two members of the team (usually the specialist health visitor and paediatric psychologist) who carried out a psychosocial and behavioural assessment; a video recording was made of a meal and parents kept a food diary. The child was weighed and height measurement was taken in the outpatients department. A feeding management programme was negotiated with the parents and a copy of this was sent to the GP, health visitor, community paediatrician and any others involved in giving feeding advice to the family. Workers maintained contact with the families through home visits and telephone calls and parents and children attended a support group where parents worked with staff on child management strategies. Weight was reviewed by the team monthly and children were discharged from the programme if weight gain was consistent and satisfactory over a three month period.

Failure to thrive has a range of adverse outcomes. It is associated with developmental delay in infancy (Black et al., 1994; Raynor et al., 1996; Skuse et al., 1994; Wilensky et al., 1996) short stature at eight years (Drewett et al., 1999) and in the long term, increased risk of ischaemic heart disease and cardiovascular disease (Barker et al., 1989; Osmond et al., 1993). Population based studies have shown that it often has a very early onset (Altemeir et al., 1985; Drewett et al., 1999). Skuse et al. (1994) found that the degree of growth restriction was important, but that when timing, duration and severity were taken into account using a statistical model, the infants with poor weight gain from birth up to six months would be a lose 10 points in predicted-mental and psychomotor abilities in their second year. If the child's poor weight gain had been delayed by four months then the loss would be reduced to three

points, and after eight months of age there was no predicted deficit in mental abilities. The early onset failure to thrive was found to be associated with particularly poor development.

The effect of a community health nursing intervention on children with growth deficiency was examined in a pre-test and post-test experimental study (Reifsnider, 1998). The study evaluated the impact of the intervention on growth quotients, children's diets, parent-child interaction, home environment, and mothers' perceived stress. Thirty nine children aged between four months and 33 months with failure to thrive were enrolled in Special Supplemental Feeding Program for Women, Infants and Children (WIC) clinics. Following an examination to exclude organic failure to thrive, 21 were randomly assigned to an experimental and 21 to a control group (but three of these were lost to follow up). After preliminary data were collected for the entire sample, the experimental group received a community-based intervention during home visits every other week which included education about nutrition, parenting and community skills for four months; after which data were collected by a research assistant who was blind as to whether the infants were in the experimental or control group. Infants in the control group had a visit to complete the pre test measures and again after four months. Positive changes were indicated ($P \leq 0.05$) in the experimental group's growth quotients, home environments, and their mothers' perceived stress.

The difference between the groups in mean growth quotient for weight scores was statistically significant, but the differences for length and dietary intake were not significant. Outcome measures of the home environment, parent-child interaction and perceived stress were analysed, and comparisons were made between groups and time

(pre and post intervention). There were no significant differences between the groups in home environment, interaction or stress, at the end of the intervention although the experimental group did however have a greater decrease in stress and a greater increase in environment and interaction, compared with the control group. The study was limited in that the sample size is small and the intervention time of four months was short.

Two years later, 56% of the sample was located and the measures were repeated (Reifsnider, 1998). The follow-up study revealed that all the children with growth deficiency in the original study had slower growth velocity after termination of the study. The experimental group had diets significantly higher in fat and zinc than did the control group. The amount of fat, calories, zinc, and protein intake in all the children's diets was significantly related to their percentile level for weight. The stress of all the mothers, both experimental and control had increased, and there was a significant increase in stress in the experimental mothers. There was no difference in the children's home environments, but the parent-child interactions were significantly more positive between the experimental children and their mothers. This follow-up study demonstrates that children with growth deficiency benefited over time from the original intervention but need continued intervention for positive significant changes to persist.

Drewett et al. (2005) analysed data on growth and development from a large population based study (Avon Longitudinal Study of Parents and Children).

Measurements used were those taken at birth, as near as possible to six weeks and nine months. Developmental data were obtained from postal questionnaires when the child was 26 weeks and 18 months old. The slowest growing 5% were identified

from birth to six weeks, from six weeks to nine months and from birth to nine months. Although developmental delay was found to be associated with slow weight gain in all categories, slow weight gain from birth to six weeks was most strongly correlated with later developmental delay and the authors concluded that slow weight gain over the period from birth to six weeks is a stronger predictor of developmental delay than poor weight gain over the rest of the first year.

In conclusion, there is evidence from a randomised controlled trial that structured health visitor intervention can successfully treat failure to thrive (Wright et al., 1998) however the benefit was small. A different randomised controlled trial of health visitor intervention for failure to thrive (Raynor et al., 1999) found no benefit for the child. The evidence suggests that interventions for failure to thrive are only of limited effectiveness; but the interventions all took place relatively late, averaging 16 months and never earlier than seven months (Bithoney et al., 1991; Black et al., 1995; Raynor et al., 1999; Wright et al., 1998). In addition many intervention studies involved infants from selected or referred samples. These infants may have been the more severe cases who may have been referred for other problems, or may have been identified using more traditional criteria which may not have truly reflected slow weight gain as compared to other infants of the same birth weight.

Studies have shown that failure to thrive often has early onset; in an entire one-year birth cohort in Newcastle upon Tyne infants who failed to thrive in the first 18 months generally showed poor weight gain from birth (Drewett et al., 1999). This is consistent with results of a major prospective study in the USA (Altemeir et al., 1985) in which 60% of cases failed to thrive by one month and 87% by three months. So if failure to thrive is likely to have such early onset then by using a prospective

cohort whose slow weight gain is identified by the use of a thrive index, infants may be identified in primary care as early as six to eight weeks which would enable earlier intervention. The benefits of intervention have been shown to be limited and there is no evidence to suggest that it is effective for cognitive outcomes. Earlier intervention may be more effective, in particular at preventing developmental delay. This would require earlier detection, therefore the current study set out to investigate the possibility of detecting slow weight gain as early as the six to eight week check. Most of these studies were carried out using older populations and there is a paucity of clinically relevant data relating to early onset failure to thrive. This study aims to add to the existing knowledge about early identification of failure to thrive in a primary care setting.

Chapter Three

Methods

Chapter 3: Methods

3.1 Overall Aims of the Study

This study aimed to examine the possibility of early detection of failure to thrive at the six to eight week check. To do so it examined the extent to which infants with slow weight gain, detected at the six to eight week check, show other characteristics classically associated with failure to thrive as detected later in infancy. An explicit screening programme was implemented for the early identification of children whose weight gain was slow, using information that is routinely available at the six to eight week check, and a conditional weight gain criterion (thrive index). The children were then examined developmentally in the first year and compared with appropriate controls. Their feeding behaviour and demographic characteristics were assessed via questionnaires to their mothers.

3.2 Study Design

The study was designed as a prospective cohort study to identify slow weight gain in the first few months of life. The weight gain of a cohort of about 2000 children (all children born in the area covered by Easington Primary Care Trust in the period from 01/04/2001 to 31/3/2003) was followed over their first year, using weights routinely collected at birth, six to eight weeks and seven to nine months as part of routine NHS care. These weights were extracted from health visitors' records. Using these weights, infants were compared with the national reference incorporated in the UK 1990 growth reference (Freeman et al., 1995; Preece et al., 1996) and those whose weight gain put them in the slowest growing 5% were identified and selected to participate in the study.

Estimated birth rates for planning purposes were based on birth rates in the year preceding the study. There were 962 births in the practices covered by Easington Primary Care Trust in the year from April 1st 2000 to 31st March 2001 and 152 births in the practice from Sunderland Primary Care Trust, giving a total of 1,114 births (see Appendix 1 for breakdown). The screening of an estimated 2,000 births (over 24 months) should identify 100 cases (those whose weight gain is in the lowest 5%) if the prevalence of failure to thrive in the Easington area were only average, although it was assumed that it could be higher as Easington is one of the most deprived areas in the country. The area Index of Multiple Deprivation scores (Office of the Deputy Prime Minister, 2000) indicate that every ward covered by Easington Primary Care Trust is in the most deprived quartile nationally; two (Eden Hill and Deneside) are among the 100 most deprived wards in England (out of 8,414). Hetton ward (where the practice from Sunderland Primary Care Trust is located) is ranked 832 out of 8,414. Failure to thrive is about twice as common in the most deprived areas as in average areas (Wright et al., 1994).

Previous studies of failure to thrive have compared the mean differences in Bayley Mental Development (MDI) scores between groups of infants with failure to thrive and groups of controls. A study by Kellerher et al. (1993) found a mean difference in MDI scores of 5.8 when they compared a group of failure to thrive children with a group of controls. Black et al. (1994) found a mean difference in MDI scores of 7.7 between groups, Skuse et al. (1994) found a mean difference of 10.3 and Wilensky et al. (1996) found a mean difference of 7.5. From these MDI scores an average mean difference of 8 was assumed. The standard deviation score from the Bayley Scales manual is 16, so a standard deviation of 16 was assumed. Table 1 shows power

calculations which were used to estimate the numbers of cases and controls which would have an 80% power to detect a difference of 0.5 SD in the Bayley MDI scores.

Table 1. Power calculations.

Formulae are from Kraemer and Thieman, 1987.

$\delta = (\mu_x - \mu_y) / \sigma$ $\Delta = \delta / (\delta^2 + 1/pq)^{1/2}$ $n = v + 2$
$\delta = 8/16 = 0.5 \text{ (effect size or standardised mean difference)}$ $p = q = 0.5 \text{ (proportion of cases and controls, equal by design)}$
$\Delta = 0.5 / (0.5^2 + 1/ (0.5) (0.5))^{1/2}$ $\Delta = 0.5 / (0.25 + 1/ (0.25))^{1/2}$ $\Delta = 0.5 / (4.25)^{1/2}$ $\Delta = 0.5 / 2.06$ $\Delta = 0.24$ $n = v + 2$

From the tables for Δ in Kraemer et al. (1987) a group of 135 (68 cases and 68 controls) has an 80% power to detect a difference of 0.5 SD in the Bayley scales.

A thrive index is a standard deviation or z score for weight gain, conditional on age and birth weight (or on another initial weight at a different age). The thrive index

procedure was first used by Wright et al. (1994) and has since been used in other major studies in the UK (Blair et al., 2004; Drewett et al., 1999).

A natural way to measure weight gain would be to examine the change in weight in the ordinary units of weight (kg). The z score standardises weights so that the median for the population is zero and the standard deviation is one. The standardisation involves subtracting the median weight (for infants of a particular age) from the weight of the infant in question and dividing by the standard deviation:

$$z \text{ score} = (\text{weight} - \text{median}) / \text{standard deviation}$$

The median and standard deviation come from the reference population, in this case the UK 1990 reference (Freeman et al., 1995; Preece et al., 1996). A z score therefore shows directly where a child is in relation to the average (eg. a z score of 0 is average, a z score of - 1 is one SD below average).

A difference between z scores shows the relative change in weight over time. For example if the z score is 0 at birth and - 1 at 6 weeks, the infant's weight has gone down by 1 SD over this period. But infants born light tend to 'catch up' relevant to the population and infants born heavy tend to 'catch down' (Fergusson, Horwood et al. 1980; Wright, Matthews et al. 1994). So a drop of 1 SD means different things in respect of infants born at different weights. It would be quite common in infants born very heavy, but very uncommon in infants born very light. The thrive index is 'conditional' on birth weight, which simply means that the z score for change is calculated in relation to that of other infants of the same birth weight, so the thrive index show how the infants weight gain compares with that of infants of the same birth weight.

For each index child identified in this way a control was identified from the same health visitor's caseload (either the previous or next child in the birth register, the one with the closest birth date to the index child) and recruited to the study. These cases and controls were followed up for the first year and compared using developmental testing and anthropometric measurements at two points in time. A questionnaire concerning feeding behaviour and demographic information was answered by the mother.

A comparison of the two groups of children, the group with slow weight gain and the group growing normally, showed the extent to which infants screened in as 'cases' at the six to eight week check showed the classic symptoms of failure to thrive over the first year (feeding problems, poor growth and developmental delay). The weight data from the whole cohort showed how many children identified retrospectively as failing to thrive over the first year (weight gain in the lowest 5%) were not detected by the six to eight week screen. Essentially these two measures provide the sensitivity and specificity of the six to eight week screen for detecting failure to thrive in the first year. Differences in feeding behaviour and demographic characteristics between the two groups were obtained from the questionnaires and compared.

3.3 Location of Study

The geographical area covered by Easington Primary Care Trust (formerly Easington Primary Care Group) has 18 General Practices (listed in Appendix 2) which are all within a ten mile radius of Durham City (map in Appendix 3). Health visitors attached to these practices were employed by Easington Primary Care Trust, as was the researcher and the nursery nurse who was employed two days a week to work on

the project to collect data from health visitors' records. The nursery nurse had worked in the same geographical area for several years and she was known to the health visitors. In addition she was familiar with their offices and filing systems which was advantageous when collecting data.

A proposal to support the project by releasing the researcher 2.5 days a week from health visiting duties was discussed and agreed following a Primary Care Group board meeting which was open to all employees. This meant that all general practitioners and health visitors in the area knew about the project and all were agreeable to taking part. The practice to which the researcher was attached was excluded as she might know which infants were gaining weight slowly and this would mean that infants could not be tested blind. In order to compensate for this exclusion, a nearby practice from Sunderland Primary Care Trust (formerly Priority Healthcare Wearside) was invited to participate. This practice had a similar number of births per year to the excluded practice and was within two miles of other practices in the study sample. In addition, the overall Index of Multiple Derivation score for the ward in which this practice was located was similar to that of wards in Easington area.

3.4 Data collection (1)

Calibration of balances.

A series of calibration tests of all balances in use for weighing infants in the study area was carried out using weights calibrated to M2 standard (see Appendices 4 and 5), over the range 1kg to 20 kg. Each weight was placed on the balances starting with 1kg then 2kg, up to 20kg, as most of the balances weighed over a range of zero to 20kg. Readings were recorded at 1kg intervals to assess the accuracy of the balances

over their whole range. Balances tested included all those used on labour wards at the University Hospital of Durham, Sunderland Royal Infirmary and the University Hospital of Hartlepool, all portable balances used by health visitors and nursery nurses, and all those used in G.P. surgeries in the study area. In total 65 balances were checked; further details are given in chapter four.

Measurement of weight of wet nappies

Infants are routinely weighed without clothes or a nappy and might empty their bladder just before or after the procedure. To find out whether the weight of the urine might have an impact on the accuracy of results, thirty four infants between the ages of four and 23 weeks of age, who attended a well baby clinic, had their wet nappy weighed and the weight of an identical dry nappy deducted from this to give the weight of the urine in grams.


Data collected on infants as part of routine care

Data was collated monthly over a two-year period from 18 general practices in the Easington area. To ensure that details of all births were recorded, it was necessary for the nursery nurse who was employed two days a week to collect birth data to contact the relevant health visitor to make an appointment to visit her at her office. This provided an opportunity to become familiar with the filing system used and storage of the birth register. The birth register is a large ring binder file with loose pages containing details of every infant in each health visitor's case load. Details of all infants born are recorded in a health visitor's birth register in chronological order and each month begins on a new page (see Appendix 6). Information recorded in the birth register included the child's date of birth, name, address, telephone number, mothers

name and age, G.P., method of feeding, birth weight, gestation, dates of developmental screening, date of weaning visit, date and result of hearing test and any other relevant comments e.g. whether the child has transferred out of the area or died.

From each health visitor's birth register all names and dates of birth of infants born in a given month, from 1st July to the 31st July for example, were written down and the health visiting records for those infants taken from the filing cabinet and checked against the birth register. For each recorded infant, details were extracted from the health visitor's records and entered into a Microsoft Access database on a Dell lap top computer. A code number was automatically assigned to each individual infant's details by the Access programme. Further details of the Access database are given in section 3.4. The health visiting record is an A4 size folder which contains demographic details concerning the family, all of the child's medical examinations, developmental surveillances, discharge summaries from maternity units, letters from paediatricians, and test results; e.g. of the Guthrie and thyroid tests. Significant events are documented in chronological order; these may include visits to casualty, illnesses, referrals to other agencies and hospital visits. The folder also contains a section containing information about the mother's physical and emotional well being.

Each infant's details were entered into a selection form in Microsoft Access as shown in Figure 2. If there was no appropriate weight recorded then the infant's details remained in the programme so that the information could be collected at the next visit.



**University of
Durham**

Child Growth Database

Surname: Forename

Health Visitor: G.P.

Date of Birth: Gestational Age: Weeks

Preterm

Birth weight: kg Sex: Multiple Birth:

6 week check done: Date of examination:

Weight at 6 weeks: kg Length: cm

Head circumference: cm

Syndromes

Nurse notes


X

Figure 2. Selection form in Access Programme

At a later stage, details of the infant's seven to nine month developmental assessment by the family health visitor were entered into a nine month form (see Figure 3). For each initial selection form completed a nine-month form was generated automatically by the programme. The majority of health visitors record details of the infant's

weight, length and head circumference at this assessment and also any health or development problems. Some health visitors had not weighed or measured infants at this assessment and where this was the case, the first recorded weight after seven months was used. For those infants with no weight available by the end of the data collection period a missing data value of -1 was entered.

Figure 3. Nine month form in Access programme. Used to record details of the 9 month check for each infant in the cohort.

 University of Durham

Child Growth Database

Record identifier:

Health Visitor:

9 month check done: Date of 9 month check:

Weight at 9 month: kg Length at 9 month cm:

Head circumference at 9 month: cm

There is a health visiting record for every infant registered with a general practice. Any discrepancies, e.g. if a name was entered in the birth register but notes for the child were not available, or if records were available but a name was not recorded in the birth register, were clarified with the relevant health visitor. In some instances the health visitor had removed the records from the filing cabinet if a visit was planned, or records might have been missing if the infant had transferred into the caseload from another practice and health visiting records from the previous health visitor had not yet been received. In some instances records were simply misfiled, which involved a time consuming search. If a child had died or transferred out of the area shortly after birth and there was no birth weight recorded in the birth register, the research assistant entered a missing data value of -1 for the birth weight in order for that infant's details to be registered on the database.

The required information was usually filed in the health visiting records. In the case of health visitors employed by Sunderland Primary Care Trust, weight data were often entered in a clinic record which was stored in a different filing cabinet to the health visiting records. The health visitors concerned clarified this and ensured that the information was accessible. When the required information had been retrieved from health visiting records, clinic records and birth registers, these were returned to the filing cabinet and locked away in accordance with the Primary Care Trust's policy. The list of names was shredded prior to leaving the health visitor's office.

Many health visitors had a backlog of filing which meant that information about the six to eight week check might not be available for several months. In addition, some GPs occasionally forgot to remove the tear out slip containing information about the six week to eight examination from the parent held record; consequently there would

be no weight filed in the health visitor's records unless the health visitor removed the slip when she was next in contact with the family, which could be several months later.

Health visitors hold clinics in the community where parents can take their infants to be weighed or immunised or to ask for advice about their infant's health. Some parents attend the clinic weekly, others rarely. The majority of parents do attend for the infant's six to eight week check where their infant is weighed and measured by a health visitor; measurements are plotted on a centile chart and discussed with the parents then the infant is examined medically by their own GP. This procedure is recorded in the parent's child health record, which is a small yellow booklet containing details of the infant's birth, subsequent weights, immunisation, illness history, developmental progress and contacts with health professionals.

Developmental surveillance checks which include measurements of weight and length are carried out at six weeks, seven months, two years and three years of age. The infants head circumference is measured and recorded up to one year of age.

Surveillance details and measurements are recorded in triplicate, one copy being retained in the parent held record, one in the health visitor's record and one in the G.P.'s record. All parents are invited to attend for this examination with two repeat appointments being offered if they fail to attend. If by 12 weeks of age the infant had not attended for this examination, the health visitor would usually arrange to weigh and measure the infant at home. In a national feeding survey in 1995 (Forster et al., 1997) 66% of mothers took their infants for their medical examination between six and ten weeks (63% in the North of England). The fourth edition of Health for all Children (Hall et al., 2003) recommends the continuation of the six to eight week

physical examination for every baby.

Database used to collate data

Phillip Lowe, a bio-engineer of the Institute of Child Health at Newcastle professionally designed a database for the project using Microsoft Access. The data extracted from the health visiting records were 'linked anonymised data' as defined by the Medical Research Council (2000) document 'Personal Information in Medical Research'. The Microsoft Access database used in the data collection was registered with the appropriate department of North Tees and Hartlepool NHS Trust's Information Technology department in accordance with the Data Protection Act (1998).

Information relating to each infant was given an identifier, which comprised the first three letters of the infant's forename, the first three letters of the surname and the date of birth. The information was entered into the database which only the researcher and the nursery nurse working under her supervision could access by means of a password. The programme allocated an identification number to each infant, based on the order in which the data were entered; this number was used to link together questionnaires and Bayley Scale assessment forms. No patient identifiable information was taken from the health visitor's office.

The selection screen on the lap top computer enabled infants' details to be entered into boxes on the screen and the programme was able to identify a range of measurements and dates which were within the acceptable range expected for a child's sex, age and birth weight, as shown in Table 2. Any deviations from these ranges were flagged up by the programme and the research assistant given a prompt to

check whether these entries were correct. Measurements were based on the extreme upper and lower limits of normal on the UK 1990 nine centile growth charts (Freeman et al., 1995; revised Preece et al., 1996).

Table 2. Acceptable range of variables.

Variable	Acceptable	
Surname	First three letters	
Forename	First three letters	
DOB	Before date of entry	
GPs name	From drop down menu	
HVs name	From drop down menu	
Gestational age	Weeks and days Term + days Term / pre term	or or
Sex	M F	or
Birth weight	0.5 to 7 kg -1 if no weight given	or
Date of 6-8 week check	Between DOB and date of data entry	
Weight at 6-8 week check	1 to 15 kg -1 if no weight given	or
Length at 6-8 week check	30 to 70 cm -1 if no length given	or
Head circumference at 6-8 week check	25 to 50 cm -1 if no head circumference given	or
Date of 6-9 month check	Between 6 months after DOB and entry date	
Weight at 6-9 month check	3 to 15 kg -1 if no weight given	or
Length at 6-9 month check	50 to 90 cm -1 if no length given	or
Head circumference at 6-9 month check	37 to 57 cm -1 if no head circumference given	or
Weight SDS score 6-9 months	Between +2 and -2	

Each health visitor's and GP's name had a code assigned; this code appeared in the database and was a means of tracing the child. The child's gestational age was recorded in the database exactly as it was recorded in records and if the child was

born before 37 weeks completed gestation the database automatically ticked a box to alert the team that the child should be excluded from recruitment to the study. The child's birth weight was entered either into a box on the screen in kilograms, or into a separate screen which gave a choice of entering the weight in pounds and ounces, grams or kilograms. This enabled the research assistant to enter the weight exactly as recorded in the health visiting record and eliminate the possibility of error when converting weights. The programme automatically converted weights into kilograms so that they were always displayed as such in the database.

If the child had attended clinic for a six to eight week check a box on the selection screen was ticked; this enabled the researcher to enter a date for the event. A weight at six to eight weeks was entered into a box on the screen if it was recorded in kilograms, or into a separate screen which gave a choice of entering the weight in pounds and ounces, grams or kilograms. The research assistant entered the weight as it was recorded in the health visiting record to eliminate the possibility of error when converting weights. As with the birth weight, the programme converted the weight automatically so that weights in the database were always displayed in kilograms.

After the child's details were entered into the selection form the data was stored in a database as shown in Table 3. If the six to eight week check box was not ticked the child's details would remain on the selection form until such time as these became available. After these details had been entered, the selection form for that child was deleted from the screen but all recorded details remained stored in the database.

Using the data from the selection forms the programme allocated a unique identifier number to each child, based on the order in which the child's details were entered; those children born at the start of the study had the lower numbers. A tick box in a

table entitled 'children' was ticked by the researcher if the child had been selected for the study either as a case or a control and this was followed by the record identifier. The birth SDS which was calculated by the programme and the predicted SDS score which was based on the child's birth weight and actual age at the six to eight week check was shown. The infant's six week measurements were displayed and the programme calculated a SD score based on the child's birth weight, sex, actual age in days at the six to eight week check and the child's weight at the examination. The difference between child's predicted SD score and actual SD score is the thrive index. The predicted value was based on regression analysis on a large representative sample (Blair et al., 2004).

Table 3. Data stored in database.

Child ID	In Study	Surname	Forename	Record Identifier	GP	HV
	<input type="checkbox"/>					

Sex	Date of birth	Gestational age	Preterm	Birth weight	SDS birth	6 week check done
			<input type="checkbox"/>			<input type="checkbox"/>

Predicted 6-8 week SDS	Date of examination	Length	Head circumference	Weight 6-8 weeks

SDS (6-8weeks)	Thrive index	Selected	9 month check done	Date of 9 month check
		<input type="checkbox"/>	<input type="checkbox"/>	

Length (9 months)	Head circumference (9 months)	Weight (9 months)	SDS (9 months)

Thrive Index (9 months)	Syndromes	Nurse Notes	Multiple Birth
			<input type="checkbox"/>

As a check on accuracy of data recording a check of 10% of all health visitor records was carried out against data recorded in the database. It would have been impractical to check every tenth record on the database as health visitor's case loads had changed radically due to the introduction of Sure Start programmes in some areas and the reorganisation of the health visiting service. Health visitors had been relocated, caseloads redistributed, some staff had left and new staff had joined the service. Tracing records via information on the database would have been very time consuming as the key to tracing them was through the health visitor code recorded in the database. This information was inaccurate after the reorganisation of caseloads, but it was a simple matter to cross check from a set of records to the database using the infant's date of birth and first three letters of the forename and surname and GP code.

Identification of index children from data collected at 6-8 week checks

The database converted weights to z scores based on the new British Growth Standard (Freeman et al., 1995; revised Preece et al., 1996). The z scores were automatically checked for suspicious values so they could be verified at the time. Cases (infants with weight gain in the lowest 5%) were automatically identified by the programme and controls were chosen by Dr Drewett and notified to the researcher. Controls were chosen by selecting the term singleton infant closest in date of birth to the index child from the same health visitor's case-load. Cases and controls were not matched on any other variables.

Thrive indices were calculated by Drs Drewett and Wright and the researcher did not

know which children were cases and which were controls as this may have biased the study. The 'thrive index' is based on the change in weight standard deviation scores between two different points in time. It is the child's actual weight, minus the predicted weight (based on the earlier weight).

The thrive index was calculated using regression methods (Healy 1978; Wright, Matthews et al. 1994). An average six week weight for infants of different birth weights for a large nationally representative population (Blair, Drewett et al. 2004) was calculated using linear regression as follows:

$$Z_2 = 0.08268 + (0.830)*Z_b - (0.001848)*(age) - (0.003044* Z_b*age)$$

Here Z_2 is the infant's weight at about 6 weeks and Z_b is the infant's birth weight both as z scores. The terms involving age adjust for the infant's exact age (in days) when the weight at the 6 week check was recorded. A z score of 0 indicates average weight gain, and a z score of -1.71 was the 5th centile of the reference population, calculated from the residual standard deviation of the above regression equation (0.715305). A z score below this was therefore used to identify children whose weight gain was in the lowest 5% for this study.

At nine months the linear regression was

$$Z_2 = 0.130 + (0.406)*Z_b$$

Here Z_2 is the infant's weight at 9 months and Z_b is the infant's birth weight both as z scores. There is no adjustment for age as none of the age terms were statistically significant (reflecting the much slower growth later in the first year, and the much longer time interval from birth, making small differences in the actual age of the

infant of no significance in respect of difference in their Z scores from birth). A z score of -1.61 was used as the cut off for the 5th centile, calculated from the residual standard deviation of 0.981306.

Thrive indices were used to identify all infants whose weight gain was in the lowest 5% (Wright et al. 1994). Pre term infants, i.e. those born before 37 weeks completed gestation and multiple births, were excluded from recruitment at the screening stage. If an infant was selected for the study and the family health visitor advised against contacting the family e.g. due to child protection issues, domestic violence or refusal to co-operate with health professionals, then that infant (of which there was only one), was excluded at the recruitment stage. Infants with a major organic syndrome which might affect weight gain were identified retrospectively by reviewing the health visiting records of the cases and controls selected for the study and by asking the family health visitor if the child had any health problems. In addition, the parents of children participating in the study were asked at the second home visit about sleep, feeding and health problems. These were recorded on a questionnaire and added to the SPSS file containing information about infants taking part in the study. The remaining cases were compared with an equal number of controls, obtained by selecting the previous or next infant in the same health visitor's birth register whose birth date was closest to that of the index child.

The infants identified as having slow weight gain at their six to eight week check were the candidate cases of failure to thrive. In addition controls were selected, comprising the baby in the same health visitor's birth register closest in age to the index child.

When the Access programme selected a case or control infant for the study it was possible to identify the health visitor and G.P. from their code numbers. From the

infant's date of birth, G.P. and first three letters of the surname, the family health visitor was able to identify those infants selected for the study and these were recruited to the study by the research health visitor working in collaboration with the family's own health visitor. Using this procedure the research health visitor did not know which infants were cases and which were controls.

The family health visitor wrote to the child's mother inviting them to participate in the study (Appendix 7) and an information sheet about the study was included with the letter (Appendix 8). The research health visitor contacted the mother around two weeks later to ask if she would participate, and if so, an appointment was arranged at the mother's home to give more information about the study and recruit the mother and infant. All cases and controls were invited to participate and those who agreed to do so were visited at home by the research health visitor, at between four and six months of age and again between nine and 12 months of age.

3.5 Data collection (2)

Home visits

The first home visit was scheduled to take place as close as possible at four months of age. The visit was arranged on a day and at time convenient to the mother and infant. If the infant was unwell or sleepy when the researcher visited, the visit was rearranged. Following a detailed discussion about the study, the mother was given the opportunity to ask questions then asked to sign a consent form (Appendix 9). The child's own health visitor and the mother each received a copy of the consent form and the original was filed in the researcher's records with the Bayley Scale forms and the questionnaire. At this visit the infant was weighed and measured, assessed

developmentally using the Bayley Scales of Infant Development (2nd ed) and the mother was interviewed using a questionnaire (see Appendix 10). Although visiting at home was more time consuming for the researcher, it is unlikely that recruitment rates would have been as high if mothers had been invited to travel to a health clinic or university laboratory to participate. The 18 General Practices from which the sample was drawn were spread throughout East Durham, and travelling with a young child would have been problematic or impossible for many mothers in the study. A home visit was more acceptable to mothers as they were familiar with this through their own health visitor and it often saved them a clinic visit to have their baby weighed.

The second home visit was scheduled to take place when the baby was between nine and 12 months of age. This was arranged with the mother in advance at her convenience. At this visit the infant's weight, length and head circumference were measured as at the first visit. Measurements were recorded in the questionnaire and in the parent held child health record. The child was assessed using the Bayley Scales (2nd ed), and from the parent held child health record the date of the infant's seven to nine month developmental assessment (as carried out by the family health visitor) was recorded in the researcher's records in addition to any relevant details about health and development and the child's weight length and head circumference at that time. The mother was asked about any health, development, sleeping and feeding problems the child might have had since the first visit, and if identified, details of these were recorded. The mother was thanked and offered the opportunity to receive a summary of the research findings, and to ask any questions she might have about the study.

Following the second home visit a letter was sent to the family health visitor

informing her of the child's measurements and of any relevant issues which may have arisen during the visit.

Anthropometric measurements

The researcher weighed the infant using portable self zeroing electronic baby scales (model Tanita 1583). The infant was weighed without clothes or nappy, and scales were placed on a firm surface, as recommended in the Hall report (Hall et al., 2003). The balances used by the researcher throughout the study weigh up to a maximum of 20 kg and are accurate to 10 g under 10 kg, and 20 g over 10 kg. They were calibrated by the Trust's electronics department prior to the start of the study and yearly after that. The infant's length was measured with the infant nude and supine using a Starters Measuring Mat as recommended by the Child Growth Foundation. The infant's head was held against the headboard and eased into the correct plane (Frankfurt plane), that is, eyes looking very slightly down so that centre of ear hole is level with lower border of eye socket (Hall, 2000). The researcher held the legs straight with feet together and heels straight down. This can be a difficult procedure and was carried out with assistance from the mother. The infant's occipito frontal head circumference was measured with a lasso measure, as recommended by the Child Growth Foundation. The occipito frontal is the largest circumference and is the only repeatable measurement. These measurements and the date they were taken were recorded in the parent held child health record and in the researcher's notes. The parent held child health records were checked and details of the child's birth weight, six-week examination measurements and any subsequent weights were transcribed to the questionnaire. This was to ensure accuracy and to reduce the possibility of an

erroneously recorded weight.

Following the child's assessment, maternal height was measured and recorded by the researcher. The mother was asked to remove her shoes and socks and loosen her hair. She was then instructed to stand on a flat surface against a closed door or a wall with her spine at pelvis and shoulder level against the door. Her head was positioned in the Frankfurt plane (see Appendix 11) looking slightly downwards with a horizontal imaginary line drawn from the centre of her ear hole level with the lower border of her eye socket. She was reminded to breath normally and the edge of a two inch thick book was lowered onto her head, ensuring good contact. A chalk mark was made on the wall to show where the head and book met and this was measured using a flat steel tape measure. The procedure was repeated to check for accuracy and recorded on the questionnaire. Previous studies have found maternal height to be strongly correlated with child height and weight (Boddy et al., 2000). The father's height (as reported by the mother) was also recorded, although 19 % of the mothers participating in the study were single and did not know the height of the child's father, or were unsure of his exact height.

Developmental measures

A developmental assessment was carried out using the Bayley Scales of Infant Development (2nd ed) (Bayley, 1993). The Bayley Scales are a standardised, individually administered examination, which assesses the current developmental functioning of infants and young children, from the age of one to 42 months of age, producing a standardised score. It consists of three scales, the Mental Scale, Motor Scale and Behaviour Rating Scale. The Mental scale assesses the child's level of

cognitive, language and personal-social functioning. The Motor Scale assesses fine and gross motor development.

The Behaviour Rating Scale assesses the child's behaviour during testing. There are four factors on the Behaviour Rating Scale and the items in each factor are rated on a five point scale. In the age group one to five months infants are assessed on The Attention / Arousal factor which includes an assessment of the infants' state, affect, energy, interest, exploration and responsiveness to the examiner; and on the Motor Quality Factor that assesses the appropriateness of movement and tone. Two additional items from the Emotional Regulation factor are also included.

In the age groups six to 12 months and 13 to 42 months infants are assessed on Orientation / Engagement Factor that measures fear, withdrawal and disinterest behaviours. The Orientation / Engagement factor includes many of the Attention / Arousal items, as well as additional items that assess aspects of the infant's behaviour towards the materials. The Emotional Regulation Factor measures hyperactive, distractible, easy-frustration behaviours and assesses the infant's range of affect and emotional response toward success and failure on the assessment; and Motor Quality Factors that assesses the appropriateness of movement and tone. The Behaviour Rating Scale is scored as a percentile; raw scores are converted to percentiles for each factor within each age group and a total raw score can be converted to a percentile by age group to provide an overall assessment of the infant's behaviour. Lower scores reflect more problematic behaviours.

The Bayley Scales were published in 1969 and have been extensively used to document the differences between normal infants and those born at risk. They were

revised and modernised in 1993 (2nd edition) following extensive validation and statistical verification. The Bayley Scales of Infant Development have been used as a research tool since its publication in 1969. They have been used to document the differences between normal infants and those born at risk, for example comparing differences between a group of infants who have failed to thrive and a group of controls (Black et al., 1994; Kelleher et al., 1993; Skuse et al., 1994; Wilensky et al., 1996). The Behaviour Rating component has been used in research to examine differences in behaviour between groups of infants (Black et al., 2004; Engle et al., 1999; Lowe et al., 2005; Mendelsohn et al., 1998).

The researcher was trained in the use of the Bayley Scales during a full days training at the Royal Free Hospital in London (Appendix 17) and further individual training was obtained from Dr Katherine Parkinson, a psychologist working in a Sub-Department of Community Child Health in Gateshead. A series of repeat tests of 10 children were carried out by researcher and Dr Parkinson as a check on reliability. The correlations between the two testers were 0.738 for the MDI and 0.840 for the PDI ($p < 0.05$ in both cases).

In addition the researcher carried out 35 Bayley assessments on children aged between four and 15 months prior to assessing infants participating in the study. This provided an opportunity to become familiar with the testing and scoring procedures. The children tested were part of the researcher's health visiting caseload and therefore excluded from the study. Parents were given an explanation about why the researcher was using the Bayley Scales and they were asked if they would be willing for the researcher to carry out the assessment during a routine home visit. All of the parents approached were agreeable. The Bayley Scale assessments involve the use of toys

and take the form of play, therefore parents perceived the procedure as pleasurable for their infant. After leaving the home, the items used in the assessment were washed and dried to reduce any risk of cross infection and the infant's scores were calculated using the Bayley Scales Manual.

Questionnaire

A 38 item questionnaire (Appendix 10) was used to record relevant covariates for those participating in the study. Some questions have been used previously in the Infant feeding survey (Hamlyn et al., 2002) and the ALSPAC study (Avon Longitudinal Study of Parents and Children). In order to obtain the required information, the researcher asked the mother questions and recorded the answers on the questionnaire.

Demographic information

Demographic information was obtained and recorded. The aim of this was to find out if there were differences between the group of cases and the group of controls in terms of demographic details. Questions included maternal age, date of birth and parity, the child's ordinal position and the mother's level of educational attainment. Codes used to grade educational qualifications were those used by the Higher Education Statistics Agency for highest qualification on entry, and their permission was received to use these codes (Appendix 12). The following questions were designed to allow classification of the families by a simple measure of relative affluence and by the mother's educational level;

Does anyone in your house earn a wage at the moment?

Does your household own or rent your house or flat?

Does anyone in the household own a car?

Is there a working installed telephone in your house?

Do you have a mobile phone?

How old were you when you finished full time education?

Did you gain any qualifications at school or later?

If yes, can you tell me which qualifications you have?

A classification by Social Class Based on Occupation (OPCS 1991) requires not simply a job title, but a considerable level of detail concerning the woman's employment history, including the number of people supervised and what the woman actually did. In the 1990 National Feeding Survey, for example, there were 14 employment related questions (White et al., 1990). This classification does not work well with young mothers who may or may not have working partners and who may not have a history of employment themselves. For this reason it is now common to classify families in studies of this kind using indicators that do not rely on the employment history of the mother (Davey Smith, 1994; Moser et al., 1988).

Questions of the type listed above have been used in previous work on failure to thrive in the Northern region for this reason (Wright et al., 1998) and are simple and effective in practice. Census based methods classify local areas of residence rather than individual families.

Other demographic information included questions about family composition; for example:

What other adults are living with you?

How many children have you had altogether? How many children of your own are living with you?

Are there any other children living with you?

What is your ethnic origin?

Do you smoke at all?

Feeding and health

Information about infant feeding was collected. Mothers were asked if they had ever breast fed their baby, if they were still breast feeding and how frequently their baby breast fed or if breast feeding had ceased and if so, how old their baby was when this happened. Mothers were asked if they currently gave their baby any milk from a bottle, and whether they gave their baby any food such as a cereal, rusks or any other solid food. They were also asked the age of their baby was when they first had any food apart from milk.

The mothers were asked their baby's feeding behaviour, eg. had the baby shown any slow feeding, weak sucking or whether they had taken only small quantities at each feed in the first two months after birth and whether this was often, sometimes or never. They were asked if their baby shown any of these after two months of age and whether the baby had refused solids if offered and whether this was often, sometimes or never. They were also asked if they felt they ever had any difficulties feeding their baby and if so whether they had great difficulty or just some of the time.- If they ever woke their baby for a feed during the night or during the day mothers were asked

whether this was usually, sometimes or never.

Mothers were asked about their baby's sleeping. If their baby had woken at night over the last week they were asked if this happened occasionally, most nights, more than once a night and if so how many times, once every night, or don't know. Those mothers whose babies did wake at night were asked what they did when their baby woke from a choice of feeding her, giving a drink of water, rocking or cuddling, giving a dummy, bringing baby into their bed, changing her nappy or anything else they did that was not included in this list. For each of these the mothers were asked if they did it always, usually, sometimes or never.

Mothers were asked how they would describe their baby's health, given a choice of good, average and poor and if their baby had any major health problems at birth. If the baby had health problems at birth or any major health problems since birth, these would be recorded in the health visiting records and in the parent held child health record so the researcher would be aware of these and could ask the mother to give details in her own words. They were also asked who they saw about the health problem and then asked to describe their own health given a choice of good, average or poor.

Measurements as recorded in parent held child health record were transcribed on the questionnaire. These included the infants' birth weight, the date of the six to eight week check and the weight, length and head circumference if available. The date of the infants' seven to nine month check as carried out by the family health visitor was recorded on the questionnaire including the infants' measurements if available. This served as an extra check against data entered on the database and in the health

visitors' records.

At the second home visit the mother was asked if her baby had any health or feeding or sleeping problems since the first home visit. The date, the infants' age in weeks and weight length and head circumference were recorded to provide information about the range and means of measurements of the infants at the second visit by the researcher. Following the home visit the family health visitor was sent a letter by the researcher informing her of the child's measurements and any relevant issues which may have arisen during the visit.

Those who mothers who did not agree to participate in the study, those who could not be contacted and those who had moved away from the area prior to recruitment may have had different characteristics to those who participated in the study. For families those who did not wish to participate or could not be contacted it was possible to extract information relating to some of these covariates from health visitor's records. For some family's who had moved out of the area limited data could be obtained from the birth register. For purposes of comparison, the same information as was collected on the questionnaire from participating mothers was retrieved from health visitor's records and birth books for non participating families as far where possible. Some of the information however could only be obtained by asking the mother which meant that a direct comparison was not possible.

3.6 Ethics Approval, Confidentiality and Communication

The practices included in the research project came under three health authorities and therefore ethics approval was sought and obtained prior to commencement of the study from Durham, Hartlepool and Sunderland Local Research Ethics Committees.

The Nursing and Midwifery Council code of professional conduct states that:

“As a registered nurse, midwife or specialist community public health nurse, you must protect confidential information. You must treat information about patients and clients as confidential and use it only for the purposes for which it was given” (Nursing and Midwifery Council, 2004).

All information relating to infants in the study was anonymised by using an identifier. Information should be used only for the purposes for which it was given; however where there is an issue of child protection, action taken must be in accordance with local child protection policies. Where there were any concerns relating to a child during the home visit by the research health visitor (for example, child protection issues) the family health visitor was informed.

A letter was sent to General Practitioners in the area (Appendix 13) with an information sheet about the study (Appendix 14). The research health visitor presented an overview of the study to her health visitor colleagues, health visitor managers, and practice managers, and provided an information sheet (Appendix 15) in order to answer any questions they may have. A letter containing an information sheet about the study and an invitation to participate was sent by their own health visitor to mothers whose infants were selected for the study (Appendix 7). The research Health Visitor then telephoned or wrote to mothers inviting them to participate (Appendix 16). The mothers who were willing to participate were given a full explanation of the study, the opportunity to ask questions and discuss the study, and were asked to sign a consent form (Appendix 9). This stated that the mother had been given an explanation of the study and had given her consent for her infant to take part in the study but that she was able to withdraw at any time without this

affecting her care. One copy was retained by the mother, one was retained by the research team and one copy was filed in the family Health Visitor's record.

Chapter Four

Results

Chapter 4: Results

4.1 Calibration of Balances

A series of calibration tests of all balances used for weighing infants in the study area was carried out using weights calibrated to M2 standard (see Appendices 4 and 5), over the range 1kg to 20 kg. All portable balances used by health visitors and nursery nurses, and all those used in G.P. surgeries in the study area and all those in the three maternity units that served the study area were tested. When a balance was checked a small adhesive sticker with the date of the check was attached underneath to avoid the possibility of checking the same balance twice. Some health visitors have the same make and model number as colleagues sharing their office and there was a possibility that a health visitor could take a colleague's set of balances by mistake. There were 65 balances in total.

Sixty three of the 65 balances (97%) were electronic. Two were not and these were checked in the same way as the electronic balances. One of the two balances that were not electronic weighed in imperial measure; this was in a G.P. surgery where the GP who was involved with the baby clinic preferred to use imperial measure to weigh babies. These were checked in the same manner as the metric balances but imperial units were converted to metric units by multiplying imperial units of ounces by 28.35 (the number of grams in an ounce). So, for example, if a weight of one kilogram is placed on the balances the reading should be 35.27 ounces which is the imperial weight conversion of one kilogram.

For each balance, the calibration weight was deducted from the recorded weight at each 1 kg test and the deviation averaged. Shown in Table 4 are three examples of the

least accurate balances. The three examples shown in Table 4 were all clinic balances and all weighed light. The mean errors in grams were -623 -259 and -83.

Table 4. Three examples of calibration weighings selected as the three with greatest average error. The table shows the make and range of the balance and its code number in the study, the mass of the calibration weights used (CW), the weight shown on the balance for each test weight used (RW) and the difference between the two (DEV).

Seca 835. Max weight 14 kg.

Seca 724. Max weight 20 kg.

Salter 180. Max weight 15 kg.

Clinic balance number 59.

Clinic balance number 62.

Clinic balance number 47.

CW	RW	DEV		CW	RW	DEV		CW	RW	DEV
1.000	1.000	0.000		1.000	0.960	-0.040		1.000	1.000	0.000
2.000	2.000	0.000		2.000	1.940	-0.060		2.000	2.000	0.000
3.000	2.960	-0.040		3.000	2.940	-0.060		3.000	3.000	0.000
4.000	3.880	-0.120		4.000	3.900	-0.100		4.000	3.900	-0.100
5.000	4.620	-0.380		5.000	4.860	-0.140		5.000	4.900	-0.100
6.000	5.400	-0.600		6.000	5.840	-0.160		6.000	6.000	0.000
7.000	6.360	-0.640		7.000	6.840	-0.160		7.000	6.900	-0.100
8.000	7.000	-1.000		8.000	7.820	-0.180		8.000	8.000	0.000
9.000	8.010	-0.990		9.000	8.760	-0.240		9.000	8.900	-0.100
10.000	9.020	-0.980		10.000	9.760	-0.240		10.000	9.900	-0.100
11.000	9.990	-1.010		11.000	10.750	-0.250		11.000	10.900	-0.100
12.000	11.000	-1000		12.000	11.700	-0.300		12.000	11.850	-0.150
13.000	12.020	-0.980		13.000	12.700	-0.300		13.000	12.800	-0.200
14.000	13.020	-0.980		14.000	13.650	-0.350		14.000	13.800	-0.200
				15.000	14.650	-0.350		15.000	14.900	-0.100
				16.000	15.650	-0.350				
				17.000	16.550	-0.450				
				18.000	17.550	-0.450				
				19.000	18.500	-0.500				
				20.000	19.500	-0.500				
Mean	error	-0.623kg		Mean	error	-0.259kg		Mean	error	-0.083kg

Three examples of accurate balances are shown in Table 5. There is one from a maternity unit, one from a GP clinic and one portable balance used by a health visitor. One weighed slightly heavy, one weighed slightly light and one was very accurate. These were among the most accurate balances, with mean errors of 0, - 13 and 10 grams respectively.

Table 5. Three examples of calibration weighings selected as the three with least average error. The table shows the make and range of the balance and its code number in the study, the mass of the calibration weights used (CW), the weight shown on the balance for each test weight used (RW) and the difference between the two (DEV).

Tanita 1582. Max weight 14 kg. Seca 727. Max weight 20 kg. Avery 302 Max weight 20 kg.
 Portable balance number 25. Maternity balance number 8. Clinic balance number 54.

CW	RW	DEV		CW	RW	DEV		CW	RW	DEV
1.000	1.000	0.000		1.000	1.000	0.000		1.000	1.000	0.000
2.000	2.000	0.000		2.000	2.000	0.000		2.000	2.000	0.000
3.000	3.000	0.000		3.000	3.000	0.000		3.000	3.000	0.000
4.000	4.000	0.000		4.000	4.000	0.000		4.000	4.000	0.000
5.000	5.000	0.000		5.000	5.000	0.000		5.000	5.000	0.000
6.000	6.000	0.000		6.000	5.995	-0.005		6.000	6.000	0.000
7.000	7.000	0.000		7.000	6.995	-0.005		7.000	7.000	0.000
8.000	8.000	0.000		8.000	7.990	-0.010		8.000	8.000	0.000
9.000	9.000	0.000		9.000	8.990	-0.010		9.000	9.020	0.020
10.000	10.000	0.000		10.000	9.990	-0.010		10.000	10.000	0.000
11.000	11.000	0.000		11.000	10.985	-0.015		11.000	11.020	0.020
12.000	12.000	0.000		12.000	11.980	-0.020		12.000	12.020	0.020
13.000	13.000	0.000		13.000	12.980	-0.020		13.000	13.020	0.020
14.000	14.000	0.000		14.000	13.980	-0.020		14.000	14.020	0.020
				15.000	14.985	-0.015		15.000	15.020	0.020
				16.000	15.980	-0.020		16.000	16.020	0.020
				17.000	16.980	-0.020		17.000	17.020	0.020
				18.000	17.980	-0.020		18.000	18.020	0.020
				19.000	18.970	-0.030		19.000	19.020	0.020
				20.000	19.965	-0.035		20.000	20.000	0.000
Mean	error	0.000kg		Mean	error	-0.013kg		Mean	error	0.010kg

Table 6 shows three examples (two portable balances and one clinic balance) chosen at random from the balances not already illustrated. They show mean errors of 5, 49, and 30 grams respectively.

Table 6. Three examples of calibration weighings selected at random. The table shows the make and range of the balance and its code number in the study, the mass of the calibration weights used (CW), the weight shown on the balance for each test weight used (RW) and the difference between the two (DEV).

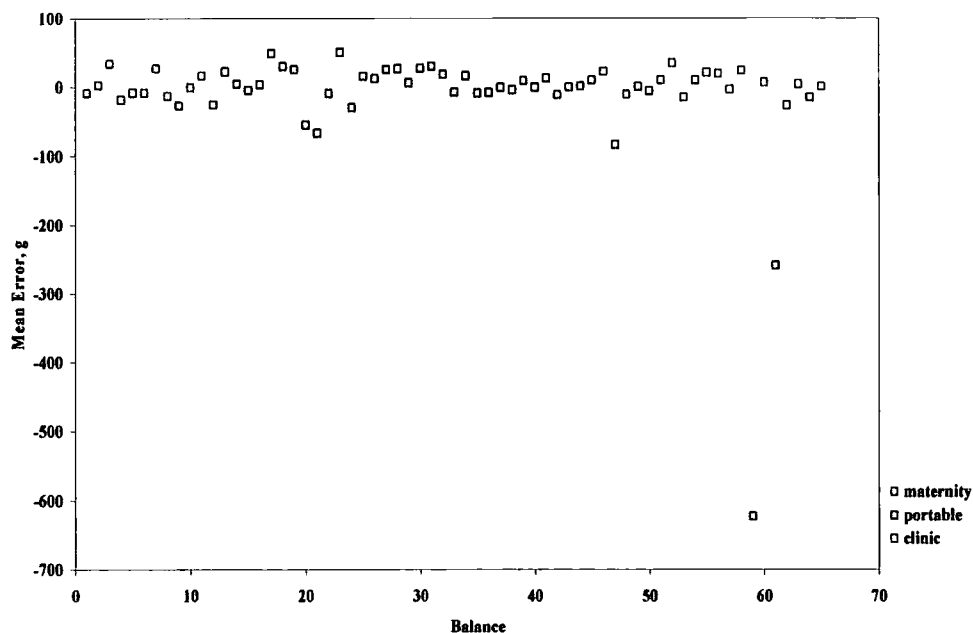
Tanita 1583 max weight 20 kg. Tanita 1583 max weight 20 kg. Tanita 1583 max weight 20 kg.
 Portable balance number 14. Portable balance number 17. Portable balance number 15.

CW	RW	DEV		CW	RW	DEV		CW	RW	DEV
1.000	1.000	0.000		1.000	1.000	0.000		1.000	1.000	0.000
2.000	2.000	0.000		2.000	2.000	0.000		2.000	2.010	0.010
3.000	3.000	0.000		3.000	3.010	0.010		3.000	3.010	0.010
4.000	4.010	0.010		4.000	4.020	0.020		4.000	4.020	0.020
5.000	5.020	0.020		5.000	5.030	0.030		5.000	5.020	0.020
6.000	6.010	0.010		6.000	6.030	0.030		6.000	6.020	0.020
7.000	7.010	0.010		7.000	7.020	0.020		7.000	7.020	0.020
8.000	8.010	0.010		8.000	8.080	0.080		8.000	8.030	0.030
9.000	9.000	0.000		9.000	9.030	0.030		9.000	9.040	0.040
10.000	10.000	0.000		10.000	10.040	0.040		10.000	10.040	0.040
11.000	11.020	0.020		11.000	11.060	0.060		11.000	11.040	0.040
12.000	12.000	0.000		12.000	12.080	0.080		12.000	12.060	0.060
13.000	13.000	0.000		13.000	13.080	0.080		13.000	12.940	-0.060
14.000	14.020	0.020		14.000	14.060	0.060		14.000	14.060	0.060
15.000	15.000	0.000		15.000	15.060	0.060		15.000	15.040	0.040
16.000	16.000	0.000		16.000	16.060	0.060		16.000	15.940	-0.060
17.000	17.000	0.000		17.000	17.100	0.100		17.000	17.080	0.080
18.000	18.000	0.000		18.000	18.080	0.080		18.000	18.080	0.080
19.000	19.000	0.000		19.000	19.100	0.100		19.000	19.060	0.060
20.000	20.000	0.000		20.000	20.100	0.100		20.000	20.100	0.100
Mean	error	0.005kg		Mean	error	0.049kg		Mean	error	0.030kg

For summary analysis the average deviation from the calibration weight was used as a summary statistic for each balance. This simple average was acceptable in this context because in almost every case the balance weighed either systematically light or systematically heavy, so it was not necessary to use absolute (or root mean square) deviations in the summary statistics.

Figure 4 shows the average error for each balance. The figure is organised so that the balances used in maternity units (used in the recording of birth weights) can be distinguished from portable balances used by health visitors and those used in clinics (both of which are used for recording later weights).

Figure 4. Scatter plot showing weight deviations of balances used in maternity units (in green), clinics (in red) and by health visitors (in blue). The y axis shows the weight deviations in grams and the x axis shows the balance number.



Eighty percent of the balances were accurate to within 60g. The mean error was 11g. Two of the electronic balances were found to have major problems; both of these belonged to General Practices and were used for weighing babies in clinics. Balance number 59 (model Seca 835) was checked while the health visitor who worked in that particular baby clinic was on holiday. The balance was found to weigh light with a mean error of -623g. Practice staff had moved the balances to make space for equipment that had been delivered, and had lifted them onto a filing cabinet. On return from annual leave the health visitor was informed and the balance was sent to be re-calibrated. There had been no reported problems with the balances prior to this and the health visitor suspected that the balances had been dropped or mishandled in some way while being moved. Balance number 62 (model Seca 724) weighed light and had a mean error of -259g. This balance was used in a GP baby clinic and the health visitor who worked there had not been aware of any problems. The balance was sent to be recalibrated prior to the start of the study.

Balances used on all three maternity units in the study area were found to have an acceptable level of accuracy. The maternity unit at University Hospital of Durham used two electronic balances; one had a mean error of 17g (balance number 11) and the other a mean error of -25g (balance number 12). The maternity unit at Sunderland Royal Infirmary used three electronic balances which were found to have an acceptable level of accuracy; mean errors were -8g (balance number 1), 3g (balance number 2) and 35g (balance number 3). The maternity unit at the university hospital at Hartlepool used seven electronic balances (numbers 4 - 10); these were all found to have an acceptable level of accuracy, with mean errors ranging from 0g to

28g. The remainder of balances were portable electronic balances used by the health visitors and nursery nurses in the community. These were found to have an acceptable level of accuracy, with mean errors ranging from 0g (balance number 37 and 40) to -66g (balance number 21).

For purposes of comparison wet nappies of 33 infants attending baby clinics were weighed, and the weight of a corresponding dry nappy deducted. The average weight of urine in an infant's nappy was 66g (Table 11). If an infant had a full or empty bladder during weighing, this could therefore affect recorded weight by an average of 66g. Eighty percent of all the balances tested were accurate to within 60g; therefore the mean errors in the accuracy of the balances were comparable to errors from this other source. The mean weight gain over the period from birth to six to eight weeks of all infants in the study was 1.633 kg (SD .648 kg). The mean error from one weighing (11g) is <1% of this difference.

Table 7. Weight of wet and dry nappies of infants of different ages and the weight of the urine in grams.

age in weeks	dry nappy (g)	wet nappy (g)	weight urine (g)
6	40	100	60
18	40	90	50
18	40	130	90
16	40	90	50
7	30	150	120
13	40	120	80
6	40	90	50
5	40	80	40
6	40	120	80
8	30	100	70
8	30	130	100
8	20	60	40
8	30	110	80
8	30	90	60
18	30	80	50
7	30	100	70
9	30	100	70
8	30	90	60
15	30	110	80
20	40	120	80
10	30	80	50
9	30	60	30
17	30	90	60
11	30	100	70
4	20	80	60
9	30	100	70
10	30	80	50
12	40	100	60
6	30	80	50
7	40	110	70
13	30	120	90
4	20	80	60
9	30	100	70
	Mean 32g	Mean 98g	Mean 66g

4.2 Checks on data collected from records

When the data collection was completed, each health visitor's office was visited and every tenth record where the date of birth was between 1st April 2001 and 31st March 2003, in the health visitor's filing cabinet was checked against the database. Infants who were in the study and those who had transferred into the caseload after the data collection period were excluded. One hundred and ninety seven records (10% of the total on the database) were checked against the database. There were four infants with birth weights recorded incorrectly on the database (2.03% of the records checked). Differences between the weight recorded on the database and in the health visiting records were 270 g, 100 g, 50 g, and 13 g. Erroneously recorded birth weights could affect the screening process and result in infants being incorrectly identified as failing to thrive, or infants who were failing to thrive not being identified. One infant had a gestation of 40 weeks and 13 days recorded on the database but as 40 weeks in the health visiting records, this would not have affected the screening process in any way. One infant (0.5% of records checked) had the date of a nine month check recorded incorrectly (one month later than in the health visiting records) and one infant (0.5% of records checked) had a nine month weight recorded as 8.93 kg in the database but as 8.98 kg in the health visiting records (a difference of 50 g), which could affect the screening process and result in false positive and false negative results. One infant had a nine month length recorded as 66.5 cm on the database and as 66 cm in the health visiting records. One infant had a six week head circumference of 37.5 cm recorded in the database and 37 cm in the health visiting records; another was 38 in the database and 37.9 in the records another infant had a

six week head circumference of 37cm recorded in the database and as 37.3cm in the health visiting records. It is important to note, that while accurate recording of head circumference and length measurements is important, it does not affect the screening process as do measurements of weight, gestation (if the infant is pre term) and the date a measurement was taken. Accurate recording of an infant's weight, gestation and dates when weight was measured are necessary for the Access programme to successfully screen infants for slow growth. The numbers and percentages of errors are shown in Table 8.

Table 8. Errors found in the records checked.

	checked	error	% error
Sex	197	0	0.00
DOB	197	0	0.00
Gest age	197	1	0.50
BW	197	4	2.03
Date 6/52 check	197	0	0.00
6 wk weight	197	0	0.00
6 wk length	197	0	0.00
6/52 ofc	197	3	1.52
Date 9/12 check	197	1	0.50
9 m weight	197	1	0.50
9 m length	197	1	0.50
9 month ofc	197	0	0.00
Syndromes	197	0	0.00
Nurse notes	197	0	0.00
Total	197	11	5.58

At the same time, records of all infants recorded on the database as in the study (i.e. as cases or controls) were checked to reduce the risks of errors at the data analysis stage.

Of the 204 infants recorded on the database as being in the study, three had inadvertently been omitted at the recruitment stage due to administrative errors. Of

the remaining 201 infants who had been eligible for recruitment, one had died and seven had transferred out of the area therefore their records were not available for checking. The numbers and percentages of errors for the remaining 193 records are shown in Table 9. Where an error was found it was corrected prior to data analysis. Nine discrepancies were found.

There were six instances where the head circumference at the six to eight week check differed in the health visiting records from the database. The differences ranged from 0.1 cm to 0.5 cm. Two infants had a six to eight week length recorded incorrectly in the database, one as 55.5 cm but recorded in the health visiting records as 56.5 cm, the other as 53.5 cm in the database but 54 cm in the records. One female infant was incorrectly recorded as male in the database, this error was not picked up at the checking stage and the infant was subsequently excluded from the analysis. Incorrect recording of an infant's sex would affect the screening process as thrive index values are standardised for age and sex.

Table 9. Errors found in the records of infants in the study.

	checked	error	% error
Sex	193	1	0.52
DOB	193	0	0.00
Gest age	193	0	0.00
BW	193	0	0.00
Date 6/52 check	193	0	0.00
6 wk weight	193	0	0.00
6 wk length	193	2	1.03
6/52 ofc	193	6	3.10
Date 9/12 check	193	0	0.00
9 m weight	193	0	0.00
9 m length	193	0	0.00
9 month ofc	193	0	0.00
Syndromes	193	0	0.00
Nurse notes	193	0	0.00
Total	193	9	4.66

In total 390 health visiting records were checked against the database. This number included all infants selected for the study (where records were available) and 197 (10%) of the total number of infants in the database. The total number of errors found was 20 (5.12 % of records checked).

4.3 Population screened

The projected number of births in the participating practices over the period 1 April 2001 to 31 March 2003 was 1857. This was based on the number of births in Easington area in the previous year, 1 April 2000 to 31 March 2001. The actual number of births as identified from birth books in the practices was 1966.

Of these 1966 infants, a birth weight was available for 1964. One missing birth weight was due to a family moving out of the area very soon after the infant's birth; no health visitor records were available and no weight was available from the Child

Health Department computer as these were deleted once the child had transferred out of the area. The second missing weight was for a child born in Japan but brought to England within a few days of birth. The health visitor was notified of the birth, recorded it in her register and completed the health visitor records as for an infant born in the area. There was no record of a birth weight, despite the fact that the health visitor had checked the documentation that the mother had brought with her and had asked the parents (who spoke virtually no English). There were 1049 male infants and 917 female infants in the cohort, 1808 of whom were born at term, 157 were born before 37 completed weeks gestation and one had no gestation recorded (the family had moved out of the area and there were no documents or computer records available). There were 60 multiple births and 1906 singleton births. Singletons born at term numbered 1779.

As shown in Table 10, a six week check was recorded for 1892 (96.2%) of the 1966 infants. There were no records of a six to eight week check for the remaining 74. This includes 15 infants who moved out of the area before the six week check was carried out, one who died shortly after birth, and four for whom no records could be traced. There was no explanation or record of a six to eight week check having been carried out for the remaining 54 infants. Although 1892 infants were recorded as having had a six to eight week check, there was no weight recorded for nine of these infants.

Table 10. Number and percentage of infants recorded as having attended clinic for their six to eight week check.

		Number	Percent
Was 6 week check done?	No	74	3.8
	Yes	1892	96.2
Total		1966	100.0

Figure 5 shows the distribution of the infants' ages at the six to eight week check. The mean age when infants had a six to eight week weight recorded was 7.8 weeks. One hundred and sixty infants (8.2%) had a six week weight recorded before six weeks of age. Nineteen infants (0.96%) had a six to eight week weight before four weeks. The health visitor records of these infants were rechecked to eliminate the possibility of erroneously recorded data. It was possible to trace and check 91 records for these infants and all weights and dates were recorded correctly, however 32 of these weights had not been recorded at the six to eight week check. Where no record of a weight at the six to eight week check was available, the research assistant had recorded the first available weight after six weeks of age, from the health visitor's records; or the first weight available after birth if no other weight was available.

Figure 5. Age of infants (in weeks) at the six to eight week check. The age in weeks is shown on the x axis and numbers of infants on the y axis.

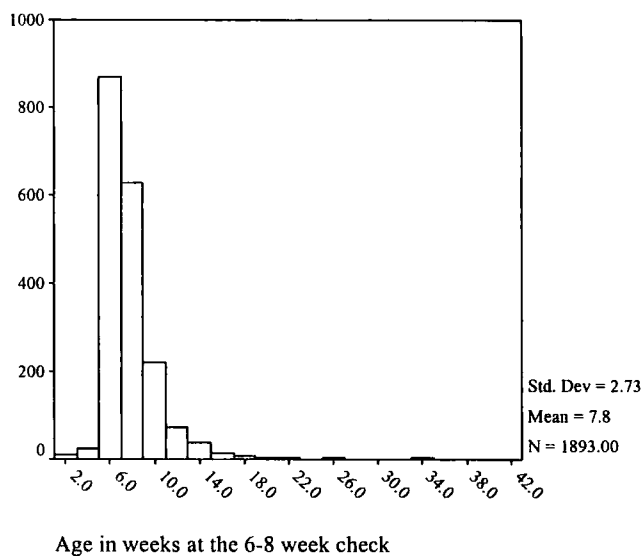


Figure 6 shows ages at which a nine month weight was recorded. No nine month weights were recorded before the infants were six months old; 88.1% were recorded before 10 months and 97% before one year. Where no nine month weight was available the research assistant recorded the nearest weight to nine months from the health visitor's records. Although 1,765 infants were recorded as having had a nine month check, weights were not always available as health visitors occasionally recorded a developmental assessment without weighing or measuring the infants. A weight at nine months was available for 1,632 infants.

Figure 6. Age (in months) nine month check. The age in months is shown on the x axis and numbers of infants on the y axis.

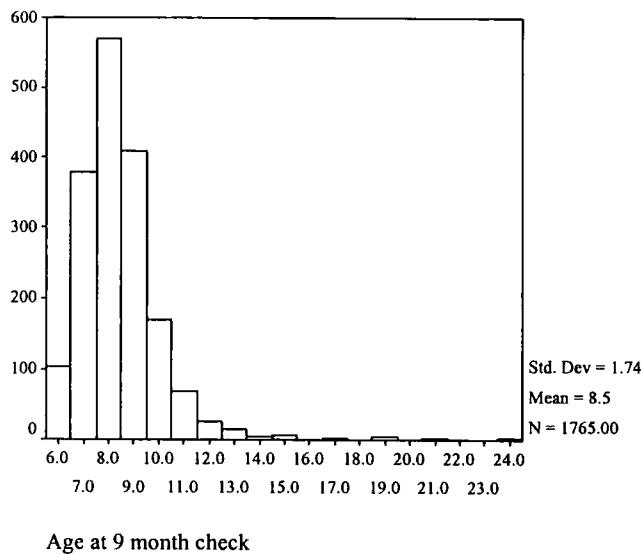


Table 11 shows summary statistics for the raw weights of the infants in kg at birth, at six to eight weeks and at nine months. A birth weight was available for 1964 infants and a weight at six to eight weeks was available for 1883. Although 1892 infants were recorded as having had a six to eight week check, there was no weight recorded for nine of these infants. A nine month check was recorded for 1765 infants and of these a weight was recorded for 1632.

Table 11. Mean, maximum and minimum raw weights of the infants (in kg) at birth, at six to eight weeks and at nine months of age.

	Number	Mean	Std Deviation	Maximum	Minimum
Birthweight, kg	1964	3.32	.59	5.01	.88
Weight (6-8 weeks), kg	1883	4.95	.82	9.22	2.00
Weight (9 month), kg	1632	8.78	1.21	14.96	4.90

The mean differences in weights at birth, at six to eight weeks and at nine months between males and females are summarised in Table 12. Males weighed heavier than females at birth with a mean difference of 0.14kg. Using an independent samples t test, the mean difference in birth weight between males and females was statistically significant ($t = 5.399$, $df = 1962$, $p = 0.000$). Males weighed heavier than females at six to eight weeks with a mean difference of 0.45kg. An independent samples t test was used to compare the mean weight in males and females at six to eight weeks. This was statistically significant ($t = 12.217$, $df = 1881$, $p = 0.000$). Mean differences were compared again at nine months using an independent samples t test. There was a statistically significant difference in weight between males and females at nine months. Males weighed heavier than females with a mean difference of 0.72kg, ($t = 12.520$, $df = 1630$, $p = 0.00$).

Table 12. The mean, SD, maximum and minimum weights of males and females at birth, at six to eight weeks and at nine months.

	Number	Mean	Std. Deviation	Maximum	Minimum
F Birthweight, kg	915	3.25	.57	4.83	1.16
Weight (6-8 weeks), kg	873	4.71	.74	9.22	2.00
Weight (9 month), kg	739	8.39	1.13	12.54	4.90
M Birthweight, kg	1049	3.39	.60	5.01	.88
Weight (6-8 weeks), kg	1010	5.16	.83	9.12	2.69
Weight (9 month), kg	893	9.11	1.17	14.96	5.42

The raw weights were converted within the ACCESS programme to standard deviation scores based on the current UK growth reference (Freeman et al., 1995; Preece et al., 1996). The SD score is sex standardised, so in the SD scores the male and female weights will be the same on average if the sample under study is

comparable to the national reference population on which the growth reference is based.

Table 13 shows a summary of mean SD scores for the cohort at birth, at six to eight weeks and at nine months. A SD score of zero corresponds to average weight for the population that the growth reference was based on (Freeman et al., 1995; Preece et al., 1996). An SD score of -1 is one SD below average. The mean birth weight SD score for the sample was -0.16 , and at the six to eight week check it was -0.05 , which were slightly lower than in the national reference population. At nine months the mean weight SDS was 0.08 , which was above zero, showing a slightly above average weight for age compared to the national reference population.

Table 13. Mean, maximum and minimum weight SD scores at birth, at six to eight weeks and at nine months.

	Number	Mean	Std Deviation	Maximum	Minimum
SDS (Birth)	1964	-.16	1.04	3.03	-3.63
SDS (6-8 weeks)	1880	-.05	.98	3.23	-3.82
SDS (9 months)	1631	.08	1.12	4.20	-5.27

Weight SD scores for males and females at birth, six to eight weeks and nine months are shown in Table 14. Using an independent samples t test for equality of means, differences in SD scores between males and females were calculated. The mean difference between males and females in the birth SD score was -0.025 , which was not statistically significant ($t = -0.53$ with 1962 df, $p = 0.596$). At six to eight weeks the mean difference in weight SD scores between males and females is 0.141 , with males weighing heavier. The difference was statistically significant ($t = 3.11$, $df =$

1878, $p = 0.002$). At nine months of age the mean difference in weight SD scores between males and females was 0.166, again males were heavier, the difference was statistically significant ($t = 2.99$, $df = 1629$, $p = 0.003$).

Table 14. Weight SD scores for males and females showing mean, minimum and maximum weights of males and females at birth, at six to eight weeks and nine months of age.

		Number	Mean	Std Deviation	Maximum	Minimum
F	SDS (Birth)	915	-.14	1.04	3.03	-3.63
	SDS (6-8 weeks)	870	-.12	.93	2.76	-3.75
	SDS (9 month)	738	-.01	1.14	3.78	-5.27
M	SDS (Birth)	1049	-.17	1.04	2.87	-3.36
	SDS (6-8 weeks)	1010	.02	1.02	3.23	-3.82
	SDS (9 month)	893	.16	1.11	4.20	-4.82

Table 15 shows the number of infants for whom thrive index values were calculated and their descriptive statistics. There were 1880 infants who had both a birth weight and a six to eight week weight recorded (95.7% of the whole cohort). A thrive index of zero corresponds to average weight gain. The mean thrive index value from birth to six to eight weeks was -0.12 which is a slightly below average weight gain. Birth to nine months thrive indices were available for 1631 (83% of the cohort); these were also slightly below average mean weight gain (-0.12) showing an average weight gain which was also slightly below that of the national reference population.

Table 15. Mean, maximum and minimum thrive indices (SD scores for weight gain) available at six to eight weeks and nine months.

	Number	Mean	Std Deviation	Maximum	Minimum
Thrive Index (6-8 weeks)	1880	-.12	.73	3.03	-4.43
Thrive Index (9 months)	1631	-.12	1.34	4.74	-6.04

Table 16 shows thrive indices available for males and females at six to eight weeks and at nine months. An independent samples t test was used to calculate the difference between males and females in the rate of weight gain from birth to six to eight weeks. The mean difference in the thrive index between males and females was 0.155. The difference in the rates of weight gain between males and females from birth to six to eight weeks is statistically significant ($t = 4.63$, $df = 1878$, $p = 0.00$).

An independent samples t test was used to calculate the difference between males and females in the rate of weight gain from birth to nine months. The mean difference in the thrive index from birth to nine months between males and females was 0.171.

There was a statistically significant difference in the rate of weight gain between males and females in the population from which the sample was taken, with males gaining weight at a greater rate than females ($t = 3.33$, $df = 1629$, $p = 0.001$). Table 16 shows that the males' weight gain was very close to that of the reference population while that of the females was substantially lower.

Table 16. Mean, minimum and maximum thrive indices (SD scores for weight gain) available for males and females at six to eight weeks and nine months.

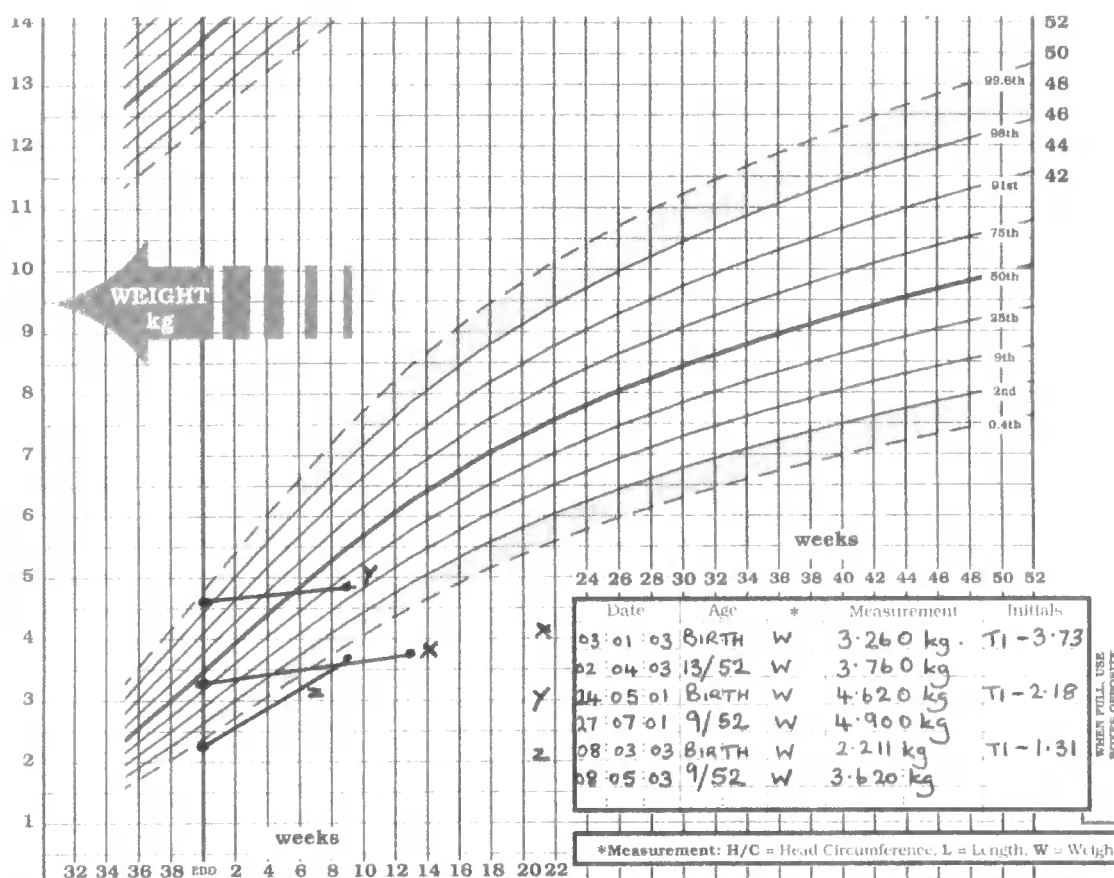
		Number	Mean	Std Deviation	Maximum	Minimum
F	Thrive Index (6-8 weeks)	870	-.20	.68	1.96	-2.71
	Thrive Index (9 months)	738	-.20	1.35	3.71	-6.04
M	Thrive Index (6-8 weeks)	1010	-.05	.76	3.03	-4.43
	Thrive Index (9 months)	893	-.04	1.33	4.74	-5.26

Growth charts used routinely used in clinical work (Cole, 1994; Freeman et al., 1995) are used in Figures 7, 8 and 9. Examples of term male infants with low, average and high thrive indices are plotted on the charts to illustrate what different thrive indices

mean in relation to the charts. Each chart shows three examples; an infant with a low birth weight, an infant with a high birth weight and an infant with an average birth weight.

Beginning with infants with low thrive indices, as shown in Figure 7, infant y was born heavy, weighing 4.620 kg. At nine weeks of age his weight was 4.900 kg, a gain of only 280g. His centile position has fallen from between the 98th and 99.6th centile to between the ninth and 25th centile. His thrive index is -2.18 . Infant x was of average birth weight of 3.260 kg. His weight at 13 weeks was 3.760kg, a weight gain of only 500g. His centile position had fallen from between the 25th and 50th centile to below the 0.4th centile. The thrive index for this infant is -3.73 . Infant z was born with a low birth weight of 2.211 kg which is below the 0.4th centile. Weight at nine weeks of age was 3.620kg, a weight gain of 1.419 kg which remains below the 0.4th centile. This infant's thrive index is -1.31 . Each of the infants in the examples shown were eligible for recruitment to the study, as their thrive indices were below -1.17 . Note that the weight gain of infant z is roughly parallel with the 0.4th centile. But an average weight gain for an infant with this birth weight would show a rise over centiles (regression to the mean).

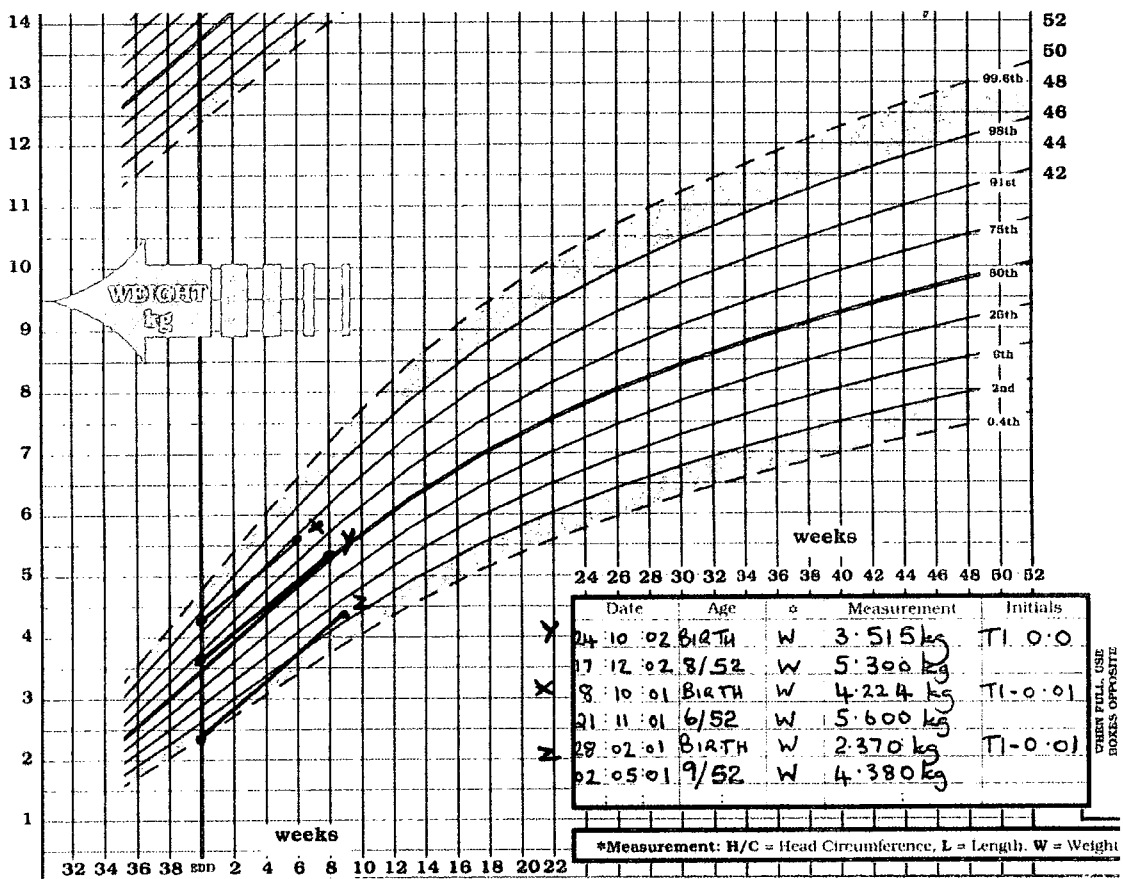
Figure 7. Growth chart showing centile positions and weight trajectories of 3 male infants with low thrive indices.



Turning to infants with average thrive indices, as shown in Figure 8, infant y weighed 3.515 kg at birth which is average birth weight; the centile position is between 50th and the 75th centile. At eight weeks of age he weighed 5.300 kg, a gain of 1.785 kg, which corresponds to the 50th centile. This infant had a thrive index of -0.00 which means that his attained weight at eight weeks corresponds exactly with his predicted weight (based on his birth weight). Infant x was born heavy with a weight of 4.224 kg which is between the 91st and 99.6th centiles. Attained weight at six weeks was 5.600 kg which is between the 75th and 91st centiles. The infants thrive index was -0.01 which means that he was growing as expected (given his birth weight). Infant z was

born with a low birth weight of 2.370 kg, which is on the 0.4th centile. By nine weeks of age he had gained 2.010kg and his centile position had moved up to between the 2nd and the 9th centiles. His Thrive index is 0.01 and his weight gain is as would be expected given his birth weight. Note that average growth for a low birth weight baby involves crossing upwards across centiles (compare with infant z in Figure 7).

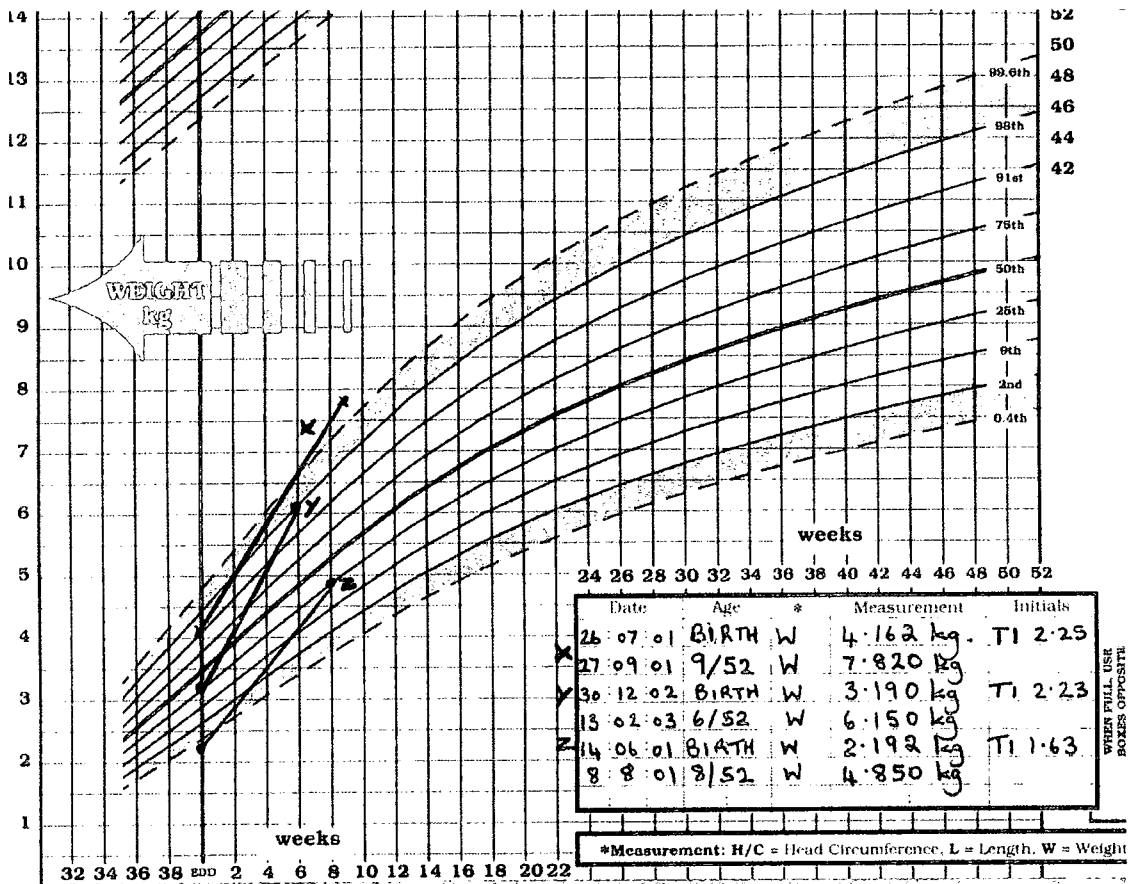
Figure 8. Growth chart showing centile positions and weight trajectories of 3 male infants with average thrive indices.



Finally the three examples shown in Figure 9 are of term male infants with high thrive indices. Infant x was born heavy at 4.162 kg. At nine weeks of age his weight was 7.820 kg, a weight gain of 3.658 kg and with a thrive index of 2.25. His centile

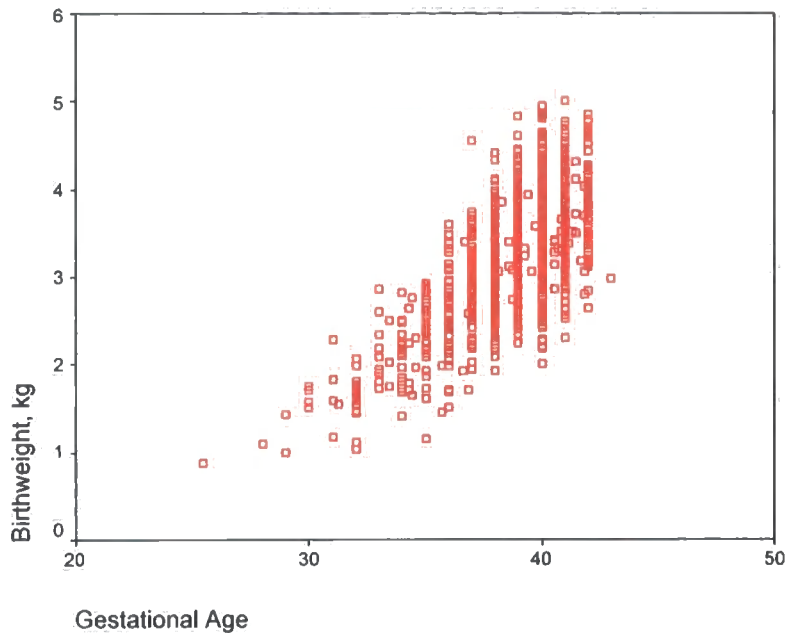
position has moved from the 91st centile at birth to above the 99.6th at nine weeks of age. Infant y was born at an average birth weight of 3.190 kg. By six weeks of age his weight was 6.150, a gain of 2.960 kg and his thrive index was 2.23. His position at birth was on the 25th centile and by six weeks was on the 98th centile. Infant z was a low birth weight baby whose weight increased from 2.192 kg at birth to 4.850 kg by eight weeks of age; a weight gain of 2.758 kg. This infants thrive index was 1.63 and his centile position moved from below the 0.4th at birth, to 25th at eight weeks.

Figure 9. Growth chart showing centile positions and weight trajectories of 3 male infants with high thrive indices.



Although thrive indices were calculated for all infants, the study was restricted to singleton, term infants. In England in the year 2002-03, about 88% of deliveries in occurred between 37 and 41 weeks gestation, and 5% occurred after a longer gestation (i.e. were post term). The remaining 7% were born preterm (Department of Health, 2004). The graph in Figure 10 shows birth weights in kg and gestational ages (in weeks) of infants in the study sample. There were 157 (8%) preterm infants in the cohort from the Easington area, which is 1% higher than the average for England.

Figure 10. Birth weights and gestational ages of infants in the cohort



The majority of singleton deliveries in 2002-03 in England were of babies weighing between 2410 and 4220 grams (5th to 95th percentiles). Fewer than 2% of singleton babies weighed 4500g or more, but about 5% were low (but not very low) birth weight (between 1500 and 2499g) and a further 1% were very low birth weight (under 1500g). Six percent were born at a weight below 2500g (Department of Health, 2004). There were 149 (7.6%) infants with a birth weight below 2500g in the study sample which is 1.6% higher than for England in the year 2002 – 2003.

Of the 1807 term infants in the sample, 41 were of low birth weight, and of the 157 pre term infants 108 were of low birth weight. Table 17 shows a cross-tabulation for pre-maturity and low birth weight. Although the study was restricted to term infants, it did not exclude low birth weight infants born at term, of which there were 41 (2.3%).

Table 17. Percentage of term and preterm infants with low birth weight.

		Term	Preterm	Total
BW > 2.5 kg	Number	1765	50	1815
	Percent	97.7%	31.6%	92.4%
BW < 2.5kg	Number	41	108	149
	Percent	2.3%	68.4%	7.6%
Total	Number	1806	158	1964
	Percent	100.0%	100.0%	100.0%

4.4 Sample selected

Infants with a thrive index of ≤ -1.17 were automatically selected by the Access database. This criterion identifies those infants whose weight gain is in the lowest 5%, assuming that weights in this population correspond to the national growth reference. The number of infants in this category was 121. There were 61 females and 60 males. Multiple births, preterm infants and one infant with no gestational age recorded were excluded, and the remaining term singleton infants with a thrive index of ≤ -1.17 numbered 102; this is 5.2% of the cohort, very close to the expected proportion of 5%. These were the infants who were eligible for recruitment to the study; they comprised 51 females and 51 males. For each of the 102 case infants identified a control was chosen from the same health visitor's caseload. This was the term singleton infant of either sex nearest in birth date to the index infant, either the previous or next infant recorded in the birth register. In total, then, 102 cases and 102 controls were eligible for recruitment to the study.

However, three control infants were inadvertently omitted at the recruitment stage owing to an administrative error. The remaining case and control infants (no = 201)

were invited to take part in the study by their own health visitors if they were still resident in the Easington area. They comprised 97 females, of whom 46 were controls and 51 were cases, and 104 males, of whom 53 were controls and 51 were caes.

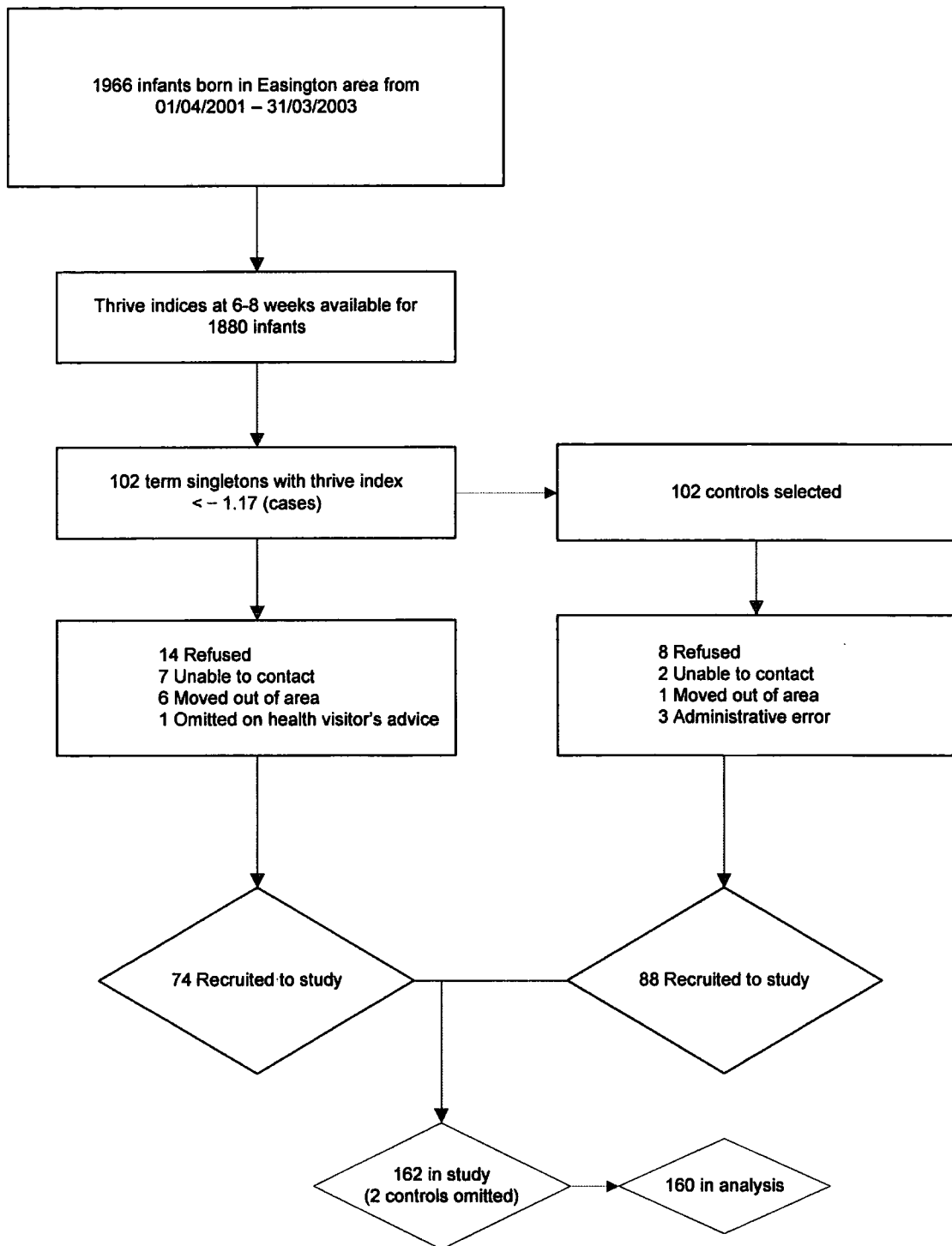
Of the 201 infants eligible for recruitment to the study, it was not possible to recruit all of them. Shown in Table 18 are the reasons for non recruitment. Some parents declined the invitation to participate (N = 22), nine were not contactable, one was on the child protection register and parents were hostile towards health professionals so the family health visitor advised against contacting the family, and seven had transferred out of the area prior to recruitment.

Table 18. Reasons for non recruitment of 39 infants who had been selected for the study.

	Number
Refused	22
Unable to contact	9
Transferred out of area	7
Advised against by family health visitor	1
Total	39

Of the 201 infants eligible for recruitment 88 controls and 74 cases were recruited (81%). Two control group infants were subsequently excluded from the analysis. One was incorrectly recorded as a male but was a female and one had no six week thrive index. In summary, Figure 11 shows a flowchart of the recruitment process.

Figure 11. Flowchart of recruitment process



4.5 Early and late cases

Over the period birth to nine months 61 children of the 1434 for whom data were available met the criterion for failure to thrive (4.3%). As shown in Table 19, out of those infants who were not cases at six weeks, 1300 (97.2%) were not cases at nine months, and 38 (2.8%) were cases at nine months. Of those infants who were cases at six weeks, 73 (76%) were not cases at nine months and 23 (24%) were cases at nine months. If an infant was a case at six weeks, it was eight to nine times more likely to be a case at nine months than if it had not been a case at six weeks.

Table 19. Cases at 6 weeks and 9 months.

			Case at 9 months		Total
			No	Yes	
Case at 6 weeks	No	Number	1300	100	1338
		% within case 6w	97.2%	2.8%	100.0%
		% within case 9m	94.7%	62.3%	93.3%
	Yes	Number	73	23	96
		% within case 6w	76.0%	24.0%	100.0%
		% within case 9m	5.3%	37.7%	6.7%
Total	Number	1373	61	1434	
	% within case 6w	95.7%	4.3%	100.0%	
	% within case 9m	100.0%	100.0%	100.0%	

4.6 Case-control comparisons

Demographic and educational information

The cases and controls were not matched; the study was designed so that control for relevant variables used regression methods. Demographic data from the questionnaires could therefore be analysed to determine characteristics of the families of case group infants and those of controls, which is not of course meaningful if the cases and controls were matched on these variables. As shown in figure 11, the total sample size was 160; minor discrepancies were due to small amounts of missing data on individual questionnaires.

The mean age of the mothers taking part in the study was 27.7 years with a range from 16 to 47 years. Mothers of case infants had a mean age of 28.0 years (SD 5.7), and mothers of controls had a mean age of 27.6 years (SD 6.05). The difference (-0.4 years) was not statistically significant ($t = 0.45$, $df = 158$, $p = 0.650$). Twelve (16.2%) of case group mothers lived alone compared to seven (8.1%) of control group mothers. The difference is not statistically significant ($\chi^2 = 2.479$, $df = 1$, $p = 0.115$).

Information about indicators of affluence was examined. The housing tenure data of families of case group infants and controls was cross tabulated (see Table 20).

Slightly more of the case group families owned their own homes, 59.5% compared with 51.2% of control group infants. There was no significant difference between the groups in home ownership ($\chi^2 = 1.106$, $df = 1$, $p = 0.29$).

Table 20. Housing tenure of families of cases and controls.

			Control	Case	Total
Home owner?	Yes	Number	44	44	88
		Percent	51.2%	59.5%	55.0%
	No	Number	42	30	72
		Percent	48.8%	40.5%	45.0%
Total	Number		86	74	160
	Percent		100.0%	100.0%	100.0%

Table 21 shows the differences in car ownership between families of case and control infants. No statistically significant differences were found between the groups in car ownership ($\chi^2 = 0.171$, $df = 2$, $p = 0.918$).

Table 21. Car ownership of case and control group families.

			Control	Case	Total
Do you own a car?	No	Number	27	22	49
		Percent	31.8%	29.7%	30.8%
	Yes - one	Number	42	39	81
		Percent	49.4%	52.7%	50.9%
	Yes - more than 1	Number	16	13	29
		Percent	18.8%	17.6%	18.2%
Total	Number		85	74	159
	Percent		100.0%	100.0%	100.0%

As shown in Table 22, data from the questionnaires showed that 117 of the families taking part in the study reported a wage earner living in the house hold; this is 73.1% of the sample. Fifty four mothers of case group infants (73.0 %) reported a wage earner in the house hold compared with 63 (73.3 %) of control group mothers. The

difference between the groups was not statistically significant ($\chi^2 = 0.002$, $df = 1$, $p = 0.968$).

Table 22. Number of families with a wage earner.

			Control	Case	Total
Does anyone in the household earn a wage?	Yes	Number	63	54	117
		Percent	73.3%	73.0%	73.1%
	No	Number	23	20	43
		Percent	26.7%	27.0%	26.9%
Total	Number		86	74	160
	Percent		100.0%	100.0%	100.0%

As shown in Table 23, 58 (79.5 %) families of case group infants had a working telephone installed in their home compared to 60 (69.8 %) of controls. This difference was not statistically significant ($\chi^2 = 1.94$, $df = 1$ and $p = 0.16$).

Table 23. Number of families with an installed working telephone.

			Control	Case	Total
Is there a working installed telephone in your house?	Yes	Number	60	58	118
		Percent	69.8%	79.5%	74.2%
	No	Number	26	15	41
		Percent	30.2%	20.5%	25.8%
Total	Number		86	73	159
	Percent		100.0%	100.0%	100.0%

As shown in Table 24, no significant difference was found between case and control families in mobile phone ownership; with 67 (90.5%) of case group families having a mobile phone, compared with 80 (93.0%) of control families ($\chi^2 = 0.33$, $df = 1$, $p = 0.57$).

Table 24. Number of families who have a mobile phone.

			Control	Case	Total
Do you have a mobile phone?	Yes	Number	80	67	147
		Percent	93.0%	90.5%	91.9%
	No	Number	6	7	13
		Percent	7.0%	9.5%	8.1%
Total	Number	86	74	160	
	Percent	100.0%	100.0%	100.0%	

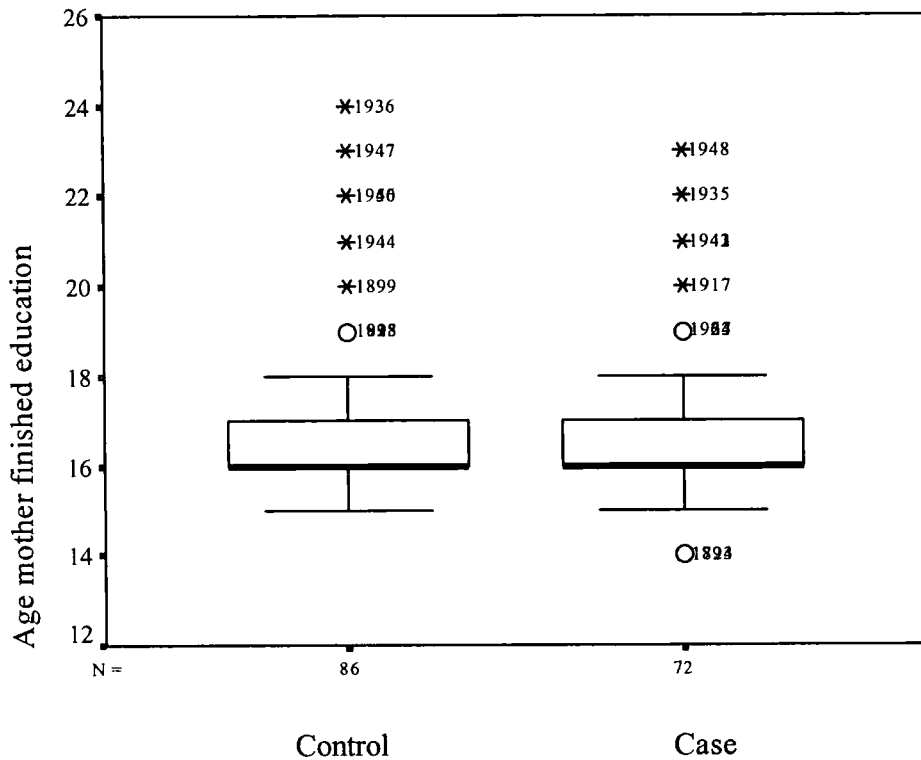
The educational achievements of the mothers and the age when mothers had finished full time education were compared. As shown in Table 25, 59 (68.6%) of control group mothers had finished their education by 16 years of age compared with 44 (61.1%) of case group mothers. Seventeen (19.8%) of controls and 18 (25%) of cases finished their education at 17 to 18 years, and 10 (11.6%) of controls and 10 (13.9%) of cases finished their education at 19 years or later. This difference was not statistically significant ($\chi^2 = 0.98$, $df = 2$, $p = 0.61$).

Table 25. Age at which mothers finished full time education.

			Control	Case	Total
Age finished full time education	16.00	Number	59	44	103
		Percent	68.6%	61.1%	63.6%
	18.00	Number	17	18	35
		Percent	19.8%	25.0%	21.6%
	19+	Number	10	10	20
		Percent	11.6%	13.9%	12.3%
Total	Number	86	72	162	
	Percent	100.0%	100.0%	100.0%	

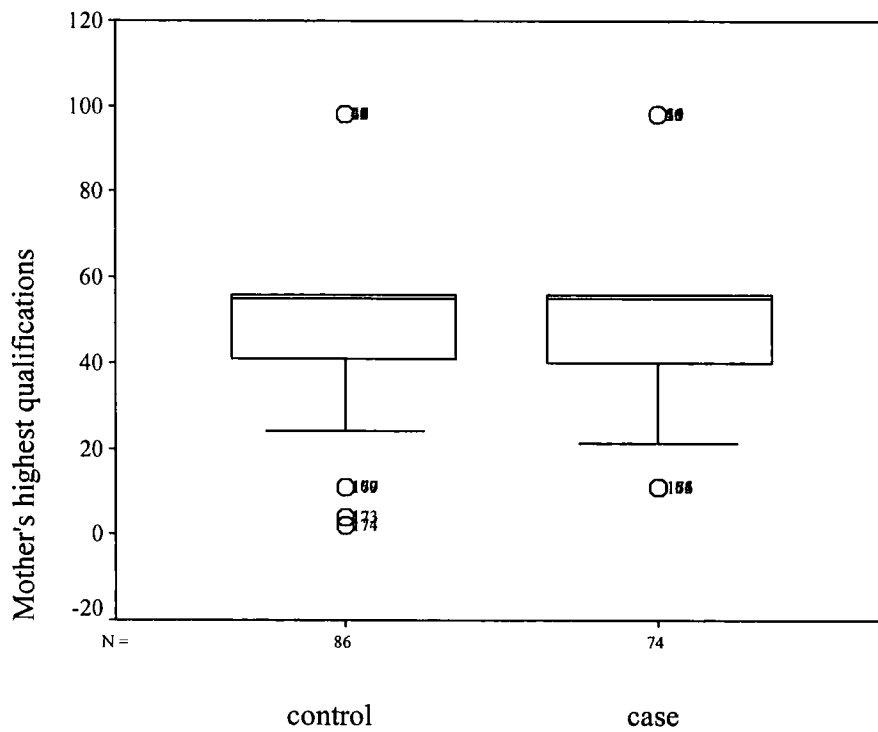
The box plot in Figure 12 shows the complete distribution of ages when mothers of case and control group infants finished full time education. The median is the same (16).

Figure 12. Box plot showing age when mothers of cases and controls finished full time education.



Years in education is not the same as educational attainment, and Figure 12 shows the median educational attainment (on the HESA scale). There was no difference in the median between the two groups of mothers. The median educational achievement of both groups was GCSE O level (HESA code 55).

Figure 13. Box plot showing levels of educational achievement of case and control group mothers.



Using a Mann-Whitney test, the difference in ranks between the groups was not statistically significant ($U = 2817$, $p = 0.19$).

Mothers and cigarette smoking.

Mothers of case and control group infants were asked if they smoked cigarettes (Table 26). There was no significant difference between the groups, with 43.0% of control group mothers and 41.9 % of case group mothers smoking ($\chi^2 = 0.02$, $df = 1$, $p = 1.0$).

Table 26. Number of mothers who smoked.

		Do you smoke at all?		Total
		Yes	No	
Control	Number	37	49	86
	Percent	43.0%	57.0%	100.0%
Case	Number	31	43	74
	Percent	41.9%	58.1%	100.0%
Total	Number	68	92	160
	Percent	42.5%	57.5%	100.0%

Using eight indicators of affluence and three of education, these results show no significant difference between case and control families. The families were, indeed, remarkably similar.

Heights of mothers and fathers

Mean parental heights are shown in Table 27. The mean height of mothers of control group infants was 163.23 cm (SD 5.34); and of mothers of case group infants was 162.11 cm (SD 6.09). The mean difference between the groups was 1.11 cm. The difference in heights was not statistically significant ($t = 1.23$, $df = 158$ and $p = 0.22$). Fathers of control group infants had a mean height (reported by the mother) of 178.48 (SD 7.58) and fathers of case group infants had a mean height of 176.41 cm (SD 8.15). The difference in height between the groups was 2.07 cm and was not statistically significant ($t = 1.632$, $df = 152$, $p = 0.11$).

Table 27. Mean parental heights.

		Number	Mean	Std. Deviation
Mother's height (cm)	Control	86	163.2	5.34
	Case	74	162.1	6.09
Father's height (cm)	Control	84	178.5	7.58
	Case	70	176.4	8.16

Figures 14 and 15 show box plots of heights (in cms) of mothers and of fathers.

There was no difference in the median heights of the mothers, 162.78 cms for mothers of controls and 162.50 cms for mothers of cases. The median reported height (in cms) was 180.00 cms for fathers of controls and 176.50 cms for cases.

Figure 14. Boxplot showing heights (in cms) of mothers.

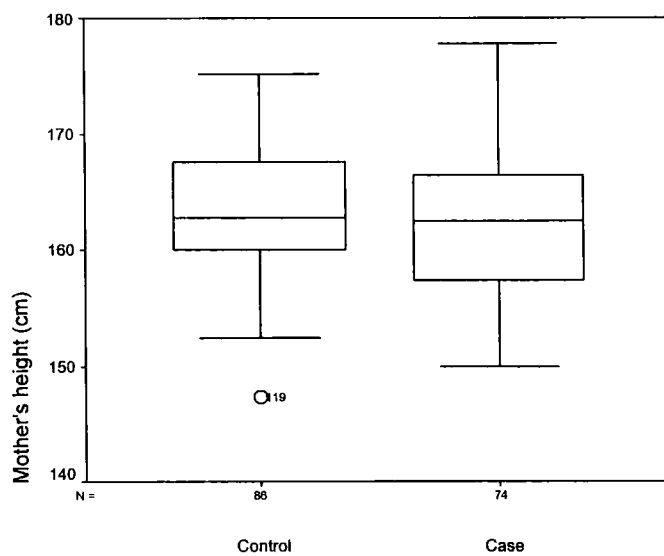
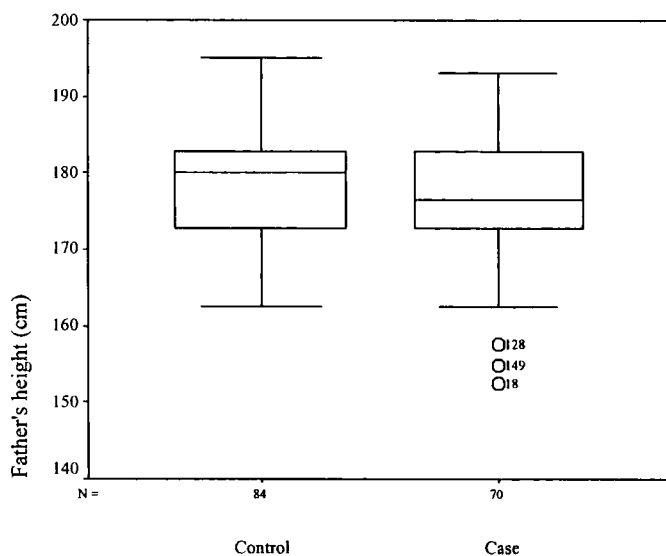


Figure 15. Boxplot showing heights (in cms) of fathers.



Feeding behaviour

Mothers were asked if they had ever breast fed their infant, even once. As shown in Table 28, thirty nine (42.9%) mothers of controls had breast fed their infants compared with 41 (56.2%) of mothers of cases. There was no statistically significant difference between cases and controls ($\chi^2 = 1.85$, $df = 1$, $p = 0.17$).

Table 28. Numbers and percentages of case and control group infants who had ever been breast fed.

		Have you ever breast fed this baby even once?		Total
		Yes	No	
Control	Number	39	47	86
	Percent	45.3%	54.7%	100.0%
Case	Number	41	32	73
	Percent	56.2%	43.8%	100.0%
Total	Number	80	79	159
	Percent	50.3%	49.7%	100.0%

As shown in Table 29, of the 39 control group infants who had ever been breast fed, 12 (31.6% of those who had initially breast fed) were still breast feeding at the time of the first interview. Only nine (20.9%) of the 43 case group infants who had been breast fed initially were still breast feeding at the time of the first interview. The difference between cases and controls was not statistically significant ($\chi^2 = 1.9$, $df = 1$, $p = 0.28$).

Table 29. Numbers and percentages of case and control group infants who were still breast feeding at the time of the first interview.

		Are you still breast feeding your baby at all?		Total
		Yes	No	
Control	Number	12	26	38
	Percent	31.6%	68.4%	100.0%
Case	Number	9	34	43
	Percent	20.9%	79.1%	100.0%
Total	Number	21	60	81
	Percent	25.9%	74.1%	100.0%

The feeding behaviours of case and control groups were compared. Mothers were asked if their infant had shown any slow feeding in the first two months, with a choice of responses: often, sometimes or never. Table 30 shows the responses for the cases and controls. Twenty one (28.4%) of the case group infants were reported to have had slow feeding often in the first two months compared with three (3.5%) controls. The difference between the groups is highly significant ($\chi^2 = 20.72$, $df = 2$, $p = 0.00$). The answers to the question 'Did your baby show any slow feeding in the first two months?' are on an ordered scale and for the linear association $\chi^2 = 20.18$, $df = 1$, $p = 0.00$.

Table 30. Numbers and percentages of case and control group infants reported to have shown slow feeding in the first 2 months.

		Did your baby show any slow feeding in first 2 months?			Total
		Yes often	Yes sometimes	No never	
Control	Number	3	7	76	86
	Percent	3.5%	8.1%	88.4%	100.0%
Case	Number	21	8	45	74
	Percent	28.4%	10.8%	60.8%	100.0%
Total	Number	24	15	121	160
	Percent	15.0%	9.4%	75.6%	100.0%

Mothers were asked if their infants had showed any weak sucking in the first two months. As shown in Table 31, nine (12.2%) of the cases were reported to have weak sucking often in the first two months but none of the controls (0.0%). Six cases (8.1%) had week sucking sometimes, compared with one (1.2%) control. The groups

were significantly different ($\chi^2 = 16.46$, $df = 2$, $p = 0.00$). The answers to the question ‘Did your baby show any weak sucking in the first two months?’ are also on an ordered scale and for the linear association $\chi^2 = 15.81$, $df = 1$, $p = 0.00$.

Table 31. Numbers and percentages of case and control group infants reported to have weak sucking in the first 2 months.

		Did your baby show any weak sucking in the first 2 months?			Total
		Yes often	Yes sometimes	No never	
Control	Number		1	85	86
	Percent		1.2%	98.8%	100.0%
Case	Number	9	6	59	74
	Percent	12.2%	8.1%	79.7%	100.0%
Total	Number	9	7	144	160
	Percent	5.6%	4.4%	90.0%	100.0%

Mothers were asked if their infant had taken only small quantities of milk in the first two months, with a choice of responses: often, sometimes or never. From Table 32 we can see that eight (9.3%) of controls group mothers reported that their infants often took only small quantities of milk in the first two months compared with 21 (28.4%) of case group mothers. Twenty four (27.9%) of control group mothers reported that their infants sometimes took only small quantities of milk in the first two months, compared with 16 (21.6%) of cases. The difference was statistically significant ($\chi^2 = 9.76$, $df = 2$, $p = 0.01$). The answers to the question ‘Did your baby take only small quantities at each feed in the first two months?’ are on an ordered scale and for the linear association $\chi^2 = 6.69$, $df = 1$, $p = 0.01$.

Table 32. Numbers and percentages of case and control group infants reported to be taking small quantities of milk in the first 2 months.

		Did your baby take only small quantities at each feed in first 2 months?			Total
		Yes often	Yes sometimes	No never	
Control	Number	8	24	54	86
	Percent	9.3%	27.9%	62.8%	100.0%
Case	Number	21	16	37	74
	Percent	28.4%	21.6%	50.0%	100.0%
Total	Number	29	40	91	160
	Percent	18.1%	25.0%	56.9%	100.0%

Mothers were asked if their infant had shown slow feeding *after* two months of age, with a choice of responses; often, sometimes or never. From Table 33 we can see that 12 (16.2%) mothers of case infants reported that slow feeding occurred often, compared with only one (1.2%) control. Six of the case group mothers reported it sometimes (8.1%), compared with four of the control mothers (4.7%). The difference in those with slow feeding after two months between the cases and controls was statistically significant ($\chi^2 = 15.01$, $df = 2$, $p = 0.001$). The answers to the question 'After two months did your baby show any slow feeding?' are on an ordered scale and for the linear association $\chi^2 = 13.21$, $df = 1$, $p = 0.00$.

Table 33. Numbers and percentages of case and control group infants reported to have shown slow feeding after 2 months.

		After 2 months did your baby show any slow feeding?			Total
		Yes often	Yes sometimes	No never	
Control	Number	1	4	81	86
	Percent	1.2%	4.7%	94.2%	100.0%
Case	Number	12	6	56	74
	Percent	16.2%	8.1%	75.7%	100.0%
Total	Number	13	10	137	160
	Percent	8.1%	6.3%	85.6%	100.0%

Mothers were asked if their infants had ever refused breast milk after two months of age. As shown in Table 34, 19 infants in the control group were still breast feeding after two months. None of these had ever refused breast milk. There were 22 case group infants who were breast feeding after two months; of these one was reported to have refused breast milk often, and five to have refused it sometimes. Restricting the analysis to infants offered breast milk, and pooling the 'yes often' and 'yes sometimes' response, the difference was statistically significant ($\chi^2 = 6.07$, $df = 1$, $p = 0.023$).

Table 34. Numbers and percentages of case and control group infants who had refused to take breast milk after 2 months.

		Did baby ever refuse to take breast milk?				Total
		Yes often	Yes sometimes	No never	Never offered	
Control	Number			19	67	86
	Percent			22.1%	77.9%	100.0%
Case	Number	1	5	16	52	74
	Percent	1.4%	6.8%	21.6%	70.3%	100.0%
Total	Number	1	5	35	119	160
	Percent	.6%	3.1%	21.9%	74.4%	100.0%

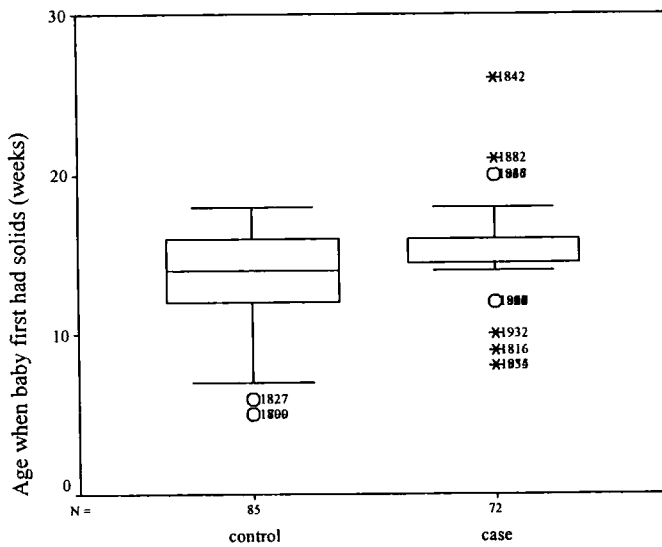
Table 35 shows that six case group infants (8.1%) were reported to have refused other milk often compared with one control group infant (1.2%). Fifteen (20.3%) of case group infants had refused other milk sometimes compared with 20 (23.3%) of control group infants. Restricting the analysis to infants offered other milk and pooling the 'yes often' and 'yes sometimes' responses, the difference between the groups was not, however, statistically significant ($\chi^2 = .245$, $df = 1$, $p = 0.717$).

Table 35. Numbers and percentages of case and control group infants who refused to take other milk after 2 months.

		Did baby ever refuse to take other milk?				Total
		Yes often	Yes sometimes	No never	Never offered	
Control	Number	1	20	61	4	86
	Percent	1.2%	23.3%	70.9%	4.7%	100.0%
Case	Number	6	15	51	2	74
	Percent	8.1%	20.3%	68.9%	2.7%	100.0%
Total	Number	7	35	112	6	160
	Percent	4.4%	21.9%	70.0%	3.8%	100.0%

Figure 16 shows the age when solids were introduced to cases and controls. Control infants first had solids at a mean age of 13.68 (SD 2.77) weeks and cases at a mean age of 15.39 (SD 2.80) weeks. The mean difference in age between the groups that solids were first introduced was 1.71 weeks. Using an independent samples t-test, the difference was statistically significant ($t = 3.82$, $df = 155$, $p = 0.00$).

Figure 16. Box plot showing age in weeks of cases and controls when solids were introduced.



As shown in Table 36, two case group infants (2.7%) were reported to have refused solids 'often' compared with one control group infant (1.2%). Twenty four (32.4%) of case group infants had refused solids 'sometimes' compared with 18 (20.9%) of control group infants. After pooling the 'yes sometimes' and 'yes often' responses, and excluding 'never offered' from the analysis, the difference between the groups was not statistically significant, ($\chi^2 = 3.79$, $df = 1$, $p = 0.05$).

Table 36. Numbers and percentages of infants who had refused to take solids after 2 months.

		Did baby ever refuse to take solids?				Total
		Yes often	Yes sometimes	No never	Never offered	
Control	Number	1	18	67		86
	Percent	1.2%	20.9%	77.9%		100.0%
Case	Number	2	24	46	2	74
	Percent	2.7%	32.4%	62.2%	2.7%	100.0%
Total	Number	3	42	113	2	160
	Percent	1.9%	26.3%	70.6%	1.3%	100.0%

Table 37 shows that 21 (28.4%) mothers of case group infants were reported to have had difficulties feeding their babies 'some of the time' but only eight (9.3%) mothers of control group infants. Six (8.1%) of mothers of case infants were reported to have had 'great difficulties' feeding their infants, but none of the mothers of control group infants (0.0%). When the two groups were compared, the difference between the case and control infants was statistically significant, with a higher percentage of mothers of case infants reporting 'great difficulty' feeding their baby, or difficulty in feeding 'some of the time' ($\chi^2 = 18.72$, $df = 2$, $p = 0.0$). The answers to the question 'Did you feel that you ever had difficulties feeding your baby?' are on an ordered scale and for the linear association $\chi^2 = 18.53$, $df = 1$, $p = 0.00$.

Table 37. Numbers and percentages of mothers of case and control group babies who reported having had difficulty in feeding their babies.

		Did you feel that you ever had difficulties feeding your baby?			Total
		Yes great difficulty	Yes, some of the time	No, not at all	
Control	Number		8	78	86
	Percent		9.3%	90.7%	100.0%
Case	Number	6	21	47	74
	Percent	8.1%	28.4%	63.5%	100.0%
Total	Number	6	29	125	160
	Percent	3.8%	18.1%	78.1%	100.0%

Sleeping behaviour

The reported sleeping behaviour of case and control infants was also examined and compared. Mothers were asked about their infants sleeping over the previous week. As shown in Table 38, 30 (40.5%) of case infants were reported to never have woken at night compared to 36 (41.9%) of controls. Nineteen (25.7%) of cases were reported to have woken more than once in the night compared to 17 (19.8%) of controls. Over all categories, the difference between the groups was not statistically significant ($\chi^2 = 3.07$, $df = 4$, $p = 0.54$). The categories (answers to the question 'how often has your baby woken in the last week?') are on an ordered scale and for the linear association $\chi^2 = 0.66$, $df = 1$, $p = 0.41$.

Table 38. How often baby reported to have woken at night in last week.

		How often baby has woken in last week					Total
		never	occasionally	most nights	once every night	more than once a night	
Control	Number	36	19	1	13	17	86
	Percent	41.9%	22.1%	1.2%	15.1%	19.8%	100.0%
Case	Number	30	11	3	11	19	74
	Percent	40.5%	14.9%	4.1%	14.9%	25.7%	100.0%
Total	Number	66	30	4	24	36	160
	Percent	41.3%	18.8%	2.5%	15.0%	22.5%	100.0%

Mothers were asked if they ever woke their babies to feed them during the night. As shown in Table 39, three (4.1%) of mothers of case infants said that they usually woke their baby to feed them during the night but none of the mothers of control group infants. Seven (9.5%) of mothers of case infants said they ‘sometimes’ woke their baby for a feed during the night compared with three (3.5%) of mothers of control infants with. Sixty four (86.5%) of mothers of case infants said that they ‘never’ woke their baby for a feed during the night compared to 83 (96.5%) of mothers of control infants. There was a statistically significant difference between the groups ($\chi^2 = 6.19$, $df = 2$, $p = 0.04$). The categories (answers to the question ‘Do you ever wake your baby for a feed during the night?’) are also on an ordered scale and for the linear association, $\chi^2 = 6.145$, $df = 1$, $p = 0.01$.

Table 39. How often mothers woke their babies in the night for a feed.

		Do you ever wake your baby for a feed during the night?			Total
		Yes usually	Yes sometimes	No never	
Control	Number		3	83	86
	Percent		3.5%	96.5%	100.0%
Case	Number	3	7	64	74
	Percent	4.1%	9.5%	86.5%	100.0%
Total	Number	3	10	147	160
	Percent	1.9%	6.3%	91.9%	100.0%

Mothers were also asked if they ever woke their babies to feed them during the day. As shown in Table 40, none of the mothers of control group infants or mothers of case infants said that they ‘usually’ woke their baby to feed during the day. Fourteen (18.9%) of mothers of control infants said they ‘sometimes’ woke their baby for a feed during the day compared with 11 (12.8%) of controls. There was no statistically significant difference between the groups ($\chi^2 = 1.13$, $df = 1$, $p = 0.28$).

Table 40. How often mothers wake their infant during the day for a feed.

		Do you ever wake your baby for a feed during the day?		Total
		Yes sometimes	No never	
Control	Number	11	75	86
	Percent	12.8%	87.2%	100.0%
Case	Number	14	60	74
	Percent	18.9%	81.1%	100.0%
Total	Number	25	135	160
	Percent	15.6%	84.4%	100.0%

Mothers' perceptions of their own and their infant's health

Mothers were asked how they would describe their baby's health, with a choice of the responses: 'good', 'average' or 'not very good'. Table 41 shows that 85 (98.8%) of control group mothers described their infants health as 'good' compared with 66 (89.2%) of case group mothers. Only one (1.2%) mother of a control group infant described her infant's health as 'average' or 'not very good' compared with 8 (10.8%) of case group mothers. This difference is statistically significant ($\chi^2 = 7.1$, $df = 2$, $p = 0.01$). For the linear association the $\chi^2 = 6.77$, $df = 1$, $p = 0.01$.

Table 41. How mothers described their infant's health

		How would you describe your baby's health?			Total
		Good	Average	Not very good	
Control	Number	85	1		86
	Percent	98.8%	1.2%		100.0%
Case	Number	66	6	2	74
	Percent	89.2%	8.1%	2.7%	100.0%
Total	Number	151	7	2	160
	Percent	94.4%	4.4%	1.3%	100.0%

Mothers were asked how they would describe their own health, also with a choice of responses: 'good', 'average' or 'not very good'. As shown in Table 42 (80.2%) of control group mothers described their own health as 'good' compared with 48 (64.9%) of case group mothers. Seventeen (19.7%) control group mothers described their own health as 'average' or 'not very good' compared with 26 (35.2%) of case group mothers. This difference is statistically significant ($\chi^2 = 5.18$, $df = 2$, $p = 0.03$). For the linear association $\chi^2 = 5.12$, $df = 1$, $p = 0.02$.

Table 42. How mothers described their own health.

		How would you describe your own health?			Total
		Good	Average	Not very good	
Control	Number	69	15	2	86
	Percent	80.2%	17.4%	2.3%	100.0%
Case	Number	48	21	5	74
	Percent	64.9%	28.4%	6.8%	100.0%
Total	Number	117	36	7	160
	Percent	73.1%	22.5%	4.4%	100.0%

Developmental scales

Apart from poor growth, the most important consequence of slow weight gain in infancy is developmental delay. As the aim of this study was to investigate the possibility of screening for failure to thrive at the six to eight week check, a key part of the study was to examine the development of the infants identified as failing to thrive at six to eight weeks.

The infants and their controls were tested at four months and again at nine months using the Bayley Scales of Infant Development, (2nd ed). The box plots shown in figures 17 and 18 show Mental Development Index (MDI) scores and Psychomotor Development Index (PDI) scores of infants at four months of age.

Figure 17. Bayley Mental Development Index scores at 4 months for cases and controls.

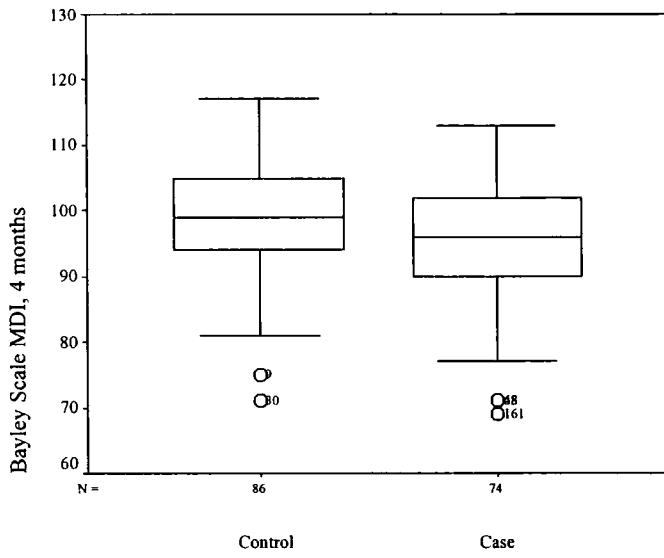
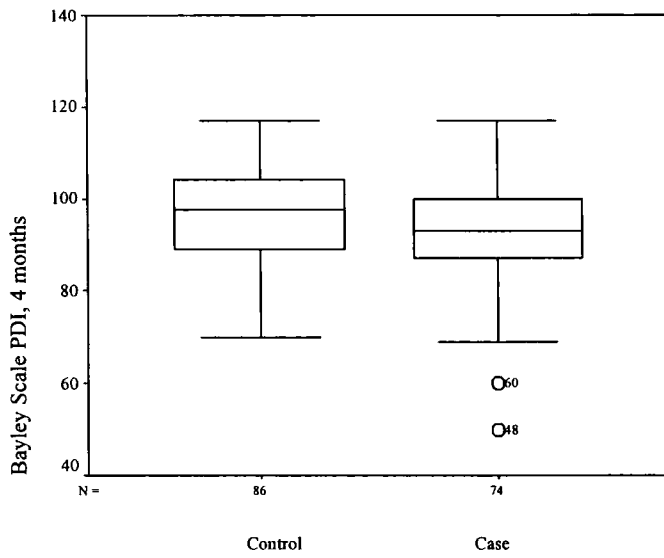


Figure 18. Bayley Psychomotor Development Index scores at 4 months for cases and controls.



MDI and PDI scores of case and control infants were compared and are shown in Table 43. There was a mean difference between cases and controls in MDI scores at four months of 3.52 which was statistically significant ($t = 2.37$, $df = 158$, $p = 0.02$), and in PDI scores at four months of 3.59 ($t = 2.12$, $df = 158$, $p = 0.04$).

Table 43. Bayley Scale scores of cases and controls at 4 months.

		Number	Mean	Std. Deviation
Bayley Psychomotor Development Index (4 months)	Control	86	96.34	10.12
	Case	74	92.74	11.32
Bayley Mental Development Index (4 months)	Control	86	98.49	8.90
	Case	74	94.97	9.86

This analysis included three infants with a major organic disease; one control infant with phenylketonuria, one case infant with Down's syndrome and one case infant with myotonic dystrophy. Bayley Scale scores were re-analysed after these infants were excluded and are shown in Table 44. There was a mean difference between cases and controls in MDI scores at four months of 3.17 which was statistically significant ($t = 2.19$, $df = 155$, $p = 0.03$). The mean difference in PDI scores at four months between cases and controls was 2.92 which was not statistically significant ($t = 1.82$, $df = 155$, $p = 0.07$).

Table 44. Bayley scale scores of cases and controls at 4 months (excluding three infants with organic disease).

		Number	Mean	Std. Deviation
Bayley Psychomotor Development Index (4 months)	Control	85	96.52	10.04
	Case	72	93.60	10.02
Bayley Mental Development Index (4 months)	Control	85	98.69	8.74
	Case	72	95.53	9.38

The box plots shown in figures 19 and 20 show Mental Development Index (MDI) scores and Psychomotor Development Index (PDI) scores of infants at nine months of age.

Figure 19. Bayley Mental Development Index scores at 9 months for cases and controls.

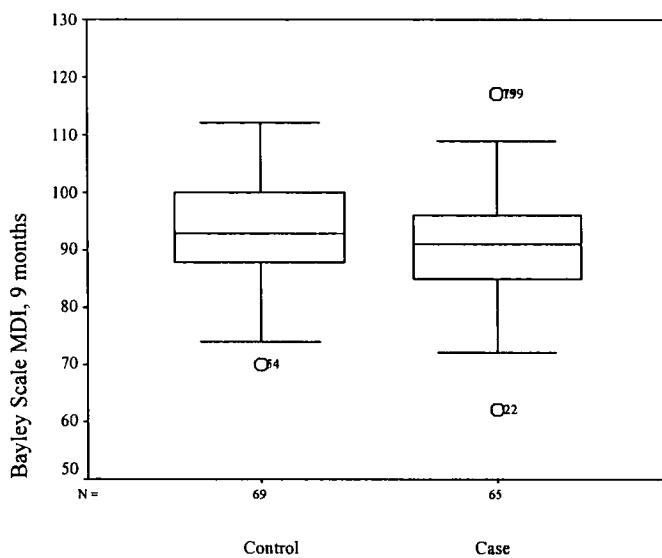
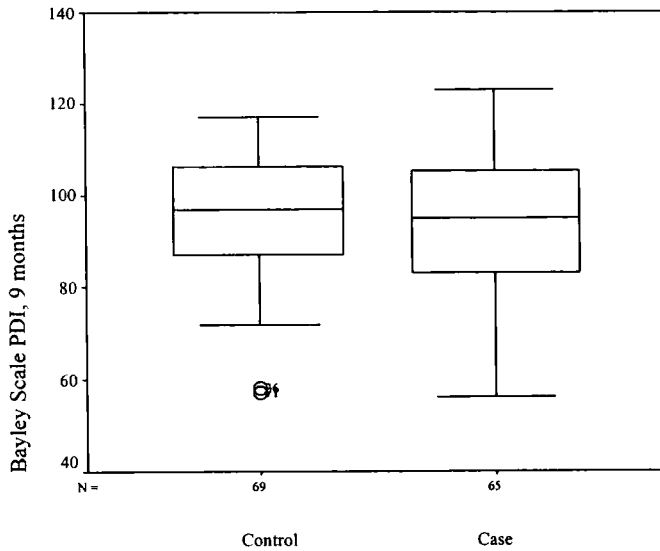


Figure 20. Bayley Psychomotor Development Index scores at 9 months for cases and controls.



At nine months the mean difference in MDI scores between the cases and controls was 2.26 which was not statistically significant ($t = 1.25$, $df = 132$, $p = 0.21$). The mean difference in PDI scores between case and control infants at nine months was 2.25 which was not statistically significant ($t = 0.94$, $df = 132$, $p = 0.35$).

Table 45. Bayley scale scores of cases and controls at 9 months.

		Number	Mean	Std. Deviation
Bayley Psychomotor Development Index (9 months)	Control	69	95.51	12.78
	Case	65	93.26	14.80
Bayley Mental Development Index (9 months)	Control	69	93.03	9.63
	Case	65	90.77	11.26

As shown in Table 46, when the three infants with organic disease were excluded from the analysis at nine months, the mean difference in MDI scores between the cases and controls was 2.01 which was not statistically significant ($t = 1.11$, $df = 130$, $p = 0.27$). The mean difference in PDI scores between case and control infants at nine months was 1.6 which was not statistically significant ($t = 0.68$, $df = 130$, $p = 0.5$).

Table 46. Bayley scale scores of cases and controls at 9 months (excluding three infants with organic disease).

		Number	Mean	Std. Deviation
Bayley Psychomotor Development Index (9 months)	Control	68	95.44	12.86
	Case	64	93.84	14.15
Bayley Mental Development Index (9 months)	Control	68	93.03	9.70
	Case	64	91.02	11.17

The Behaviour Rating Scale was used to assess the infants' behaviour during testing. There are four factors on the Behaviour Rating Scale; the Attention / Arousal Factor, the Orientation / Engagement Factor, the Emotional Regulation Factor, and the Motor Quality Factor. Items in each factor are rated on a five point scale. Raw scores are converted to percentiles for each factor within each age group and the total raw score is converted to a percentile to provide an overall assessment of the infant's behaviour. The factor structure is different for the three different age groups. In the one to five months age group the Behaviour Rating Scale assesses Attention/Arousal and Motor Quality. In the other two age groups (six to 12 and 13 to 42 months) infants are assessed on Orientation/Engagement, Emotional Regulation and Motor Quality.

Attention/Arousal includes an assessment of the infant's state, affect, energy, interest,

exploration and responsiveness to the examiner. Orientation/Engagement is used for infants six months and older; it includes many of the Attention/Arousal items and additional items that assess aspects of the infant's range of affect and emotional response to success and failure on the assessment. Motor quality refers to the quality of infant's movements including tone and control. A percentile of 26 or above relative to age is categorised as within normal limits, scores ranging from the 25th to the 11th percentiles are categorized as questionable and a percentile score below 11 is categorized as non optimal.

As shown in Table 47, at four months the mean difference in the Attention /Arousal factor percentile was 3.96 ($t = 0.67$, $df = 84$, $p = 0.51$). The mean difference in the Emotional Regulation Factor percentile was 5.33 ($t = 0.88$, $df = 76$, $p = 0.38$). The mean difference in the Orientation/Engagement factor percentile was 12.62 ($t = 2.08$, $df = 77$, $p = 0.04$). The mean difference in the Motor Quality Factor percentile was 10.1 ($t = 2.29$, $df = 160$, $p = 0.023$) and the mean difference in overall Behaviour Rating percentile between the groups was 11.06 ($t = 2.58$, $df = 158$, $p = 0.01$).

Table 47. Mean Attention/Arousal, Orientation/Engagement, Emotional Regulation, Motor Quality and Behaviour Rating centiles at 4 months.

		Number	Mean	Std. Deviation
Attention/arousal percentile (4 months)	Control	45	73.91	25.77
	Case	41	69.96	29.83
Orientation/engagement percentile (4 months)	Control	42	58.05	25.97
	Case	37	45.43	27.79
Emotional regulation percentile (4 months)	Control	42	67.33	25.42
	Case	36	62.00	28.10
Motor quality percentile (4 months)	Control	87	78.92	27.19
	Case	75	68.84	28.66
Behaviour rating centile (4 months)	Control	86	75.28	23.69
	Case	74	64.22	30.45

Table 48 shows the means with the three infants with organic illness removed. The mean difference for the Attention/Arousal factor was 2.43; for the Orientation/Engagement factor it was 11.52 and for the Emotional Regulation Factor it was 4.28. For the Motor Quality factor percentile the mean difference was 8.7. The mean difference in the overall Behaviour Rating percentile was 9.44 ($t = 2.23$, $df = 155$, $p = 0.03$). Each of the non-significant differences remains non-significant, and each of the significant differences remains significant, except for Orientation/Engagement (here a marginally significant p value of 0.04 becomes 0.06).

Table 48. Mean Attention/Arousal, Orientation/Engagement, Emotional Regulation, Motor Quality and Behaviour Rating centiles at 4 months (excluding 3 infants with organic disease).

		Number	Mean	Std. Deviation
Attention/arousal percentile (4 months)	Control	44	73.68	26.02
	Case	40	71.25	29.01
Orientation/engagement percentile (4 months)	Control	42	58.05	25.97
	Case	36	46.53	27.36
Emotional regulation percentile (4 months)	Control	42	67.33	25.42
	Case	35	63.06	27.77
Motor quality percentile (4 months)	Control	86	79.30	27.12
	Case	73	70.60	26.95
Behaviour rating centile (4 months)	Control	85	75.27	23.83
	Case	72	65.79	29.32

As shown in Table 49, at nine months, the mean difference in the Orientation/Engagement factor percentile was 8.34 ($t = 1.51$, $df = 129$, $p = 0.13$). The mean difference in the Emotional Regulation Factor percentile was 0.04 ($t = -0.08$, $df = 131$, $p = 0.99$). The mean difference in the Motor Quality Factor percentile was 6.85 ($t = -1.47$, $df = 131$, $p = 0.14$) and the mean difference in the overall Behaviour Rating percentile between the groups had narrowed, the difference was 5.94 ($t = 1.15$, $df = 131$, $p = 0.25$). None of these results were significant.

Table 49. Orientation/Engagement, Emotional Regulation, Motor Quality and Behaviour Rating centiles at 9 months.

		Number	Mean	Std. Deviation
Orientation/engagement percentile (9 months)	Control	68	58.34	29.47
	Case	65	49.91	28.22
Emotional regulation percentile (9 months)	Control	68	57.07	27.99
	Case	65	57.03	31.30
Motor quality percentile (9 months)	Control	68	76.24	24.64
	Case	65	69.38	29.10
Behaviour Rating percentile (9months)	Control	69	65.75	29.34
	Case	64	59.81	29.96

When the three infants with organic disease were excluded from the analysis the results remained non significant. As shown in Table 50, the mean difference in the Emotional Regulation factor percentile was -0.46 ($t = -0.88$, $df = 129$, $p = 0.93$). The mean difference in the Orientation/Engagement factor percentile was 7.61 ($t = 1.51$, $df = 129$, $p = 0.13$). The mean difference in the Motor Quality factor percentile was 6.04 ($t = -1.31$, $df = 129$, $p = 0.19$) and the mean difference in the overall Behaviour Rating percentile was 4.91 ($t = 0.95$, $df = 129$, $p = 0.34$).

Table 50. Mean Behaviour Rating percentiles at 9 months (excluding 3 infants with organic disease).

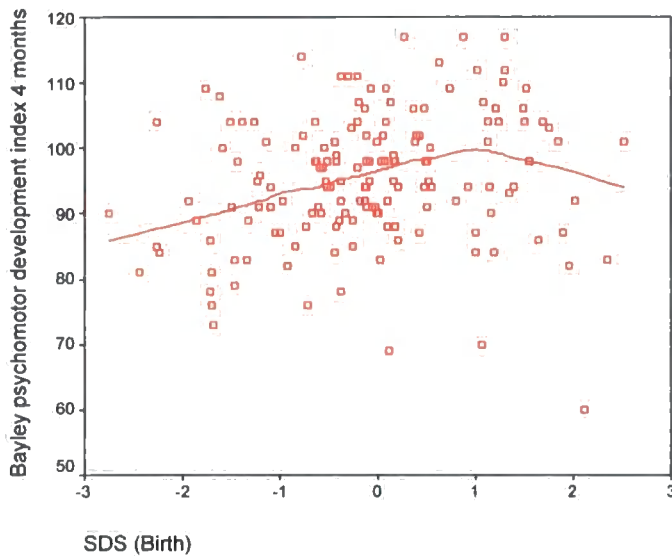
		Number	Mean	Std. Deviation
Orientation/engagement percentile (9 months)	Control	67	58.24	29.68
	Case	64	50.63	27.84
Emotional regulation percentile (9 months)	Control	67	56.75	28.07
	Case	64	57.20	31.52
Motor quality percentile (9 months)	Control	67	76.43	24.77
	Case	64	70.39	28.16
Behaviour Rating percentile (9months)	Control	68	65.59	29.52
	Case	63	60.68	29.37

Bayley Scale Scores and birth SD scores.

The Bayley scale data were collected in order to examine the relationship between weight gain over the first six to eight weeks and subsequent development. But they also make it possible to examine the relationship between birth weight and subsequent development. This is an important relationship as there is good evidence that birth weight (adjusted for the length of gestation) is associated with later IQ. Shenkin et al. (2001) carried out a retrospective cohort study to examine the relationship between birth weight and cognitive function at age 11 years. Mean test scores increased from 30.6 at a birth weight of <2500 g to 44.7 at 4001- 4500 g, after correcting for gestational age, maternal age, parity, social class, and legitimacy of birth. Drewett et al (2005) also found an independent significant effect of birth weight on development scores at six months and eighteen months; higher birth weight was associated with higher developmental scores.

The relationship between birth weight and Bayley PDI at four months was examined. The scatter plot in Figure 21 shows the positive association between birth SDS and Bayley PDI scores. As birth weight increases Bayley PDI scores increase.

Figure 21. Scatter plot showing positive association between birth SDS and Bayley PDI at four months



Regression analysis was carried out with the birth SDS as the independent variable and Bayley PDI at four months as the dependent variable (Table 51). The association was highly significant. The adjusted r square was 0.03 therefore the birth SDS explained 3.0% of the variation in the Bayley PDI at four months.

Table 51. Regression of Bayley PDI on Birth SDS at four months.

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	571.044	1	571.044	5.766	.018 ^a
	Residual	15351.963	155	99.045		
	Total	15923.006	156			

a. Predictors: (Constant), SDS (Birth)

b. Dependent Variable: Bayley psychomotor development index 4 months

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	95.353	.798		119.549	.000
	SDS (Birth)	1.792	.746	.189	2.401	.018

a. Dependent Variable: Bayley psychomotor development index 4 months

The simultaneous relationship between birth weight, weight gain over the first six to eight weeks (case or control) and Bayley PDI scores at four months was examined next using birth SDS and case at six weeks as the independent variables and Bayley PDI score at four month as the dependent variable (Figure 52). The adjusted R square is 0.043 therefore the independent variables explain over 4.0% of the variation in the dependent variable. There is a significant association between birth SDS and case at six weeks with Bayley PDI score at four months ($F = 4.487, p = 0.013$). Birth SDS had the most significant effect on PDI score at four months ($\beta = 0.185, t = 2.360$ and $p = 0.020$).

Table 52. Birth SDS and case at six weeks correlated with Bayley PDI score at four months

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	876.723	2	438.361	4.487	.013 ^a
	Residual	15046.284	154	97.703		
	Total	15923.006	156			

a. Predictors: (Constant), CASE6W, SDS (Birth)

b. Dependent Variable: Bayley psychomotor development index 4 months

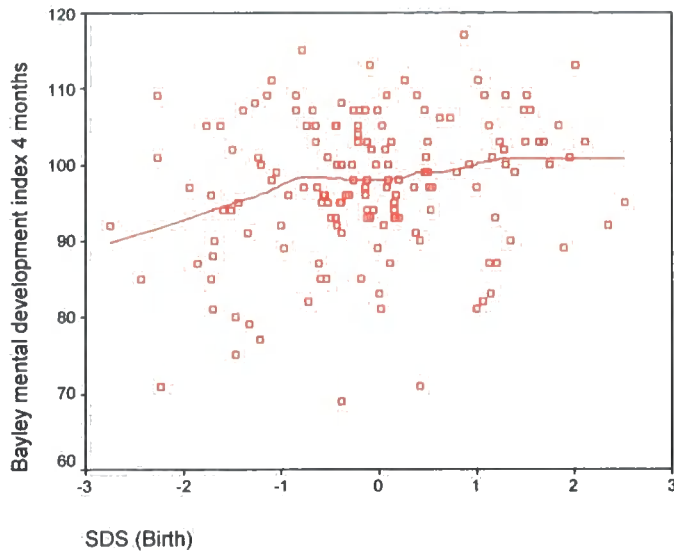
Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	96.634	1.073		90.038	.000
	SDS (Birth)	1.750	.741	.185	2.360	.020
	CASE6W	-2.802	1.584	-.139	-1.769	.079

a. Dependent Variable: Bayley psychomotor development index 4 months

The effects of birth weight on Bayley MDI scores at four months were examined and the scatter plot in Figure 22 shows the positive association between birth SDS and Bayley MDI scores. As birth weight increases Bayley MDI scores increase.

Figure 22. Scatterplot showing positive association between birth SDS and Bayley MDI at four months.



The relationship between birth weight and Bayley MDI at four months was examined. (Table 53). The association was highly significant. The adjusted r square was 0.038 therefore the birth SDS explained 3.8% of the variation in the Bayley MDI scores at four months.

Table 53. Birth SDS and Bayley MDI score correlation.

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	577.300	1	577.300	7.170	.008 ^a
	Residual	12479.503	155	80.513		
	Total	13056.803	156			

a. Predictors: (Constant), SDS (Birth)

b. Dependent Variable: Bayley mental development index 4 months

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	97.418	.719		135.467	.000
	SDS (Birth)	1.801	.673	.210	2.678	.008

a. Dependent Variable: Bayley mental development index 4 months

The relationship between birth weight, weight gain over the first six to eight weeks (case or control) and Bayley MDI scores at four months was examined next (Table 54). The adjusted R square was 0.060 therefore the independent variables explain 6% of the variation in the MDI score. There is a significant association between birth SDS and case at six weeks with Bayley MDI score at four months ($F = 5.966$, $p = 0.003$). Birth SDS had the most significant effect on MDI score at four months (beta = 0.205, $t = 2.639$, $p = 0.009$).

Table 54. Birth SDS and case at six weeks correlated with Bayley MDI score at four months

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	938.895	2	469.448	5.966	.003 ^a
	Residual	12117.907	154	78.688		
	Total	13056.803	156			

a. Predictors: (Constant), CASE6W, SDS (Birth)

b. Dependent Variable: Bayley mental development index 4 months

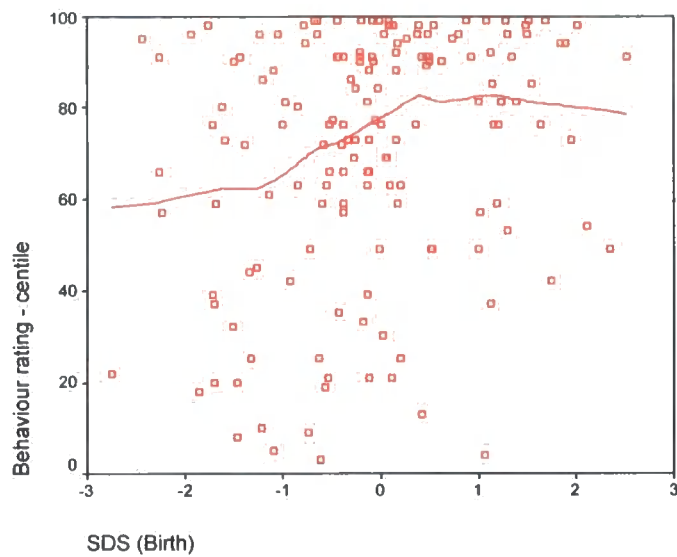
Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	98.811	.963		102.589	.000
	SDS (Birth)	1.756	.665	.205	2.639	.009
	CASE6W	-3.047	1.421	-.166	-2.144	.034

a. Dependent Variable: Bayley mental development index 4 months

The effects of birth weight on Bayley Behaviour Rating centiles at four months were examined and the scatter plot in Figure 23 shows the positive association between birth SDS and Bayley Behaviour Rating centiles. As birth weight increases Bayley Behaviour Rating centiles increase.

Figure 23. Scatter plot showing association between birth SDS and Bayley Behaviour Rating centiles at four months.



The relationship between birth weight and Bayley Behaviour Rating centile at four months was examined (Table 55). The adjusted r square was 0.06 therefore the birth SDS explained 6% of the variation in Behaviour Rating centiles at four months.

Table 55. Birth SDS and Behaviour Rating centile correlation.

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7334.654	1	7334.654	10.836	.001 ^a
	Residual	104914.4	155	676.867		
	Total	112249.1	156			

a. Predictors: (Constant), SDS (Birth)

b. Dependent Variable: Behaviour rating - centile

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	75.690	2.791		27.123	.000
	SDS (Birth)	6.287	1.928	.250	3.261	.001
	CASE6W	-9.053	4.119	-.169	-2.198	.029

a. Dependent Variable: Behaviour rating - centile

The relationship between the birth weight, case at six to eight weeks and Bayley Behaviour Rating centile at four months was examined next (Table 56). The adjusted R square is 0.082 therefore the independent variables explain over 8% of the variation in the dependent variable. There is a significant association between birth SDS and case at six weeks with Bayley behaviour rating centile at four months ($F = 7.968, p = 0.001$). Birth SDS has the most significant effect on Bayley Behaviour Rating centile at four months ($\beta = 0.250, t = 3.261, p = 0.001$).

Table 56. Relationship between birth SDS, case at 6 weeks and Behaviour Rating centile

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10525.851	2	5262.926	7.968	.001 ^a
	Residual	101723.2	154	660.540		
	Total	112249.1	156			

a. Predictors: (Constant), CASE6W, SDS (Birth)

b. Dependent Variable: Behaviour rating - centile

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	75.690	2.791		27.123	.000
	SDS (Birth)	6.287	1.928	.250	3.261	.001
	CASE6W	-9.053	4.119	-.169	-2.198	.029

a. Dependent Variable: Behaviour rating - centile

Chapter Five

Discussion

Chapter 5: Discussion

5.1 Aims of study

The study aimed to

1. Implement a screening programme using the thrive index methodology to detect slow weight gain (failure to thrive) in infants at the six to eight week examination using information that is routinely available.
2. Examine the extent to which infants with slow weight gain show other characteristics classically associated with failure to thrive as detected later in infancy, i.e. developmental delay and poor weight gain.
3. Compare feeding behaviour of infants with slow weight gain and normally growing infants.
4. Assess demographic characteristics of cases and controls via questionnaires to their mothers.

Results of the study will be discussed with these aims in mind.

5.2 Implementation of a screening programme to identify infants with slow weight gain.

Screening for slow weight gain

The National Screening Committee was set up in 1998 to oversee new and existing screening programmes in the United Kingdom and the Child Health sub-group was set

up as an advisory body to advise the Committee on the implementation, development, review, modification, and where necessary, the cessation of UK childhood screening programmes. The UK National Screening Committee (Health Departments of the United Kingdom, 1998) define screening as

'The systematic application of a test or inquiry, to identify individuals at sufficient risk of a specific disorder to warrant further investigation or direct preventive action, amongst persons who have not sought medical attention on account of symptoms of that disorder'. (Page 12).

The National Screening Committee has developed criteria relating to five areas for establishing whether screening programmes are worthwhile. These are: the disease, the screening test, the treatment, costs and benefits of screening and the organisation of the screening programme. Many childhood screening programmes have been shown not to meet the criteria and have been discontinued. The value of growth monitoring in infants has been questioned (Garner et al., 2000; Hall, 2000; Wright, 2000). A multi professional meeting was organised in 1998 by the Child Growth Foundation to formulate guidelines on growth monitoring and as a result of this, the Coventry Consensus was published (Hall, 2000). The recommendations for weight monitoring were that in the first year of life were that weight gain is a valuable indicator of health and nutrition and infants should be weighed at birth then at two, three and four months of age whilst attending clinic for immunisations. Also at eight months during routine health surveillance and after one year when attending for the MMR immunisation. As far as screening was concerned the conclusion was that there was no evidence to demonstrate any benefit in regular weighing of healthy infants and weight monitoring in infancy and in older children did not fulfil the criteria for a

screening procedure. On the subject of the difficulties associated with interpreting rates of weight gain in infants, it was agreed that this could be helped by using recently developed criteria based on conditional weight gain (Cole, 1995; Wright et al., 1998) but more development work was needed in this area.

The aim of the work underlying this thesis was not to establish whether health visitors should or should not be weighing infants. It was to investigate whether the information that they do in fact regularly collect could be used to identify slow weight gain (failure to thrive) at the six to eight week check. There are good reasons for wishing to do so, since there is evidence that early malnutrition may have particularly adverse effects, and earlier intervention may be more effective. To evaluate the costs and benefits of identifying slow weight gain as early as this would first require an effective procedure for doing so, this was developed and then tested in a sample of 1966 infants in 18 general practices in the work reported here. The study used a computer based programme which was quick and easy to use and relied only on information which is collected routinely by health visitors. Because the programme was based on conditional weight gain, it was standardised for birth weight, sex and the infant's age at subsequent weight. It identified those infants with weight gain in the slowest 5% from birth to six to eight weeks (compared with a national reference group).

Calibration of Balances

Any screening procedure depends on the accuracy of the balances used, and all the balances used to weigh babies in the study were calibrated. To check the portable

balances of the individual health visitors and nursery nurses an appointment was made with each. In some instances where two or more staff shared an office it was possible to check all the balances in one visit. In most cases though, a return visit was necessary as staff were often out visiting clients and had their balances with them.

Making arrangements to check the calibration of the balances on two of the maternity units was straightforward, as the researcher had previously worked in both and was acquainted with staff working there. The third unit was more difficult to access. The unit manager asked for the request to be submitted in writing with information about the study, and proof of ethics committee approval (for calibrating a balance!). In addition, before permission was given, the hospital electronics department who were responsible for maintaining and calibrating the balances had to be consulted, and arrangements made for an engineer to accompany the researcher whilst checking the balances.

The three most serious errors were all clinic balances in GP practices and all weighed light. The mean errors in grams were -623 -259 and -83 . Eighty percent of the balances were accurate to within 60g, with the mean error being 11g. Two of the electronic balances had major problems; both of these belonged to General Practices and were used for weighing babies in clinics. The balance with the greatest error (-623 g) was checked while the health visitor was on holiday. Practice staff had moved the balances to make space for equipment that had been delivered, and had lifted them onto a filing cabinet. On her return the health visitor was informed and the balance was sent to be recalibrated. There had been no reported problems with the balances prior to this and the health visitor suspected that the balances had been

dropped or mishandled in some way while being moved. The balance with a mean error of -259g was used in a GP baby clinic and the health visitor who worked there had not been aware of any problems. The balance was sent to be recalibrated prior to the start of the study. Balances used on all three maternity units in the study area were found to have an acceptable level of accuracy. The portable electronic balances used by the health visitors and nursery nurses in the community also had an acceptable level of accuracy, with mean errors ranging from 0g to -66g .

Checking balances was very time consuming but it was important to establish their level of accuracy before collecting weights of infants, as any major discrepancies might have affected selection of appropriate cases and controls for the study. It was also very reassuring to find that almost without exception balances were of an acceptable level of accuracy. Clinic balances in GP practices were checked either just before or just after a baby clinic. This was the easiest way to do this as the health visitor responsible for the clinic was present and the balances accessible. In addition the health visitors were happy to co-operate as they were interested to know if the clinic balances were accurate.

The EEC Council Directive 90/384/EEC (1990) deals with weighing instruments.

The amended directive 90/384/EEC 'Non-Automatic Weighing Instruments for Medical Use' requires that any new electronic balances purchased for weighing infants in the UK after 31st December 2002 have to be of an approved type, i.e. class three or class four. They should either weigh in metric only or have two displays, primarily metric but with an imperial conversion display which does not require the

infant to be lifted off the balances and then repositioned. The directive also states that

these balances should be checked and serviced by qualified staff, and calibration procedures carried out in accordance with UK Weighing Federation code of practice 1998 (Medicines and Healthcare Products Regulatory Agency, 2003). Any balances purchased before 1st January 2003 are not approved but may be used until they reach the end of their life.

Calibration of balances used by health visitors and nursery nurses and in community health clinics in the study area is available twice a year. Easington Primary Care Trust has a contract with Avery who provides service support for all weighing equipment. Avery recommends twice yearly calibration checks; however any balances which are suspected of inaccuracy can be checked at any time on request. When the engineer is due to call to check the accuracy of the balances, the administrator at the Community Health Centre sends a memo to all health visitors and nursery nurses to inform them of the date when the engineer will be calling. There is however no monitoring of which balances are checked. If they are not brought in to the health centre on the day the engineer calls then they will not be checked. In theory a set of balances could remain unchecked for ten years, whilst others could be checked twice a year. Balances in the Primary Care Trust community child health clinics are checked twice a year by Avery, but in the GP practices it is the responsibility of the individual practices. Balances in some practices have never been checked (other than by the researcher during the project). Others GP practices have them checked by the manufacturer annually, and other practices stated that they would only arrange to have them checked and calibrated if there was a problem reported.

Some practices do not own electronic balances and rely on the health visitors bring their portable balances for the baby clinics.

In the three hospitals in the study area there were different procedures for checking balances. The balances on the labour ward at Hartlepool were checked annually by the electronics department, though the engineer responsible for checking them described the interval between checking as a 'grey area' and it could sometimes be as long as 18 months. If these balances were inaccurate the manufacturer would be contacted to carry out the necessary recalibration. The balances on the labour ward at Durham were only ever checked if staff requested this. The engineer responsible for checking the balances explained that there were new recommendations from the Medicines and Healthcare products Regulatory Agency (2003) which state that any calibration has to be traceable to a national standard; and that it was expected that the Trust would have to comply with this standard in the near future. The labour ward balances at Sunderland were checked six monthly by a specialist firm who had a long term contract with the trust.

In view of the lack of uniformity among the hospitals, the GP surgeries and the community staff, in checking the accuracy of balances, it was surprising that they were almost all of an acceptable standard of accuracy. Obviously checking weight gain over a short period (birth to six to eight weeks) requires more accurate weighing than checking it over a long period (e.g. birth to one year). It would be desirable to see a standard protocol for the calibration of balances.

Data collection

Data were collected from health visitors' records monthly, by prior appointment with the health visitors. Several unexpected problems arose. Some health visitors' offices were within GP surgeries and others were in clinic buildings which are generally kept locked. Problems arose when visiting the offices to collect data if a Health Visitor had to leave work unexpectedly or forgot that the nursery nurse or researcher was calling. On one occasion a health visitor who worked from an office in a GP surgery had arranged for the nursery nurse to visit one morning, and for the surgery staff to open the office for the nursery nurse to collect the data. When the nursery nurse arrived the practice staff refused her entry to the health visitor's office, despite the fact that she had her identification badge. This resulted in a wasted morning.

It was common for the records of infants recorded in the birth book to be missing, as families receive more intensive visiting from health visitors in the first few months of life and the health visitor often had these records with her. It was not uncommon for records to be misfiled; this usually involved a time consuming search by the research assistant. In some instances, although it was uncommon, records were missing; this was more likely during the stage of the nine month data collection. Sometimes information about infants' six to eight week and nine month checks were missing from health visitors' records. These are recorded in triplicate in the parent held records. One copy remains, one is filed in GP records and the other is filed in the health visitor's record. These would wait for clerical staff to file them in the health visiting records, which could take several months. This could result in a delay in recording data and later identification and recruitment of an infant.

There were some difficulties with the collection of six to eight week weights. Infants are usually weighed and measured by health visitors at the six to eight week check, and then examined by the GP who completes the surveillance slip in the parent held record. This sheet contained the information required for the database, but some GPs left the slips in the parent held record, so the data might not be available unless the health visitor noticed this and removed it at her next meeting with the family. When these slips were missing, individual health visitors were asked if they would retrieve them. This sometimes delayed the identification of cases and controls. Two health visitors in the study area worked in villages that had traditionally been served by the Child Health Department at Durham and they returned the surveillance slips from the parent held record to this department. Staff at Durham Child Health Department entered data from the slips onto the computer system; they then returned the slips to the health visitors for filing in the health visitors records. This procedure resulted in a delay between the six to eight week and nine month checks being carried out and the tear out slips being returned from Child Health Department.

In some instances it was difficult to extract data from health visitor records due to illegible writing or missing information and if there were any queries about data the appropriate Child Health Department was contacted. Batchelor and Kerslake (1990) carried out a study of failure to thrive using health visitors' records to obtain data. They commented on the difficulties associated with the procedure, which included: legibility of records, storage and filing problems, missing data, duplication of data and problems associated with changes in health visiting staff.

It was very common for infants' surnames to change in the first few weeks after birth. They were given their mothers surname in hospital; the infant was notified to the health visitor by that name and recorded in the birth register. By the time the health visitor had carried out the primary visit the baby had usually been registered in the father's surname, and this was recorded on the health visitor's record. If this was not changed in the birth register it could cause confusion and the correct name had to be verified with the family health visitor.

If an infant had transferred out of the study area then there was no way of following up that infant. If however the infant had transferred to another health visitor within the study area it was possible to trace the infant either by contacting the Child Health Department. If this happened when the six to eight week data were being collected it was possible to make a note on the selection form on the database about where the infant had transferred to, and the data collected from the office of the infant's new health visitor. The nine month selection form did not have this facility, so the problem was resolved by making a note of the infants ID number and the name of the health visitor to whom the notes had been sent. A major unforeseen problem encountered during the data collection period was the total reorganisation of health visitors and the health visiting service during the project. The introduction of Sure Start programmes resulted in different working practices for health visitors and changes in caseloads and caseload holders. Health visiting records were redistributed several times during the project, a number of health visitors left the service and new ones joined. The result was that by the time the nursery nurse was due to collect the

nine month data, most of the records were located in a different office with a different health visitor. Tracing the records was extremely difficult and time consuming.

Within six months of the completion of the data collection there was a staffing crisis within the health visiting service which resulted in a substantial number of health visiting records being redistributed to several health visitors. In theory it should have been possible to trace these records; however in reality the process would have taken so much time that it could not have been accomplished. Any further studies which used this method of data collection would need to take into account the stability of the health visiting service and consider the effect of any proposed changes to staffing and working practices.

It should be noted, however, that these problems almost all arose because the screening was carried out as a research project, in which weights had first to be retrieved from the health visitors' records. In a screening programme in clinical use each health visitor would enter weights as soon as they were available as part of their clinical duties, so these problems would not arise.

Analysis of weight gain using a thrive index

In the current study the weight gain of a cohort of 1966 children was followed over their first year using weights collected at birth, six to eight weeks and at seven to nine months as part of routine NHS care. These weights were extracted from health visitors' records.

The number of births as identified from birth books in the participating practices was 1966. Of these 1966 infants, a birth weight was available for 1964, and there were

good reasons why the other two were missing. A six to eight week check was recorded for 1892 (96.2%) of the 1966 infants however there was no weight recorded for nine of these. So of the 1966 born, 83 (4%) could not be screened using data routinely collected at birth or at the six to eight week check. Although 1,765 infants were recorded as having had a nine month check, weights were not always available. A weight at around nine months was available for 1,632 infants (83%).

Infants with a thrive index of ≤ -1.17 were automatically selected by the Access database. This criterion identified those infants whose weight gain was in the lowest 5%, assuming that weights in this population correspond to those the national growth reference. The number of infants in this category was 121 (6.15%). It is important to note that each of these infants was identified prospectively using criteria for slow growth based on nationally representative samples. They were not identified retrospectively. When multiple births, preterm infants and one infant with no gestational age recorded were excluded, the remaining term singleton infants with a thrive index of ≤ -1.17 numbered 102 (5.2% of the cohort). This is extremely close to the proportion expected on the basis of the national sample statistics (5%). These were the infants who were eligible for recruitment to the study. According to the protocol an equal number of controls were to be recruited giving 204 in all but three control infants were inadvertently omitted at the recruitment stage owing to administrative errors. The remaining 201 case and control infants were invited to take part in the study by their own health visitors if they were still resident in the Easington area.

Of the 201 eligible infants, 88 controls and 74 cases were recruited to participate in the study (81%). It was not possible to invite 20 of the infants to participate because they had either moved away from the study area or were not contactable. The recruitment percentage after exclusion of these was 89%. This is a high recruitment percentage. Two control group infants who had been recruited were subsequently excluded from the analysis. One had no six week thrive index and one was incorrectly recorded as a male but was a female. This child was called Alex, a name used both of males and females which may have led to the confusion. Errors in records of this kind would lead to misidentification of failure to thrive as in this case. What appeared to be failure to thrive in a male was in fact normal weight gain in a female.

Weight and weight gain

The mean birth weight SD score for the sample was -0.16 , and at the six to eight week check it was -0.05 , which were both slightly lower than in the national reference population. At nine months the mean weight SDS was 0.08 , which was above zero, showing a slightly above average weight for age compared to the national reference population. The material presented in Chapter three showed that the Easington area is one of the most deprived in the country, but these results do not give any indication that weight gain over the first year is any poorer than in the UK as a whole. The same conclusion can be drawn from the proportion of children who met the screening criterion for failure to thrive. After the exclusion of multiple births and infants born preterm this was 5.2% , very close to the national expected frequency of 5% . If poor weight gain in infancy in Western countries was primarily attributable to

environmental causes (infectious disease or lack of appropriate food) one would expect it to be more common in poorer communities. But there is no good reason to think that it is. If it derives from differences in the children, rather than differences in their environments, one would not necessarily expect it to be more common in poorer communities.

There was a statistically significant difference in the rate of weight gain between males and females in the population from which the sample was taken, with males gaining weight at a greater rate than females. This may be because parents tend to encourage feeding in males more than in females. One anecdotal explanation for the greater weight gain in males, from health visitors in the study area, is that small males are regarded as puny and more of a concern, whereas small females are more likely to be considered to be dainty or petite. When attending baby clinics to have their infants weighed, mothers tend to focus on the weight of their own infant and make comparisons with the weights of other infants. There is an almost competitive curiosity among parents as to whether other infants are gaining weight more or less rapidly than theirs, particularly among parents of males. This may be due to the characteristics of the area which by tradition has been predominantly a mining and heavy industry area. The traditions of the male breadwinner and female homemaker tend to persist and it may be that parents are more likely to encourage feeding in males.

However, the fact that mothers try to encourage feeding in their infants does not mean that they necessarily succeed. Kramer et al. (1983) developed scales to measure a mother's preference for fatter or thinner infants (the Ideal Infant Body-Habitus scale,

IBH), and to assess their tendency to 'push' food on their infants (the Maternal Feeding Attitudes Scale, MFA). Pushiness measured at birth using this scale was found to be associated with pressure to eat by the mother at seven years (Duke et al., 2004). In the study by Kramer et al. these scales were administered at birth, and the infants followed up to the end of the first year, with measurement of their weight, BMI and skin fold thickness. After taking birth weight into account the scores measuring the pushing of food were not related to weight or BMI. Indeed, at six months there was a negative relationship with skin fold thickness: more pushy mothers had *thinner* infants.

In conclusion, implementing a screening programme of the kind that was utilised in this project would require some change to working practices but very little cost. Most health visitors have their own personal computers, and an appropriate ACCESS programme (preferably a more user friendly version of the one used in this project) could be provided at little cost. The screening programme successfully identified the theoretically expected 5% of infants at meeting the criterion for failure to thrive.

5.3 Extent to which infants with slow weight gain show other characteristics classically associated with failure to thrive.

The second aim of the work reported in this thesis was to see whether infants identified as failing to thrive at the six to eight week check shared the other characteristics normally found in infant who fail to thrive (developmental delay and feeding problems). To investigate this, the infants were compared with a group of controls, simply chosen as the infants on the same health visitor's case load closest to

them in birth date. They were visited at home, their development was investigated directly, and their feeding via reports from the mother.

Home visits

All Bayley Scales assessments were carried out in the family homes of those participating in the project. The advantage of this was that families were more willing to participate in the study because they did not have to go to the trouble of visiting a clinic or university department.

There were some difficulties in testing at home. Occasionally older siblings and family pets were present during the testing or televisions with the volume set very high. The infant and the researcher could be distracted by these. Many infants have a daytime routine and the most appropriate time to carry out the testing was when the infant was not hungry, tired or unwell. Sometimes when the researcher arrived to carry out the testing the baby was either unwell, fractious or had fallen asleep.

Role conflict could be a problem during home visits as the families participating in the study were aware that the researcher was a health visitor. There were occasions when the researcher had to provide health visiting advice or intervention. It was unlikely that any of the health visiting interventions by the researcher would have affected either the infants' weight gain or developmental outcomes but it was not possible to control for this possibility. Examples were prescribing Paracetamol for post immunisation pyrexia, medication for oral thrush or cream for nappy rash.

Problems related to diet, behaviour or sleeping were immediately referred back to the family health visitor or nursery nurse. As a health visitor working as a researcher

visiting families in their homes it would be unethical to ignore practices which could be detrimental to a child's health or to fail to offer appropriate health advice if asked. This presents a dilemma for the researcher in so far as advice or intervention may influence the child's growth or development and thus potentially affect the results of the study. It is important to recognise that there are issues related to role conflict and the difficulties and tensions of balancing the need for objectivity in research against the duty of care to families and children. As a health visitor carrying out a research project I had anticipated and acknowledged that there would be issues of this nature and endeavoured to complete the research related tasks during visits before offering any intervention or advice.

Developmental assessments using the Bayley Scales.

There is consistent evidence that failure to thrive is associated with delayed development in infancy (Black et al., 1994; Kelleher et al., 1993; Raynor et al., 1996; Skuse et al., 1994; Wilensky et al., 1996). These studies used the Bayley Scales of Infant Development to measure cognitive outcomes in infants who failed to thrive. Black et al., (1994) found a difference in MDI scores of 7.2 between cases and controls, Kelleher et al., (1993) found a difference of 5.8. Skuse et al., (1994) found a difference of 10.3 in MDI scores and Wilensky et al., (1996) found a difference of 7.5.

Infants recruited to the study were tested at around four months and using the Bayley Scales (2nd ed). An MDI and PDI score of 100 on the Bayley Scales equates to a SD of 0 and a percentile rank equivalent of 50. Every five points is one third of an SD.

There was a mean difference in MDI scores between cases and controls of 3.52 which was statistically significant. The mean MDI score at four months for controls was just below the mean, and for cases it was one third of a standard deviation below the mean. These scores were re-analysed after the three infants with a major organic disease were excluded and the mean difference in MDI scores of 3.17, remained statistically significant. At around four months there was a mean difference in PDI scores between cases and controls of 3.59 which was also statistically significant. These scores were re-analysed after the three infants with a major organic disease were excluded and there was a mean difference in PDI scores of 2.92, which was no longer statistically significant. This shows that that the infants identified as cases have delayed development at four months compared to normally growing controls.

Infants were tested again at around nine months. The mean MDI score for controls was more than one third of an SD below the mean, and for cases it was just less than two thirds of an SD below the mean. The mean difference in MDI scores at nine months was not statistically significant and when these scores were re-analysed after the three infants with a major organic disease were excluded, the mean difference in MDI scores remained non significant. The mean PDI score at nine months for controls was just less than one third of an SD below the mean, and for cases just over one third of an SD below the mean. The mean difference in PDI scores between the groups at nine months was not statistically significant. These scores were re-analysed after the three infants with a major organic disease were excluded and the mean difference in PDI scores between the groups at nine months remained non significant. Although difference in the nine month scores was not statistically significant there

was still a difference between the groups. Bayley scores for all infants at four and nine months were below the mean and cases had had consistently lower scores.

Although the differences between the groups reported here were only of statistical significance at the 0.05 level at the four months tests, a consistent trend was found at the nine month tests and there is now evidence from two other independent studies that poor weight gain immediately after birth is associated with later developmental delay (Drewett et al 2005; Skuse et al, 1994). The results of this part of the study therefore indicate that infants recruited using a conditional weight gain criterion at the six to eight week check do show developmental delay, which is the classic behavioural correlate of failure to thrive as identified later.

Effect of birth weight on developmental scores

Although it was not one of the principal objectives of the study, the data collected with the Bayley Scales allowed analysis of the relationship between birth weight and Bayley scale score.

A retrospective cohort study (Sorensen et al., 1997) based on birth registry data and cognitive function measured during evaluation for military service in Denmark, examined the relationship between birth weight and cognitive function in young adult life. This was measured with the Boerge Prien test of cognitive function, which is related to IQ tests. Scores on the test increased from 39.9 at a birth weight of ≤ 2500 g to 44.6 at a birth weight of 4200 g; even after adjustment for gestational age, length at birth, maternal age and parity and other variables. Above a birth weight of 4200 g the test score decreased slightly. Shenkin et al. (2001) carried out a retrospective cohort

study to examine the relationship between birth weight and cognitive function at age 11 years, based on birth records from 1921; and cognitive function measured while at school at age 11 in 1932. The Scottish Mental Survey of 1932 tested the IQ of almost all children (87,498) born in 1921 who were at school in Scotland on 1st June 1932. They sat a mental test called the Moray House Test. The questions measured reasoning ability, with over 70 questions involving words, numbers and shapes. The mean score on Moray House Test increased from 30.6 at a birth weight of <2500 g to 44.7 at 4001- 4500 g after correcting for gestational age, maternal age, parity, social class, and legitimacy of birth. Richards et al. (2005) examined the association between birth weight and cognitive function, and birth weight and educational achievement, in a normal population using retrospective data from the 1946 birth cohort. Findings were that increasing birth weight was associated with higher educational attainment; also birth weight was significantly and positively associated with cognitive ability at age eight. The positive association continued and was measured at ages eight, 11 15, 26 and 43 years.

In the current study higher birth SD scores were associated with higher MDI scores up to a birth SD score of over one, after which it levelled off. Higher birth SD scores were associated with higher PDI scores and Behaviour Rating scores, but above a birth SD score of one, these scores declined.

The effects of malnutrition in utero or in the post natal period appear to have the same effects on cognitive outcomes. The current study shows an effect on early development of birth weight in term infants; however infants who are small for gestational age (SGA) may be full term or pre term. Severe grow retardation may

result in premature labour and the later effects on development may be different, depending on the stage of foetal development. The effects of early growth retardation on a term infant may mean that the infant was exposed to an adverse intrauterine environment for longer than a premature growth retarded infant.

In this study it was possible to examine relationships between birth weight and developmental delay in term infants very early in life. There is very little published evidence of this relationship, although one paper has been published on it in a less developed country (Grantham-McGregor, 1998). In the data reported here, as birth weight increased there was an increase in MDI and PDI scores, mirroring the relationship found with IQ in adults. It would now be of value to investigate further the developmental delay in term infants with lower birth weight. It suggests that malnutrition before birth (reflected in a low birth weight) is having comparable effects to malnutrition after birth (reflected in a low thrive index or failure to thrive).

5.4 Feeding behaviour.

Feeding difficulties

Previous research has shown that infants who fail to thrive as traditionally identified have more feeding problems than infants who grow at a normal rate. A further aim of this study therefore was to examine whether infants identified as failing to thrive at the six to eight week check similarly show a higher proportion of feeding difficulties as reported by their mothers.

The study found that:

1. A higher proportion of mothers of case infants reported 'great difficulty' feeding their baby or difficulty in feeding 'some of the time'
2. A higher proportion of mothers of case group infants reported slow feeding in the first two months.
3. A higher proportion of mothers of case group infants reported weak sucking in the first two months.
4. A higher proportion of mothers of case group infants reported that their infant had taken only small quantities of milk in the first two months.
5. A higher proportion of mothers reported that their infant had shown slow feeding after two months of age.

Those who failed to thrive had significantly more feeding problems than control infants in each case. This finding is consistent with previous research and shows that the feeding problems found in groups of children identified as failing to thrive using more traditional criteria are also more common the group identified at the six to eight week check in this study.

Control infants first had solids at a mean age of 13 weeks 5 days and cases at 15 weeks 3 days, i.e. the case group were introduced to solids about two weeks later. The difference was statistically significant. Studying a group identified later in infancy, Wright and Birks (2000) found that case group infants were introduced to solids nearly one month later than controls. Possible explanations for the later introduction of solids to case group infants are that children with a low appetite grow

less well and are satisfied without solids for longer; or perhaps as case group infants tend to have more reported feeding difficulties than control infants their parents may foresee further problems associated with the introduction of solids. It could be that they wait as long as possible before introducing solids in order to avoid potential difficulties.

5.4 Demographic characteristics of cases and controls.

The last aim of the study was to compare the demographic characteristics of the families of case and control group infants. Demographic characteristics of each family were obtained via a questionnaire to the mother at the first home visit. This method was preferable to extracting data from health visiting records as the demographic data available from these was often incomplete, out of date or inadequate for the purposes of the study.

There was a striking lack of significant differences between case and control group families in respect of any indicators of affluence and demographic characteristics. There was no significant difference in the age of the mother; the proportion who lived alone; in the age at which the mothers finished full-time education, or in the highest qualification they obtained; in the proportion who owned their own home; or who owned a car or had an installed or mobile phone; or in the proportion of families who had a wage earner.

This evidence is therefore inconsistent with the rather widespread belief that failure to thrive is associated with poorer or less well educated families. It is, however, consistent with recent epidemiological evidence, which shows a similar lack of

association (Wright et al 1994; Blair et al 2004). The second study was carried out on a very large population in Avon as part of the ALSPAC study.

Demographic characteristics were not related to failure to thrive and there were no significant differences in any economic or educational indicator between families of cases or controls. It would be important, therefore, not to fall into the trap of assuming that it is poor communities in particular that would benefit from such screening. The evidence provided here and elsewhere suggests that it is universal screening that would be required.

5.5 Conclusions

Recommendations for future research

This study examined relationships between birth weight and developmental delay in term infants very early in life. There is very little published evidence of this relationship, and it might be of value to investigate further the developmental delay in term infants with lower birth weight to investigate whether malnutrition before birth has comparable effects to malnutrition after birth.

Two studies which have looked at developmental outcomes of children who failed to thrive in infancy have shown adverse effects on cognitive development (Batchelor, 1999; Dowdney et al., 1987), however other recent studies found that the adverse effects of poor growth on cognitive outcomes appeared to diminish over time (Boddy et al., 2000; Drewett et al., 1999). A paediatrician who reviewed the literature on failure to thrive (Sidebotham, 2000) commented that his conclusions about cognitive

effects were the opposite to those of Wright (2000), despite the fact that he had reviewed the same studies. The wide variation in the study methodologies has not been helpful, as some studies were controlled and others were uncontrolled, some used referred samples and others used population based samples, also the definitions of failure to thrive used in the studies were not consistent. In addition different methods of assessment of children's cognitive abilities have been used which further confounds results. It would be interesting to follow up the infants in the current study at a later date to establish if there were any significant differences in cognitive outcomes between the cases and controls, and to look at changes over time in individual infants.

There may also be implications for monitoring rapid weight gain in infants. Obesity is becoming a serious problem and the National Audit Office (2001) estimate that obesity accounted for 18,000,000 sickness days and 300,000 premature deaths in 1998. They also predict that the prevalence of obesity could rise to 25% by the year 2010. The direct costs due to overweight in England were estimated by the National Audit Office as being £500 million in 1998, with indirect costs of £2 billion, potentially rising to £3 billion by the year 2010. The National Service Frameworks for diabetes (Department of Health, 1999) and for prevention of coronary heart disease (Department of Health, 2000) both refer to the urgent need to address population obesity and considerable evidence exists that reducing overweight in selected people is associated with lowering of blood pressure and lowered cholesterol levels. The National Institute for Clinical Excellence has looked at obesity, and guidance on the prevention, identification, treatment and management of obesity in children and adults is due out in 2007, with a consultation version scheduled for

publication in early 2006. The Chief Medical Officer's annual report includes a section on obesity and one of the recommendations is that health professionals, including general practitioners, school nurses, practice nurses and health visitors, should identify early signs of obesity in children and offer interventions at an early stage (Department of Health, 2003).

Recommendations for training and practice

The study was designed to investigate the usefulness of a screening programme to identify infants with slow growth at the six to eight week check. My aim was not to investigate whether weight monitoring is or is not desirable. Given that infants are weighed, my aim was to investigate whether an effective procedure for detecting slow weight gain (failure to thrive) could be implemented systematically at the six to eight week check, since there is reason to think that earlier detection of failure to thrive would be desirable. Because this is close to birth, a procedure based on a conditional weight gain standard was needed, rather than an attained weight standard.

The screening programme was easy to use and it fulfilled the task it was designed for. The slowest growing infants were identified and all infants in the study who had a recorded birth weight plus another later weight at about six to eight weeks were assigned a thrive index. This provided an easy way of identifying fast, slow or average weight gain. Although the programme worked successfully as part of the research project, it would be interesting to see how it would work as part of routine care. Health visitors might see it as an unnecessary addition to their workload and consider it a low priority. On the other hand many of the Sure Start programmes now

keep computerised records of all infants' details including home and clinic contacts, weights and advice given during consultations. If the programme could be incorporated into such a system it would be likely to be used routinely and would be a valuable resource for health visitors. It would not involve any extra weighing of infants, but only the more effective use of the weights already recorded.

The National Programme for Information Technology (NHS, 2005) is set to revolutionise the way in which NHS staff work. It will be responsible for delivering a modern, integrated IT infrastructure and systems for all NHS organisations in England by 2010. For the first time, linked computer systems will enable health information and records to be transferred between NHS organisations efficiently, securely and confidentially and there will be easier online access to patient information and records electronically, at the touch of a button. Community nurses will have access to the new systems and this could provide the way forward for screening for slow weight gain or obesity in infants.

One of the biggest problems during the project was the total reorganisation of health visitors and the health visiting service, including the introduction of Sure Start programmes and the redistribution of health visiting records which made tracing records difficult and time consuming. Any further studies which used this method of data collection would need to take into account the stability of the health visiting service and consider the effect of any proposed changes to staffing and working practices. If I were to do the study again I would make use of the newly established Child Health Department's computerised database to collect data as the continual reorganisation and movement of staff and caseloads within the health visiting service

would make data collection from individual health visitor's records difficult and time consuming. The collection of developmental, feeding and demographic data was efficient and I would use these methods again in a study like this.

From a health visiting viewpoint, early identification of slow weight gain in infants would only be of value if health visitors had the knowledge and skills to provide effective interventions and access to a multi disciplinary team who could support them. This has implications for training. Health visitors already support families with feeding and weight gain issues in infants; however further training is available, for example the Children's Society Feeding Matters Programme offers training and the training pack produced by Wright and Birks as part of the Parkin Project in Newcastle could be used as a training resource.

Infants in the study identified with slow weight gain at six to eight weeks were eight to nine times more likely to have slow weight gain over the longer period to nine. They were on average more developmentally delayed, and they had more feeding problems, both characteristics associated with failure to thrive as it is traditionally identified later in infancy. The results of the study show that it is possible to identify infants who fail to thrive early. This is only possible with a conditional weight gain standard. An attained weight standard would simply pick up infants with low birth weights. In view of the evidence that early malnutrition may have especially adverse effects, and that intervention evaluated to date for failure to thrive are of limited or no effectiveness, it would be valuable to examine the effectiveness of early intervention after early detection using the methods described in this thesis.

Appendices

Appendix One

Birth Statistics by GP Practice

Appendix 1. Birth Statistics by GP practice

(For 1st April 2000 to 31st March 2001- obtained from child health departments)

Hartlepool Child Health

G P practice	Number of births
Dr Suki	37
Dr Chandy	51
Dr Mansour	49
Dr Choudhary	35
Dr Abbott	38
Dr Burrell	98
Dr Fairlamb	42
Dr Banerjee	71
Dr Brown	134
Dr Gupta	32
Dr Sinha	19
Total	606

Sunderland Child Health

Dr Johnson	152
Dr Kapoor	59
Dr Dusad	61
Dr Reddy	46
Dr Quasim	38
Dr Rangar	74
Total	263

Durham Child Health

Dr Patel	93
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Total number births in practices participating in study 1,114 (1st April 2000 to 31st March 2001)

Appendix Two

List of GP Practices Participating in this Study

Appendix 2. List of GP practices participating in study

G P practice.
Dr Kapoor, Deneside Medical Centre, The Avenue, Seaham.
Dr Dusad, 1-2 Adelaide Row, Seaham.
Dr Reddy, Dr Kapoor, Deneside Medical Centre, The Avenue, Seaham.
Dr Quasim, The Health Centre, Front Street, South Hetton.
Dr Rangar, The Surgery, Woods Terrace East, Murton.
Dr Johnson, Hetton Medical Centre, Frances Way, Hetton le Hole.
Dr Suki, Jupiter House, Blackhills Road, Horden.
Dr Chandy, 16 Blackhills Road, Horden.
Dr Mansour, Southdene Medical Centre, Front Street, Shotton.
Dr Patel, The Surgery, Thornley Road, Wheatley Hill.
Dr Brown, The William Brown Centre, Manor Way, Peterlee.
Dr Gupta, The Surgery, Bevan Grove, Shotton.
Dr Sinha, The Medical Centre, Front Street West, Wingate.
Dr Choudhary, 16 Blackhills Road, Horden.
Dr Abbott, Station Road Surgery, Shotton.
Dr Burrell, Morven House, Hesleden Road, Blackhall.
Dr Fairlamb, The Caradoc Surgery, Front Street, Wingate.
Dr Pearson, Peterlee Health Centre, Bede Way, Peterlee.

Appendix Three

Map of Study Area

Appendix 3. Map of study area



Appendix Four

Tolerances for Different Accuracy Classes. M Standards

Appendix 4. Tolerances for different accuracy classes. M standards

The United Kingdom Accreditation Service (<http://www.ukas.org/>) is the sole national accreditation body recognised by government to assess, against internationally agreed standards, organisations that provide certification, testing, inspection and calibration services. The table below shows the tolerances allowed for calibration weights (from http://www.countyscales.co.uk/tech_infoandcert_1.htm).

Nominal Weight	Tolerance (milligrams)				
	M2 + only (Trade stamped)	M1 +/-	F2 +/-	F1 +/-	E2 +/-
1mg	0.20	0.20	0.06	0.020	0.006
2mg	0.20	0.20	0.06	0.020	0.006
5mg	0.20	0.20	0.06	0.020	0.006
10mg	0.25	0.25	0.08	0.025	0.008
20mg	0.30	0.30	0.10	0.03	0.010
50mg	1.20	0.40	0.12	0.04	0.012
100mg	1.50	0.50	0.15	0.05	0.015
200mg	2.00	0.60	0.20	0.06	0.020
500mg	2.50	0.80	0.25	0.08	0.025
1g	5.00	1.00	0.30	0.10	0.03
2g	5.00	1.20	0.40	0.12	0.04
5g	10.00	1.50	0.50	0.15	0.05
10g	20.00	2.00	0.60	0.20	0.06
20g	20.00	2.50	0.80	0.25	0.08
50g	30.00	3.00	1.00	0.30	0.10
100g	30.00	5.00	1.50	0.50	0.15
200g	50.00	10.00	3.00	1.00	0.30
500g	100.00	25.00	7.50	2.50	0.75
1kg	200.00	50.00	15.00	5.00	1.50
2kg	400.00	100.00	30.00	10.00	3.00
5kg	800.00	250.00	75.00	25.00	7.50
10kg	1600.00	500.00	150.00	50.00	15.00
20kg	3200.00	1000.00	-	-	-
25kg	4000.00	-	-	-	-
50kg	8000.00	2500.00	-	-	-

Appendix Five

Choice of Weight Class

Appendix 5. Choice of weight class

As a general guideline the classes of weights required to calibrate various machines of different capacities/increments are as shown in the table below:

Scale capacity	Increment								
	1kg	100g	10g	1g	100mg	10mg	1mg	0.1mg	0.01mg
Up to 200g							F2	F1	E2
200g - 1kg						F2	F1	F1/E2	
1kg - 30kg		M1	M1	M1	F2	F1			
30kg - 100kg		M1	M1	M1					
over 100kg	M1	M1	M1						

Appendix Six

Birth Register

Appendix 6. Birth register

Month Year.....

DOB	NAME	ADDRESS	TEL. NO	MOTHER		GP
				NAME	DOB	

MONTH..... YEAR

FEED	BW & GEST	PRIMARY VISIT	6/52	WEANING	HEARING	DEVELOPMENTAL SCREENING					COMMENTS	
						8/12	15/12	2yr	2.5yr	3yr		4yr

Appendix Seven

Letter to Mothers from Family Health Visitor

North Tees and Hartlepool 

NHS Trust

Peterlee Health Centre
Bede Way
Peterlee
Co Durham
SR8 1AD

Tel: 0191 586 2273
Fax: 0191 587 0646

Clinic Address

Date

Telephone number

Dear (name)

I would like to invite you take part in a study concerning weight gain and development of babies. We hope to develop a new method for detecting health and development problems at an early stage.

The research team includes a Health Visitor, a Doctor and a mother from this area who has a young child. Your own doctor knows about the study. Please take time to read the enclosed information sheet carefully and discuss it with your partner, friends, family and GP if you wish.

If you are willing to take part in the study, Mrs Pauline McDougall (the health visitor involved in the study) will visit you at home on two occasions. Firstly, when your baby is four months old and secondly when he/she is between nine and twelve months old. At these visits she will weigh and measure (name) and see how she/he is developing. This is similar to the routine health visitor check, using toys and taking the form of play, which babies usually enjoy. She will also ask you some brief questions about yourself and your family and about (name's) feeding and sleeping and health.

If you are interested in taking part, Mrs McDougall will contact you by telephone/letter in around one week to discuss the study further and to answer any questions you may have. She may be contacted at the Marlborough Surgery (0191 5130396).

Yours sincerely,

(Signature of family health visitor)

Appendix Eight

Information Sheet for Mothers



University of Durham

**Centre for Integrated Health
Care Research**
Wolfson Research Institute
Stockton on Tees

Information sheet

I would like to invite you to take part in a research project about weight gain and development in babies. Babies with fast, slow and those with average weight gain are to be included in the study.

Please take time to read the following information carefully and discuss it with your partner, friends, family and GP if you wish. If there is anything that is not clear or if you have any questions, please contact me.

Name of study

Early detection of slower weight gain in babies

Aim of Study

To measure babies weight gain over the few months to find out if slower weight gain affects the way in which babies develop.

Why do it?

To find out if babies weight gain in the first year affects the way in which they develop. If we can find babies who are growing slowly at the 6 week check, then in the future Health Visitors may be able to offer extra support or advice to help.

Who is involved?

The project team is:

Mrs Pauline McDougall (Health Visitor)

Miss Hilary Donaldson (Mother from the Easington area who uses the health visiting service)

Professor Pali Hungin (GP)

Dr Robert Drewett (Researcher, University of Durham)

Dr Charlotte Wright (Senior Lecturer in Community Child Health)

How might it benefit people?

If babies who are gaining weight slowly can be helped early, then this might have benefits for their future health and development.

What does it involve?

Pauline McDougall (a health visitor working in the Easington area) will visit you and your baby when she is between four and six months old and again at around 9 to 12 months of age. She will be looking at your baby's development using toys and play. She will also ask you some brief questions about your family and about your baby's feeding, sleeping and health.

How much of my time will be involved?

Approximately 30 - 45 minutes on two separate visits. One visit when your baby is around 4 - 8 months, and one when she is around 1 year.

Does it require specimens eg blood?

No.

How will confidentiality be maintained?

The identity of babies who take part in the study will be known only to Mrs McDougall (Health Visitor) and your own Health Visitor. The same rules of confidentiality apply as with your own health visitor.

Do I have to take part?

Your participation is voluntary.

Will my care be different?

No. You will receive the same care from your own health visitor that you would normally receive. The results of the study will only be of benefit to babies in the future.

Appendix 8. Information sheet for mothers

How long will it take for the study to be completed?

The study will run from August 2001 until August 2004

Will I receive a report if I want one?

Yes. This will be available from Mrs McDougall when the study is completed.

Does the study have ethics approval?

Yes. Approval has been given by Durham, Sunderland and Hartlepool Local Research Ethics Committees for the study to be carried out.

Can I withdraw at any stage?

Yes you are free to change your mind at any time, without this having any influence on the care you would usually receive.

Where can I get more information or make enquiries at any stage?

From Mrs Pauline McDougall (Health Visitor)

Marlborough Surgery

Marlborough

Seaham

Co. Durham

SR7 7SA

Telephone 0191 5130396 work

5171632 home

e-mail paulinemcdougall@msn.com

Thank you for taking part in this study.

Appendix Nine

Local Research Ethics Committee Consent Form

Appendix 9. Local Research Ethics Committee Consent Form

Hartlepool Local Research Ethics Committee

c/o Wynyard Road, Hartlepool TS25 3LQ

Tel: 01429 263589

CONSENT FORM FOR A MINOR TO TAKE PART IN RESEARCH

Name of Research Project: Early Screening for Slow Weight Gain

Name of Child

I, acting as the parent/guardian of the above named child give my consent to his/her taking part in the research project named above.

I understand that the research is designed to add to medical knowledge.

I have read the note of explanation about the study. This is attached and I have had time to think about it.

I have had the study explained to me by Pauline McDougall (Health Visitor)

I have been told that I can withdraw my consent at any stage without giving a reason and without prejudice to my treatment.

I understand that sections of any of my medical notes may be looked at by responsible individuals from the project team. I give permission for these individuals to have access to my child's records.

I know that if I become dissatisfied as a result of taking part in this research, I can speak to or write to the Local Research Ethics Committee.

I have been given a copy of this consent form.

Signed

Date

1 for patient; 1 for researcher; 1 to be kept with Health visiting records.

Appendix 9. Local Research Ethics Committee Consent Form

Durham Local Research Ethics Committee Ethics Consent Form.
CONSENT FORM

Patient Identification Number
Title of Project: Early Screening for Failure to Thrive

Names of Researchers:
Mrs Pauline McDougall (Health Visitor/ Researcher)
Professor Pali Hungin (GP, Professor of Primary Care and General Practice, Director
of Northern Primary Care Research Network)
Dr Robert Drewett (Reader in Psychology, University of Durham)
Dr Charlotte Wright (Senior Lecturer in Community Child Health, Consultant
Paediatrician)

Please initial box

- 1. I confirm that I have read and understand the information sheet
dated (version) for the above study and have had
the opportunity to ask questions. []
- 2. I understand that my participation is voluntary and that I am free
to withdraw at any time without giving any reason, without my
medical care or legal rights being affected. []
- 3. I understand that sections of any of my medical notes may be
looked at by responsible individuals from the project team. []
I give permission for these individuals to have access to my records.
- 4. I agree to take part in the above study.

Name of patient	Date	Signature
-----------------	------	-----------

Name of person taking	Date	Signature
-----------------------	------	-----------

consent if different from
researcher

1 for patient; 1 for researcher; 1 to be kept with Health Visiting records.

Appendix 9. Local Research Ethics Committee Consent Form

Sunderland Local Research Ethics Committee

FORM SLREC 4

I

of.....

.....

hereby give consent for my son / daughter to be a subject in the study entitled:-

Early Screening for Failure to Thrive

The nature of which has been explained to me by Mrs Pauline McDougall (Health Visitor).

*Professor A.P.S. Hungin is the consultant in charge of this project. Mrs McDougall is responsible for the day to day management of the project and carrying out the research.

I understand that sections of any of my medical notes may be looked at by responsible individuals from the project team. I give permission for these individuals to have access to my child's records.

I give permission under the expressed understanding that my son / daughter may be withdrawn from the study at any time and that am free to change my mind at any stage, without giving a reason.

Date Signed.....

Mother

I confirm that I have explained the nature, purpose and implications of the above study to the person who signed the above form of consent.

Date..... Signed.....

Researcher/project manager

1 for patient; 1 for researcher; 1 to be kept with Health Visiting records.

Appendix Ten

Questionnaire

Baby's ID

This questionnaire is the property of Pauline McDougall,

Health Visitor/Researcher

Marlborough Surgery

Seaham

County Durham

SR7 7SA

Telephone 0191 5130396

Confidential

Appendix 10. Questionnaire

Date of interview (as 11/May/2001) _____

Mother's DOB (as 21/Sep/2001) _____

Mother's age _____ years

Mother's height (measured) _____ cm

Father's height (as reported by mother) _____ feet _____ inches
(or _____ cm)

Baby's DOB (as 21/Sep/2001) _____

Baby's age _____ weeks

Baby's weight (measured) _____ kg

Baby's length (measured) _____ cm

Baby's head circumference (measured) _____ cm

What other adults are living with you?

Husband/partner (Yes = 1; no =2) _____

Parents (Yes = 1; no =2) _____

On your own (Yes = 1; no =2) _____

How many children have you had altogether?

Girls (0,1,2, etc) _____

Boys (0,1,2, etc) _____

How many children of your own are living with you?

Girls (0, 1, 2 etc) _____

Boys (0, 1, 2 etc) _____

Are there any other children living with you?

Girls (0, 1, 2 etc) _____

Boys (0, 1, 2 etc) _____

Mother's ethnic origin

White (= 1)

Afro-Caribbean (= 2)

Asian (= 3)

Other (= 4) _____

Does anyone in your household earn a wage at the moment?

(Yes = 1; no =2) _____

Does your household own or rent your house or flat?

- Owns (with or without mortgage) = 1
- Rents from local authority =2
- Rents from private landlord (furnished) =3
- Rents from private landlord (unfurnished) =4
- Rents from housing association =5
- Rents from employer =6
- Tied house =7 _____

Does anyone in your household own a car?

- No = 1
- Yes, one car = 2
- Yes, more than one car = 3 _____

If no: do you have the use of a car?

- (Yes = 1; no =2) _____

Is there a working installed telephone in your house (not a mobile)?

- (Yes = 1; no =2) _____

Do you have a mobile phone?

- (Yes = 1; no =2) _____

Appendix 10. Questionnaire

How old were you when you finished full-time education?

(enter -1 for 'not yet finished')

_____ years

Did you gain any qualifications at school or later?

(Yes = 1; no = 2)

If yes, can you tell me which qualifications you have?

Tick

- | | |
|---|------------|
| Higher degree of UK institution | _____ = 01 |
| Post graduate diploma or certificate, excluding PGCE | _____ = 02 |
| PGCE with QTS/GTC registration | _____ = 03 |
| PGCE without QTS/GTC registration | _____ = 04 |
| Postgraduate equivalent qualification not elsewhere specified | _____ = 05 |
| Undergraduate qualifications with QTS | _____ = 10 |
| First degree of UK institution | _____ = 11 |
| Graduate of EU institution | _____ = 12 |
| Graduate of other overseas institution | _____ = 13 |
| GNVQ/GSVQ level 5 | _____ = 14 |
| NVQ/SVQ level 5 | _____ = 15 |
| Graduate equivalent not elsewhere specified | _____ = 16 |
| O.U credits | _____ = 21 |
| Other credits from UK HE institution | _____ = 22 |

Appendix 10. Questionnaire

Certificate or Diploma of Education (i.e. non-graduate initial teacher training qualification).	___ = 23
HNC or HND (including BTEC and SCOTVEC equivalents)	___ = 24
Dip HE	___ = 25
GNVQ/GSVQ level 4	___ = 26
NVQ/SVQ level 4	___ = 27
Professional qualifications	___ = 28
Foundation course at HE level	___ = 29
Other HE qualification of less than degree standard	___ = 30
A-level equivalent qualification not elsewhere specified	___ = 39
Any combinations of GCE A-level Higher and GNVQ/GSVQ or NVQ/SVQ at level 3	___ = 40
ONC or OND (including BTEC and SCOTVEC equivalents)	___ = 41
Foundation course at FE level	___ = 43
Baccalaureate	___ = 47
Access course	___ = 48
GCSE/O-level qualifications only; SCE O grades & Standard grades	___ = 55
Other non-advanced qualification	___ = 56
Accreditation of Prior (Experiential) Learning (APEL/APL)	___ = 92
Mature student admitted on the basis of previous experience (without formal APEL/APL) &/or institution	___ = 93
Other non-UK qualification, level not known	___ = 97
No formal qualifications	___ = 98
Not known	___ = 99

Appendix 10. Questionnaire

Enter highest qualification _____

Do you smoke at all ?

(Yes = 1; no =2) _____

Have you ever breast fed this baby (even once)?

(yes =1; no = 2) _____

Are you still breast feeding your baby at all?

(yes =1; no = 2) _____

If yes

How often do you breast feed your baby now?

Once a day =1

Twice a day =2

3-4- times a day =3

5-6- times a day =4

7-8 times a day =5

More than 8 times a day =6 _____

If no

How old was your baby when you last breast fed him/her? _____ days or _____

weeks

Appendix 10. Questionnaire

Do you give your baby any milk from a bottle at present (apart from expressed breast milk)?

(yes =1 ; no = 2)

Do you give your baby food such as a cereal, rusks or any kind of solid food including any that you make yourself?

(yes = 1 ; no = 2)

If yes

How old was your baby when they

first had any food apart from milk?

_____ weeks

In the first two months did your baby show any of the following

Slow feeding (Yes, often =1; yes sometime = 2; no, never = 3) _____

Weak sucking (Yes, often =1; yes sometime = 2; no, never = 3) _____

Taking only small quantities at each feed

(Yes, often =1; yes sometime =2; no, never =3) _____

After two months, did your baby show any of the following?

Slow feeding

(Yes often =1; yes sometime = 2; no, never = 3) _____

Refused to take breast milk

(Yes often =1; yes sometime = 2; no, never = 3; never offered =4) _____

Refused to take other milk

(Yes, often =1; yes sometime = 2; no, never = 3; never offered =4) _____

Refused to take solids

(Yes, often =1; yes sometime = 2; no, never = 3; never offered = 4) _____

Do you feel you ever had any difficulties feeding your baby?

- Yes, great difficulty (= 1) _____
- Yes, some of the time (= 2) _____
- No, not at all (= 3) _____

Turning now to your baby's sleeping ...

How often has your baby woken at night over the last week?

- | | | |
|------------------------|-------|-------|
| Never | (=1) | |
| Occasionally | (=2) | |
| Most nights | (=3) | |
| Once every night | (=4) | |
| More than once a night | (=5) | |
| – How many times? | _____ | |
| Don't know | (=6) | _____ |

Appendix 10. Questionnaire

If your baby wakes at night what do you do?

(circle one)

	Always	Usually	Sometimes	Never
Feed her	1	2	3	4
Give drink of water	1	2	3	4
Rock or cuddle her	1	2	3	4
Give her a dummy	1	2	3	4
Bring baby into your bed	1	2	3	4
Change nappy	1	2	3	4
Other – please describe				

Do you ever wake your baby for a feed?

During the night

- Yes usually (=1)
- Yes sometimes (=2)
- No never (=3) _____

During the day

- Yes usually (=1)
- Yes sometimes (=2)
- No never (=3) _____

How would you describe your baby's health?

- Good (=1)
- Average (=2)
- Not very good (=3) _____

Did your baby have any major health problems at birth?

No (=1)

Yes (=2) _____

Give details _____

Has your baby had developed any major health problems since?

No (=1)

Yes (=2) _____

Give details _____

Who did you see about this?

How would you describe your own health?

Good (=1)

Average (=2)

Not very good (=3) _____

Measurements as recorded in parent held child health record

Birth weight _____ Weight at 6 week medical _____

Length at 6 week medical _____ OFC at 6 week medical _____

Other weights from child health record

Date	Weight		Date	Weight		Date	Weight

Has your baby had any health development or feeding problems since my last visit?

Yes = 1

No = 2 _____

If yes, give details?

Appendix 10. Questionnaire

Date of 2nd Bayley assessment ___ ___ ___ Age in weeks _____

Weight __. __

Length __. __

OFC __. __

Date of 7 – 9 month HV check (if recorded)

Weight __. __

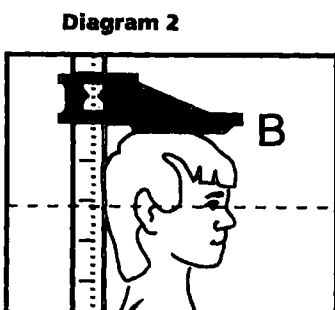
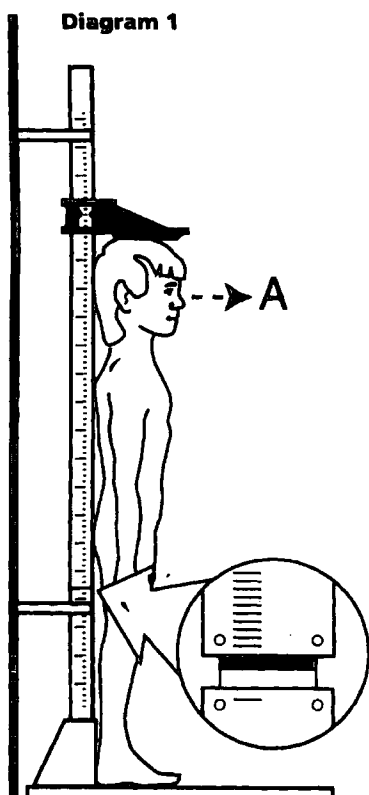
Length __. __

OFC __. __

Appendix Eleven

Procedure for Measuring Height

Leicester Height Measure



A precision instrument for measuring children and adults from 75cm [approx 2ft 6 in] - 205cm [approx 6ft 9in]. Recommended by Child Growth Foundation.

Installing the Leicester Height Measure

Slot the white upright sections firmly together* and ensure that the bottom section locks into the blue base. Slide on the measuring arm and position the 2 white stabilisers as required [see diagram 1]. Ensure the stabilisers stay clear of the joints. The base should be placed on a firm uncarpeted surface with the stabilisers resting against a wall/door to give the Leicester rigidity.

NB: The Metric and Imperial scales are calibrated to take account of the 3cm difference between the black measurement arrow and the flat surface of the measuring arm.

5 easy steps to Accurate Measurement

- 1 Stand subject on the "feet" preferably barefoot with his/her heels together and touching the backstop. The spine at pelvis and shoulder level should touch the upright. Shoulders should be relaxed, arms to the side. Remove headgear [bows, ribbons etc.] where possible.
- 2 Lower the measuring arm onto the head and position the head so that an imaginary horizontal line runs between the earhole and the lower border of the eye socket [see diagram 2].
- 3 Ask the subject to stand up straight.*
- 4 Read off the Metric height to the last completed millimetre. Do not round up! Measure with care.
- 5 Record the height in the boxes provided on the subject's PCHR, record card or centile chart. Date and Initial your entry and then plot your measurement - again with care.

[* tip: you need assemble only 2 or 3 upright sections if you are measuring young children. NB: Children under 18 months or who are not able to stand straight should be measured supinely].

This Leicester Height Measure has been distributed by the: **Child Growth Foundation,**

Appendix Twelve

Higher Education Statistics Agency Codes

Dear Pauline

Thank you for your enquiry.

I have spoken to my colleagues regarding the use of our Highest Qualification on Entry field for your questionnaire. There doesn't appear to be any problems with you using the same breakdown as the one we use. These are our categories along with the corresponding codes as used in the 1999/2000 Student data collection:

Higher degree of UK institution

Postgraduate diploma or certificate, excluding PGCE

PGCE with QTS/GTC registration

PGCE without QTS/GTC registration

Undergraduate qualifications with QTS

Graduate of EU institution

{14} GNVQ/GSVQ level 5*

{15} NVQ/SVQ level 5

{16} Graduate equivalent qualification not elsewhere specified

{21} O.U. credit(s)

{22} Other credits from UK HE institution

{23} Certificate or Diploma of Education (i.e. non-graduate initial teacher training qualification)

{24} HNC or HND (including BTEC & SCOTVEC equivalents)

{25} DipHE

{26} GNVQ/GSVQ level 4*

{27} NVQ/SVQ level 4

{28} Professional qualifications

{29} Foundation course at HE level

- {30} Other HE qualification of less than degree standard
- {39} A-level equivalent qualification not elsewhere specified
- {40} Any combinations of GCE A-level/SCE Higher & GNVQ/GSVQ or NVQ/SVQ at level 3
- {41} ONC or OND (including BTEC & SCOTVEC equivalents)
- {43} Foundation course at FE level
- {47} Baccalaureate
- {48} Access course
- {55} GCSE/O-level qualifications only; SCE O grades & Standard grades
- {56} Other non-advanced qualification
- {92} Accreditation of Prior (Experiential) Learning (APEL/APL)
- {93} Mature student admitted on basis of previous experience (without formal APEL/APL) &/or institution
- {97} Other non-UK qualification, level not known
- {98} Student has no formal qualification
- {99} Not known

I am also including our definition of Highest Qualification on Entry (see below) which I hope you will find useful.

If you have any further queries, please do not hesitate to contact me.

Regards,

Suzie Dent
Data Provision Officer
HESA
Tel: 01242 211133
Fax: 01242 211122

Highest Qualification on Entry

It should be noted that a student's highest qualification on entry is not necessarily that required for entry to the institution. Categories used are:

Postgraduate qualifications (excluding PGCE) includes all postgraduate degrees, diplomas and certificates excluding the Postgraduate Certificate of Education (PGCE).

PGCE - as described with and without QTS/GTC registration.

First degree of UK institution - as described plus undergraduate qualifications with QTS.

Other graduate and equivalent qualifications include graduate qualifications obtained outside the UK, NVQ/SVQ level 5 plus any other qualifications at graduate level not listed above.

HE credits include Open University credits and credits from other UK HE institutions.

Other HE and professional qualifications include certificates and diplomas of education, HNC or HND (including BTEC and SCOTVEC equivalents), diplomas

in HE, NVQ/SVQ level 4, professional qualifications, foundation courses at HE level and other HE qualifications of less than degree standard.

GCE A-level, SCE Highers and equivalent - includes any combination of those described plus GNVQ/GSVQ level 3, NVQ/SVQ level 3, ONC or OND (including BTEC and SCOTVEC equivalents).

A-level equivalent qualifications - as described.

Access courses - as described (both accredited and unaccredited).

GCSE/O-level qualifications only; SCE O grades and Standard grades – as described.

Other qualifications include Baccalaureate, foundation courses at FE level, and any other qualifications not listed above.

No formal qualification required/held - the institution does not require the student to hold a qualification on entry or it is known that the student has no formal qualification.

Not known/sought - nothing is known about the student's qualifications on entry to their programme of study.

Appendix Thirteen

Letter to GPs



University of Durham

Centre for Integrated Health Care Research
School for Health
Wolfson Institute
Stockton on Tees

Dear Doctor (name)

I am planning a research project concerning the early detection of failure to thrive in infants. The purpose of this letter is to inform you of the study and to give you information about it. The project is primarily a Health Visiting study. It does not involve General Practitioners directly. I have been seconded by North Tees and Hartlepool NHS Trust, and funded by Easington Primary Care Group and the Durham Health Authority research training sponsorship scheme.

The study has the full support of Dr Roger Bolas and Easington Primary Care Group, Mr Aiden Mullen, Director of Nursing, Mrs Enid Hazle, Health Visitor Manager. It is being carried out in collaboration with Dr Robert Drewett and Professor Pali Hungin, both of the University of Durham and Dr Charlotte Wright, Senior Lecturer in Community Child Health, Newcastle Upon Tyne. Ethical approval has been obtained from the Local Research Ethics Committees.

I enclose details for your information. This is a health visiting study and does not require any input from you. However, if you are interested in the study and would like to be involved, we would be delighted to welcome you to our project meetings. Please do not hesitate to contact me at the Marlborough surgery, on 0191 5130396 should you require any further information.

Yours sincerely,

Pauline McDougall (Health Visitor / researcher)

Copy to (name) practice manager

Appendix Fourteen

Information Sheet for General Practitioners

Appendix 14. Information sheet for General Practitioners

Title of Project:

Early Screening for Failure to Thrive

Aim of Study:

To determine:

The extent to which a sample of children screened for poor weight gain at the 6-8 week check go on to show the classic symptoms of poor growth and developmental delay found in older children who fail to thrive

The proportion of children in the whole population who fail to thrive who were identified at the 6-8 week check. This information will enable us to improve the effectiveness with which routinely collected data are utilised to identify infants at risk

What does it involve?

Failure to thrive (poor weight gain) in infancy is associated with poor subsequent growth and development and is particularly prevalent in deprived communities. There is evidence that it can be treated effectively by health visitors with limited specialist support, but it is often only detected late in the first year. This project is different from previous studies of failure to thrive as it aims to implement an explicit screening programme for the early detection of children whose weight gain is poor, at the 6-8 week check. Data will be retrieved from the Health Visitors records.

Using weights routinely recorded at birth and at the 6-8 week check (from every G.P. practice in the Easington area), a population of 2000 infants will be screened for poor early weight gain using a 'thrive index', a recently developed indicator of failure to thrive suitable for use in the early months.

The infants so identified will be examined developmentally at 4 and 9-12 months using the Bayley Scales of Infant Development (2nd ed). This is a standardised, individually administered examination which assesses the current developmental functioning of infants and young children, from the age of one to forty two months of age. It consists of three scales; the Mental Scale, Motor Scale and Behaviour Rating Scale. The Mental and Motor Scales assess the child's level of cognitive language, personal-social and fine and gross motor development. The Behaviour Rating Scale assesses the child's behaviour during testing. Weight gain over the first year for the whole screened population will also be collated from routine NHS records.

The Bayley scales were published in 1969 and have been extensively used to document the differences between normal infants and those born at risk.

Appendix 14. Information sheet for General Practitioners

They were revised and modernised in 1993 (2nd edition) following extensive validation and statistical verification.

Who is involved?

The project team is:

Mrs Pauline McDougall (Health Visitor/ Researcher)

Professor Pali Hungin (GP, Professor of Primary Care and General Practice, Director of Northern Primary Care Research Network)

Dr Robert Drewett (Reader in Psychology, University of Durham)

Dr Charlotte Wright (Senior Lecturer in Community Child Health)

Miss Hilary Donaldson (Lay Representative, Mother from the Easington area who uses the health visiting service)

Does it require specimens eg blood?

No.

Why do it?

Earlier detection of failure to thrive will enable Health Visitors to aim health promotion interventions at this group. If babies who fail to thrive can be helped early then this could have benefits for their future health and development.

How will confidentiality be maintained?

The identity of babies who take part in the study will be known only to Mrs Pauline McDougall (Research Health Visitor), the nursery nurse working under her supervision and the baby's own health visitor. The usual rules of confidentiality will apply (as with the Health Visitor attached to your practice). If during the course of the research I encounter any major problems of growth and development I will check that your Health Visitor is aware of them. No patient identifiable data will leave the practice.

Will I receive a report if I want one?

Yes. Please contact Pauline McDougall.

How long will the study take?

The study will run from August 2001 until August 2004

Appendix 14. Information sheet for General Practitioners

Does the study have ethics consent?

Yes. Consent has been given by the Local Research Ethics Committees.

Where can I get more information or make enquiries at any stage?

From:

Mrs Pauline McDougall

Marlborough Surgery

Seaham

Co. Durham

SR7 7SA

Telephone 0191 5130396

e-mail paulinemcdougall@msn.com

Professor A.P.S Hungin.

Centre for Health Studies

32 Old Elvet

Durham

DH1 3HN

Telephone 0191 3741842

E-mail A.P.S.Hungin@durham.ac.uk

Appendix Fifteen

Information Sheet for Health Visitors

Title of Project:

Early Screening for Failure to Thrive.

Aim of Study

To determine:

The extent to which a sample of children screened for poor weight gain at the 6-8 week check go on to show the classic symptoms of poor growth and developmental delay found in older children who fail to thrive.

The proportion of children in the whole population who fail to thrive who were identified at the 6-8 week check. This information will enable us to improve the effectiveness with which routinely collected data are utilised to identify infants at risk.

What does it involve?

Failure to thrive (poor weight gain) in infancy is associated with poor subsequent growth and development and is particularly prevalent in deprived communities. There is evidence that it can be treated effectively by health visitors with limited specialist support, but it is often only detected late in the first year. This project is different from previous studies of failure to thrive as it aims to implement an explicit screening programme for the early detection of children whose weight gain is poor, at the 6-8 week check. Data will be retrieved from the health visitors records.

Using weights routinely recorded at birth and at the 6-8 week check (from every G.P. practice in the Easington area), a population of 2000 infants will be screened for poor early weight gain using a 'thrive index', a recently developed indicator of failure to thrive suitable for use in the early months.

The infants so identified will be examined developmentally at four months and nine - 12 months using the Bayley Scales of Infant Development (2nd ed). This is a standardised, individually administered examination which assesses the current developmental functioning of infants and young children, from the age of one to forty two months of age. It consists of three scales; the Mental Scale, Motor Scale and Behaviour Rating Scale. The Mental and Motor Scales assess the child's level of cognitive language, personal-social and fine and gross motor development. The Behaviour Rating Scale assesses the child's behaviour during testing.

The Bayley scales were published in 1969 have been extensively used to document the differences between normal infants and those born at risk. They were revised and

Appendix 15. Information sheet for Health Visitors

modernised in 1993 (2nd edition) following extensive validation and statistical verification. Weight gain over the first year for the whole screened population will also be collated from routine NHS records.

Who is involved?

The project team is:

Mrs Pauline McDougall (Health Visitor/ Researcher)

Professor Pali Hungin (GP, Professor of Primary Care and General Practice, Director of Northern Primary Care Research Network)

Dr Robert Drewett (Reader in Psychology, University of Durham)

Dr Charlotte Wright (Senior Lecturer in Community Child Health)

Miss Hilary Donaldson (Lay Representative, Mother from the Easington area who uses the health visiting service)

Does it require specimens eg blood?

No.

Why do it?

Earlier detection of failure to thrive will enable Health Visitors to aim health promotion interventions at this group. If babies who fail to thrive can be helped early then this could have benefits for their future health and development.

How will confidentiality be maintained?

The identity of babies who take part in the study will be known only to Pauline McDougall, a nursery nurse working under her supervision and the baby's own health visitor. The usual rules of confidentiality apply. If during the course of the research I encounter any major problems of growth and development I will check that the family health visitor is aware of them.

Will I receive a report if I want one?

Yes. Please contact Pauline McDougall.

How long will it take?

The study will run from August 2001 until August 2004.

Appendix 15. Information sheet for Health Visitors

Does the study have ethics consent?

Yes. Consent has been given by the Local Research Ethics Committee.

Where can I get more information or make enquiries at any stage?

Mrs Pauline McDougall (Health Visitor)

Shotton Clinic

Telephone 0191 5267832

e-mail paulinemcdougall@msn.com

Professor A.P.S. Hungin

(Dean of Medicine, Professor of Primary Care and General Practice)

Centre for Integrated Health Care Research

Wolfson Institute

Queens Campus

University of Durham

E-MAIL A.P.S.Hungin@durham.ac.uk

Appendix Sixteen

Letter from Researchers to Mothers



University of Durham

Centre for Integrated Health Care Research
School for Health
Wolfson Institute Stockton on Tees

Dear (name),

You have received a letter from your health visitor (name) inviting you to take part in a study about babies weights. I would like to visit you at home to discuss the study and answer any questions you might have.

If you are willing to take part in the study I will visit you at home on two occasions. Firstly, when (name) is around 7 months old and secondly when she is 12 months old. At these visits I will weigh and measure (name) and see how she is developing. This is similar to the check carried out by your own Health Visitor, using toys and taking the form of play, which most babies find enjoyable.

I would like to visit you on (date). If this appointment is inconvenient please do not hesitate to contact me at the Marlborough Surgery (0191 5130396) to arrange a more suitable time. I look forward to meeting you and your baby.

Yours sincerely,

Pauline McDougall (Health Visitor / researcher)

Appendix Seventeen

Bayley Scales Certificate

CERTIFICATE OF ATTENDANCE

PAULINE MCDUGALL

ATTENDED THE ONE DAY WORKSHOP

**BAYLEY SCALES OF
INFANT DEVELOPMENT (BSID II)**

**HELD AT:
THE ROYAL FREE HAMPSTEAD NHS TRUST, LONDON
ON**

14TH MAY 2001



**BETTY HUTCHON
COURSE TUTOR**

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