Review

Weight monitoring of breastfed babies in the United Kingdom – interpreting, explaining and intervening

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Abstract

Weighing infants in their first 6 months is an important aspect of growth monitoring and a common activity of child health care services worldwide. During the same 6 months, support for establishing breastfeeding and the promotion of continued exclusive breastfeeding are important activities of health professionals. Parents and health professionals may perceive conflicts between achieving both robust growth and continuing breastfeeding. In this narrative review, the literature on weighing breastfed babies in the United Kingdom is examined. A companion paper examined issues of growth charts, scales and weighing frequency and accuracy. This paper considers issues of interpretation of the plotted weight values for individual breastfed babies, noting the complexities of growth patterns, which may lead to difficulties of accurate identification of those individuals whose growth merits further investigation. Little attention has been given to issues of explaining the interpreted growth curves to parents and this issue is explored and noted as of importance for further study. Research evidence on choosing appropriate interventions to improve the growth of breastfed babies is reviewed. The paucity of such evidence leads to suggestions for future study. This review gathers together a wide range of literature from many different perspectives, with the hope of informing weight monitoring practice so that this can both identify infants whose weight may be of concern, and who may need appropriate intervention, and support continued breastfeeding.

Keywords: breastfeeding, infant growth patterns, growth monitoring, weighing infants.

Introduction

Improving breastfeeding duration is a public health goal in the United Kingdom. Monitoring babies' weights provides a focus for interactions between mothers and health care providers. A companion paper examined issues of chart design and weighing frequency and accuracy (Sachs *et al*., 2005). This current paper aims to examine:

- the interpretation of the meaning of charted weight trajectories by health professionals;

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• the communication of the meaning of fluctuations shown on the chart from health professional to parent; and
• the type of interventions considered when there is concern, and the type and availability of specialist input, with particular focus on the breastfed baby and supporting breastfeeding.

Aims and methods of the review

In a Cochrane review, Panpanich & Garner (2003) conclude that there has been a great level of investment but 'little research evaluating . . . potential benefits and harms' of weight monitoring (p. 1). This review surveys a wide range of the disparate literatures relevant to routine weighing of breastfed babies in order to shed light on issues of relevance. Ideally, original research evidence would be available for all aspects of interest: in the absence of a consistent level of such evidence, this review is inclusive rather than proscriptive and seeks to investigate widely. A fuller description of the review rationale is given in Sachs *et al*. (2005). A major conclusion is that the potential literature is vast and covers many disciplines, resulting in a review which does not provide answers to discrete questions, but attempts to map a wide canvas, and delineate areas in which further detailed research, audit, review and reflection are needed.

Databases searched: Medline, CINAHL, Cochrane, British Nursing Index, MIDIRS. Many references from identified papers were followed up. Search terms: growth monitoring; growth chart; baby weight; infant weight; breastfeeding; scales.

What is known about these issues of weighing breastfed babies in the UK?

'Insufficient breast milk' is a major reason given for supplementation and abandonment of breastfeeding. Infant weight gain may be used to confirm a perception of breast milk insufficiency.

Interpretation of the weight gain trajectory of an individual baby is complex.

Faltering growth can signal a number of possible problems; these may include aspects of breastfeeding.

UK parents hold their child's plotted growth chart, but receive little information on how to interpret it.

Breastfeeding and its uptake in the UK

Breastfeeding is recognized internationally as an important part of child health and survival (WHO, 2002). Recommendation in the UK is for babies to be breastfed exclusively (with no supplements of formula, food or water) until 6 months (Department of Health, 2003). Differences in a variety of health outcomes have been documented between breastfed and never breastfed babies [Heinig & Dewey, 1996; American Academy of Pediatrics (AAP), 1997]. Breastfeeding also has a positive impact on the subsequent health of women (Heinig & Dewey, 1997). It has long been acknowledged that breastfeeding provides an important protection against mortality in developing countries (WHO, 2000) and this has recently also been found to pertain to developed countries (Chen & Rogan, 2004). An increased conviction can be noticed in the statements about the importance of breastfeeding for UK babies, over the past decade (Standing Committee on Nutrition British Paediatric Association, 1994; Nicoll & Williams, 2002).

Is the most recent of a series of six 5-yearly surveys commissioned by the UK Departments[1] of Health, 13 000 women were sent questionnaires, with respondents followed up for a second and third stage. Seventy-two per cent of women responded at the initial stage (babies were on average 46 days old), with 63% and 55% of the initial sample responding at stages two and three (4–5 months and 9 months, respectively). This survey provides the most comprehensive national picture of infant feeding practice in the UK. In 2000, 69% of women in the UK ever breastfeed, and by the time the baby was 6 weeks old, 42% were breastfeeding at all. At the time of the survey, policy was that babies be breastfed for 4–6 months (COMA, 1994): it can be seen that practice fell short of recommendations.

[1]The Department of Health, the Scottish Executive, The National Assembly for Wales, and the Department of Health, Social Services and Public Safety in Northern Ireland.

Insufficient milk and infant weight gain

A variety of factors appear to influence women; issues of weight gain are just one of these. In the first 2 weeks, 'baby falling asleep/slow feeding/not gaining weight' was reported by roughly 10% of *all* women (Hamlyn *et al*., 2002, p. 118), while at 4–5 months, 6% of breastfed and 5% of non-breastfed babies were 'not gaining weight' (p. 129). Thus, concerns about weight gain are not confined to breastfed babies, although some of the formula-fed babies may have been previously breastfed: it would be interesting to know how many never breastfed babies caused concern.

Hamlyn *et al*. (2002) note that 'insufficient milk' is the most common reason given for stopping breastfeeding between 1 week and 4 months. It has been debated whether poor breastfeeding technique; following inappropriate rules limiting feed timing and duration, and lack of skilled assistance creates an iatrogenic physical lack of milk or whether poor understanding of the physiology of breastfeeding creates a 'perceived insufficient milk syndrome' (see Dykes & Williams, 1999 for fuller discussion).

A perception of insufficient milk may be based on physiological reality. In a Swedish study, 51 women committed to breastfeeding were followed longitudinally to 18 months. Those who experienced 'transient lactation crises', about the adequacy of their milk supply, had babies who were consistently lighter than others – although all babies grew well (Hillervik-Lindquist *et al*., 1991). An understanding for an individual mother that milk supply is sometimes problematic may be related to physical production which is adequate, rather than bountiful.

Level of concern about infant weight gain – and effects on breastfeeding

Although concern about infant weight gain has been cited as a factor undermining breastfeeding, few studies have directly investigated this. More research which attempts to understand the influence of routine weighing would be worthwhile. Insights can, however, be gleaned; for example, a questionnaire sent to a cohort of 576 UK mothers showed that of those who discontinued breastfeeding by 28 days, 50% did so because of worries about the volume of milk the baby was taking or the baby's weight gain (Wylie & Verber, 1994). Longitudinal telephone interviews on feeding practices with 2450 Italian women showed a small, but significant, relationship between lower infant body weight at 1 month of age and a shorter duration of exclusive breastfeeding (Giovannini *et al*., 2004). Audits of telephone calls received, by two volunteer breastfeeding organizations, showed that in Australia, 15% of callers whose babies were 0–3 months and 17% whose babies were 3–6 months were concerned about the baby's weight (Grieve & Howarth, 2000). In the UK, 11% of all callers to a national telephone helpline mentioned their baby's weight gain as a concern (Broadfoot *et al*., 1999).

Qualitative literature also provides indications of the impact of weighing and concern with milk quantity. Six out of 10 women interviewed longitudinally in North-west England expressed concerned that they might not have adequate milk, with four discontinuing breastfeeding for this reason (Dykes & Williams, 1999). Women in this study who did not focus on the weight gain to gauge breastfeeding success breastfed for longer. A small USA study found that bottle-feeding women felt they could judge the adequacy of their baby's nutrition by measuring the amount of formula given as well as weighing the baby, but breastfeeding women had only the latter, and this quantifiable measure of breastfeeding success was reinforced in encounters with health professionals (Marchand & Morrow, 1994).

Behague's (1993) ethnographic study in Brazil found that breastfeeding women in a low socio-economic setting, who had previously identified themselves as having 'weak milk', responded to weight monitoring positively. They valued the air of scientific authority conveyed by being able to refer to the chart and its interpretation. However, as they placed a strong emphasis on keeping infants' weights up, they sometimes gave supplements in order to *prevent* falls, not just in response. Thus, weighing, while valued by mothers, impacted negatively on breastfeeding.

Interpretation

Researchers and clinicians have remarked on the difficulties of interpreting an individual baby's plotted growth trajectory (Davies & Williams, 1982; Davies, 2000; Elliman *et al*., 2002; Wright, 2002; Hall & Elliman, 2003). Growth charts show population averages at any one age. Even where charts are based on longitudinal data, any one centile line may not represent the growth pattern of any individual baby.

Is charted weight a screening tool?

In literature on weight monitoring, charted weight gain trajectories are sometimes referred to as screening 'to detect individuals at greater risk of health or nutritional disorders' (de Onis *et al*., 1997, p. e9). However there is too low a level of sensitivity or specificity to allow growth monitoring alone to successfully screen individuals to identify pathology (Hall, 2000; NSC, 2000). Children who exhibit a sustained fall through two centile spaces 'only constitute a high risk group who would merit closer investigation, rather than a definite diagnostic group' (Wright, 2000, p. 7). It is unclear how far parents understand that plotted centiles require interpretation rather than representing an actual danger to the baby. In the new parent-held child health record (PCHR) (CGF/RCPCH, 2004), weighing is listed under 'checks' rather than 'screening' and stresses that both are 'done to pick up problems before they have been noticed' and 'can never be accurate in all cases' (p. 15). This caveat is in a different section from the one containing the weight charts, so this caution may not be picked up by parents when they study the chart.

Although weight monitoring is not considered to be sensitive enough to qualify as 'screening', it is interesting to note some general points about good practice for screening programmes. It is suggested that it is important to provide information on both the benefits and risks, so that individuals can decide whether to participate (Raffle, 2001). Clinicians are urged to consider the ethical implications of screening, and any adverse effects (Grimes & Schulz, 2002). Weighing the baby at a clinic visit is presented as taken-for-granted, and potential harms of weight monitoring have not been investigated (Garner *et al*., 2000; Panpanich & Garner, 2003). Public understanding of screening may include a belief that all detection can lead to prevention of morbidity or mortality, and misunderstanding the possibility of false positives and false negatives (Raffle, 2001). It would be useful to have a population study of babies weighed in a child health clinic, evaluating how many referrals on the basis of weight resulted in diagnoses or interventions and how many were missed (rate of false positives), and how many children later deemed to be of concern were not detected during routine monitoring (rate of false negatives). No such study has been found.

There is a need for clear information for parents, balancing the need for early detection for the few against raising anxiety for the many (Wright, 2000). If more comprehensive notes for parents on weight monitoring were provided in the PCHR, and consent sought before weighing took place (as in the screening model), this might provide a focus for more thorough explanation of what charted weights mean in relation to infant feeding and the health. Even if consent is not formal, but consists of asking whether parents want the baby weighed at any particular clinic visit, it could focus attention on the purpose of weighing and the possibility that it is not needed. This could be time consuming for health care professionals, but any resulting reduction in time spent on weekly or fortnightly weighing might compensate. It would be interesting to evaluate this approach on parents' confidence.

Literature for health visitors on weight monitoring

Health visitors regularly discuss routine weights with parents. There appears to be no one standard text used in the training of health visitors, or as a reference for the interpretation of plotted centile charts. A Health Visitors' Association (1979) publication, a quarter of a century ago, included an appendix on percentile charts, evidently introducing the concept and showed several sample charts with notes on interpretation. A more recent booklet gives information on taking good

measurements, and covers a few issues of interpretation (none directly relating to the breastfed baby), but is extremely brief (CGF, 2001). A manual gathering together some of the issues discussed in the previous paper on the design of growth charts, practical implications of these, and on issues of interpretation, might provide support for health visitors and consistency in interpretation, so improving both detection of babies with possible weight patterns of concern, and assurance on which patterns lie within normal limits. It would be important to discuss differences between formula- and breastfed babies. De Onis & Victora (2004) point to a worldwide need for training.

Interpretation of charted weight in the early weeks

It is expected that babies will lose weight immediately after birth, and regain this within 10–14 days. Sachs & Oddie (2002) reviewed literature on this for breastfed babies. Wright & Parkinson (2004) conducted a prospective cohort study of 961 term babies in the UK, and found that 20% of babies had not regained their birth weight by 12 days. Breastfed babies showed less mean weight gain, but this was accounted for by their greater birth weight (lighter babies lost less). The overall effect was that actual weights in the first fortnight were one half to one centile lower than growth charts (which do not depict any initial weight loss) would suggest, and the authors say clinicians 'should be warned of their major limitations in the first 3 weeks of life' (p. F256).

Wright (2000), states that 5% of UK infants shift up or down two intercentile spaces in the first 6 weeks, with less variability after this. It is not clear if this includes the effect of early postnatal weight loss and regain, but reinforces the need for cautious interpretation in the early weeks. By 6 weeks, 36% of women who began by breastfeeding have already ceased to give any breast milk (Hamlyn *et al*., 2002, p. 37).

Distinguishing different patterns of growth

Wright (2000) asserts that failure to thrive (FTT) – now more commonly referred to as 'faltering growth' (Underdown & Birks, 1999), is the main problem identified by routine weight monitoring in the UK. Other patterns of growth, which may be confused with faltering growth, are catch-down growth and a pattern of slow weight gain. Catch-up growth is another distinct pattern identified and discussed in the literature.

A table distinguishing between FTT and a slow weight gain pattern in a breastfed baby is available in a US medical text-book on breastfeeding (Lawrence & Lawrence, 1999, p. 404), and involves consideration of overall appearance, urine and stool output and breastfeeding indicators, as well as weight patterns. This is available, in expanded form, in another US publication (Mohrbacher & Stock, 2003), which is more likely to be accessible to UK health visitors but it is unknown how many health visitors have ready access to either of these texts.

Catch-up and catch-down growth are phenomena where a baby, relatively under- or over-nourished in the womb, climbs up or down the centiles to the growth pattern suggested by genetics (Tanner, 1989; Dettwyler & Fishman, 1992; Marcovitch, 1994). Chee (1997) in reviewing growth charts and breastfeeding, postulates that catch-down, where babies are 'offsetting their greater than average intrauterine growth with slower than average growth after birth', may be more likely for breastfed babies, because the uptake of breastfeeding is higher among women of higher social class, with better prenatal care and nutrition, and because women who smoke are less likely to breastfeed (p. 30). Wright (2002) provides pointers on distinguishing catch-down growth from faltering growth, using comparisons of parental centiles and noting that with catch-down growth, the length and weight centiles are likely to correspond and the former to be normal.

A recent retrospective analysis of 10 844 US children born in the 1960s and 70s showed 39% crossed two percentiles of weight-for-age in their first 6 months. The authors warn that clinicians need to be aware that such catch-up growth and catch-down growth during early childhood are normal phenomena affecting large numbers of children (Mei *et al*., 2004). The study did not investigate effects of feeding method.

A further issue in interpretation is the statistical 'regression to the mean' effect in which any individual who is charted as being near either end of the distribution of measurements in a population, will tend, over time, to have measurements that become more like the average (Cole, 1995).

All of this complicates interpretation of a charted growth curve. An absolute loss of weight, as in an episode of acute illness, should be easy to detect, allowing for variations in measurements. Corbett *et al*. (1996) cite a review finding that failure-to-thrive was commonly defined as falling below the third centile (Wilcox *et al*., 1989). They emphasise that it is the shape of the weight change trajectory which should be studied, with a fall of two standard deviations considered to be of concern (Wright, 2000). In recent practice, both measures are considered, with weights falling absolutely below the 0.4 centile on the UK90 chart deemed to 'require immediate referral' while those between the 0.4th and 2nd centile merit 'close observation' (Freeman *et al*., 1995, p. 23) and a change of two standard deviations or centile spaces meriting referral (Wright, 2000).

The different shape of the centiles on a growth chart based solely on breastfed babies adds to the complexities of interpretation when using a chart such as the UK90 which is only partially based on breastfed infants (Sachs *et al*., 2005). De Onis & Victora (2004) suggest 'anticipatory guidance to warn parents about the imperfections' of charts (p. 85). There is no study of breastfed babies in which some were charted on the UK90 chart and some on the 'Breast from Birth' chart, comparing rates of referral, supplementation, and levels of parental anxiety about weight, on which to base such guidance

Spencer *et al*. (1996) gave health professionals four 'test' charts: 33% misclassified a 'catch down' pattern of growth as 'poor weight gain', 15% thought the chart showing transient poor weight gain indicated 'failure to thrive', and 26% mistook the growth of a normal small baby for either 'poor weight gain' or 'failure to thrive'. If repeated in practice, such misinterpretations could lead to unnecessary referral and worry. Two individuals (3%) also failed to correctly identify 'gross failure to thrive', showing that a high rate of what would have been unnecessary referrals did not ensure that all babies who should have been of concern would be identified. The use of sample charts in this study may tend to emphasise the chart as a stand-alone diagnostic tool, as no case history was supplied. No study using real cases to test assessment has been discovered.

Growth disorders or failure to thrive

One objective of monitoring is to ensure early referral for organic disease presenting with poor weight gain. Few disorders present with no symptoms other than unusual growth (Hall, 2000; Hall & Elliman, 2003). Weight may be useful in conjunction with other symptoms (Wright, 2000).

Lawrence & Lawrence (1999) remind that faltering growth *in* a breastfed baby does not automatically indicate a failure *of* breastfeeding. The sizable literature does not often consider correlations between method of milk feeding (breast only, breast and bottle or bottle only) and identified FTT. An exception is an audit by US paediatrician of 4 years of practice records, retrospectively identifying cases of breastfed babies under 6 months with faltering growth (Lukefahr, 1990). For some, the case notes indicated that a breastfeeding problem was the likely cause, but one in five had underlying illnesses. If another pathology is present, a change to formula-feeding in response to a perceived failure of breastfeeding could represent an additional physical challenge to the baby.

Concern has been expressed at poor rates of recognition of faltering growth by health visitors (Batchelor & Kerslake, 1990; Blisset *et al*., 2002). If concern is identified, a UK baby would be referred to either a General Practitioner or a Paediatrician; and no study has examined their knowledge of the normal growth pattern of breastfed infants. Guise & Freed (2000) surveyed US resident physicians with a 46% response rate, and discovered that, although 99% plotted growth at well child visits, only 5% were aware of the different growth velocity of breastfed babies. This could lead to inappropriate diagnoses. Corbett *et al*. (1996) found that identification of faltering growth status through the 'relatively crude velocity measure based on the visual examination of growth charts' identified children who exhibited

poorer weight and height than matched controls. This study did not distinguish breastfed from other children (p. 1281). A review of FTT by a UK paediatrician, intended to guide clinical practice, discussed management of breastfeeding failure (Marcovitch, 1994). Three senior midwives critiqued the implication that women should be encouraged to supplement or abandon breastfeeding, commenting on 'what little confidence health care professionals now have in their ability to help a woman breast feed successfully' (Alexander *et al*., 1994, p. 596).

Discussions of faltering growth interventions targeted at health visitors, appear to apply only after the first months as solid meals are implied (Underdown & Birks, 1999; Parry & Jowett, 2001; Blisset *et al*., 2002). However, qualitative interviews with parents of babies referred to the Children's Society for such poor growth, found almost half described the problem as starting in the early weeks, or from birth (Underdown, 2000). No indication is given if any of these children were initially breastfed and if a change to formula-feeding was a response to the feeding difficulties. A study which aimed to develop a checklist to enable hospital nurses to improve documentation of feed observations includes sucking ability and infant comfort during feeding; however, the possibility of discomfort as a result of awkwardness in the way the mother was positioning and attaching the baby during breastfeeding (MacPhee & Schneider, 1996). Lactation Consultants, skilled in observing breastfeeding, describe distress in babies which is rectified by altering the way the mother holds the baby at the breast (Wilson-Clay & Hoover, 2002). Stevenson & Allaire (1991) point out that the physical act of feeding is a complex physiologic and social process, and Reilly *et al*. (1999) identified subtle neurodevelopmental disorders which might account for poor food intake in children previously diagnosed as having no organic cause of faltering growth. Wilson-Clay & Hoover (2002) report on clinical measures to support continued breastfeeding in such infants.

A large, questionnaire-based study of more than 14 000 babies in Bristol, found that children with persistent feeding difficulties at 15 months were less likely to have been breastfed beyond 4 weeks of age (Motion *et al*., 2001). No indication was given as to why mothers decided to stop breastfeeding these babies. Early feeding difficulties were poorly predictive of later problems, as so many babies were described as having them, but this study raises the question whether timely interventions with breastfeeding difficulties might either resolve feeding problems before they become persistent, or aid early identification of underlying conditions (Lawrence & Lawrence, 1999; Wilson-Clay & Hoover, 2002). A model presented for identification and intervention for faltering growth to health visitors does not include breastfeeding assessment (although feeding assessment is mentioned) or referral to breastfeeding specialists (Blissett *et al*., 2002). Relationships between breastfeeding, breastfeeding difficulties, breastfeeding style and technique, and later faltering growth appear to offer a fruitful area of investigation.

Obesity

Obesity has been described as 'a new pandemic' whose 'root cause [. . .] remains unknown' (Kimm & Obarzanek, 2002, p. 1003). The associations between later childhood and adult obesity and infant diet have been investigated in a number of studies which examined survey data collected for other purposes. These vary in their definitions of overweight, obesity and of breastfeeding; and in the number of other variables controlled for. For example, overweight was defined as a body mass index (BMI) on or above the 90th centile by von Kries *et al*. (1999), Bergmann *et al*. (2003), and Toschke *et al*. (2002), but as a BMI of 95% or higher by Hediger *et al*. (2001), Gillman *et al*. (2001) and Grummer-Strawn & Mei (2004), while this same level was defined as 'obesity' by Armstrong *et al*. (2002). Individuals were measured as overweight or obese at ages ranging from 3 (Hediger *et al*., 2001; Armstrong *et al*., 2002) to 18 (Li *et al*., 2003). Some studies compared ever breastfed children with those never breastfed (Hediger *et al*., 2001; Toschke *et al*., 2002) while others used a variety of groups for comparison. A review of these studies concluded that 'breastfeeding reduces the risk of child overweight to a moderate extent' (Dewey, 2003, p. 17), and the

AAP (2003) included a recommendation for breastfeeding in a recent policy statement on prevention of overweight and obesity.

A recent analysis of data from 177 304 low-income US children found a 'dose–response, protective relationship with the risk of overweight' and the duration of breastfeeding for non-Hispanic white children (Grummer-Strawn & Mei, 2004, p. e81). A feature of this study is that the authors examined the variation in the standard deviation of the BMI rather than variation in the mean and found simultaneous reductions of both over- and underweight for breastfed babies. The latter observation is of interest with reference to the absence of a population study investigating associations between faltering growth and breastfeeding. Non-Hispanic black and Hispanic infants did not show the same association between breastfeeding and risk of overweight/obesity as white babies (underweight figures are not broken down by ethnicity). The authors speculate that this may be as a result of other lifestyle factors known to influence obesity, or to differences in breastfeeding exclusivity or patterns of solid feeding, or even in a different use of formula. For example could white mothers be 'more insistent that their infants finish off a predetermined quantity of formula' (p. e85)? As with the effects of 'breastfeeding style' (see below); it appears necessary to investigate patterns of bottle-feeding ('bottle-feeding style') in order to understand patterns of infant growth.

The issue of childhood obesity has attracted attention in the news media as well as the medical press, and may be a concern for parents when babies are weighed, although no reference to this was found. Population correlations are little help in assessing whether the high recorded weight of an individual breastfed baby should be of concern with regard to later obesity, or, more importantly, whether there is an intervention which would decrease the chances of later obesity or morbidity. One commentator has emphasized that 'it is generally not advisable to attempt to limit the intake of an overweight infant' except of solids and juice (Dewey, 2003, p. 11), while the AAP stresses the desirability of 'early recognition' (AAP, 2003, p. 427). It is unknown how such suggestions will affect community practitioners and parents in the UK.

In assessing adult obesity and overweight, BMI is used, and the AAP (2003) suggests the paediatric use of BMI. BMI charts for children under the age of three are not in use in the UK, and the limits of acceptable BMI in children have yet to be well defined (White *et al.*, 1995). The intention is that data being collected and analysed to create the forthcoming WHO growth chart will be used to create a BMI reference and that these will be available by 2006 (de Onis & Victora, 2004). It remains to be seen whether WHO charts will be used in the UK.

The relation between the height and weight centile has been proposed as 'a more practical tool for community use' than BMI (Hulse & Schilg, 1996). A UK study in which 42 dieticians were asked to calculate the ideal weight for height of children, by hand, found high rates of inter- and intraexaminer unreliability (Poustie *et al.*, 2000) indicating limitations of adopting such calculations for assessing the likely meaning of any weight or other growth measurements of concern.

Conditional charts/thrive lines

In order to refine the weight chart as a clinical tool and enable more precise interpretations of weight patterns, conditional growth charts and 'thrive lines' have been developed. A conditional chart was based on growth data of a cohort in Newcastle, and aimed to provide a chart which used easily identified falls of one or two standard deviations (Wright *et al.*, 1998). There is no record of how widely this is used in UK practice.

The idea is further developed with 'thrive lines' (CGF, 1996), printed on acetate, which can be laid over the growth chart. For two weights, the overlay indicates whether the change is greater or less than two standard deviations, that is, whether or not the weight should trigger a referral (Cole, 1997). The instructions state that these work 'best for measurements taken about 4 weeks apart' and should not be used for time periods of less than 2 weeks (CGF, 1996). Fry (2002) asserts that one-third of practitioners use these, but does not state a source, or whether these practitioners are health visitors, or doctors to whom children are referred. No study has been iden-

tified in which the rate of referral when thrive lines were used was compared with using the UK90 chart alone. Such a tool encourages treating weight deviation as the absolute criteria for referral, de-emphasizing reliance on other clinical signs, attention to the whole baby, and the whole feeding experience. Davies (2000), a consultant, remarks:

> My outpatient clinic is frequently attended by children referred because of abnormal weight [. . .] but not prompted by any particular [clinical] concern. [. . .] There is nothing wrong with the infants but the parents are invariably very anxious – a problem created out of nothing. (p. 201)

This implies that practitioners have difficulty identifying cases needing referral, as well as difficulty in communicating to parents the reasons for investigations.

Communication of results to parents and consultation

In developing countries mothers' understanding of growth charts has been explored (Ruel *et al*., 1990; Senanayake, 1997). Morley attributes part of the lack of success of growth monitoring to failure to give adequate consideration to the fact that 'even the simplest chart is difficult to understand' (Morley, 1993, p. 98; Morley, 1996; Meeghan & Morley, 1999): even doctors may struggle with the graphs (Morley *et al*., 1991). In the UK, graphical literacy and how it may impact on the understanding of the growth chart, by either health visitors or parents remains unexplored. Mosely & Mead (2000) write to refresh graphical understanding for nurses, starting with basics, but do not discuss growth charts. A review for teachers illustrates the range of concepts which need to be in place when interpreting graphical information (Friel *et al*., 2001). While health professionals use charts on a daily basis, for first time parents they are new. Although seductively visual and seemingly self-explanatory, centile charts map weight gain trajectories – a concept which may need refreshing for even the most numerate parent. The notes supplied in the current personal child health record refer to best practice in measuring and plotting, with guidelines for when professionals should refer, and do not provide a general introduction to the chart and its interpretation likely to be useful to parents (CGF/RCPCH, 2004).

As well as understanding charted weights, a health professional needs to be able to convey what is indicated. No written material which discusses ways of explaining growth patterns to parents has been found. Nor is there a discussion of how health visitors might convey information that frequent weighing is not needed for healthy babies, and may over-emphasise minor fluctuations.

Approval of the growth pattern may be expressed by health visitors when weight conforms to the centiles, implying that fluctuations off the line are of concern. Olin Lauritzen & Sachs (2001), in clinic observations and interviews with Swedish and English mothers, found that weighing encounters encouraged mothers to see their baby's weight and health in relation to the norm of the chart. One mother told how 'instead of thinking that he is thriving . . . you become fixated on figures and graphs' (p. 509). Some women interviewed by Dykes & Williams (1999) found the 'visual display of weight . . . worrying [when] the babies were not progressing steadily along their centile' (p. 236); they were more likely to abandon breastfeeding early than mothers with a more holistic assessment of development. Many women may introduce formula supplements in response to perceived weight difficulties without consulting health visitors – thus anticipatory guidance is indicated.

The parent-held child health record does not give information to parents on frequency, or issues such as variations in recorded weight because of time of day, relation to a feed, etc. It states that 'A normal growth curve is one that always runs roughly on/parallel to one of the printed centile lines' (CGF/RCPCH, 2004, p. 38C). (This may be intended to relate to length/height, but this is not clear.) Information that there are normal patterns of growth, such as catch-down, which involve deviation from centiles could usefully form part of the initial explanation of weight monitoring given by health visitors. Discussing such issues with parents and supporting longer weighing intervals might need to involve restructuring clinic contacts (Fulford, 2001). Developing and evaluating a simple guide to interpreting weight charts for parents could

prove a valuable endeavour, although, in view of the complexities discussed here, a challenging one!

A cost analysis study of child health surveillance found, at the 6–8 week check, that just over 2 min was spent talking about feeding, indicating, at best, a superficial discussion (Sanderson *et al*., 2001). Fulford (2001) describes dissatisfaction of health visitors themselves with drop-in clinics which were 'rushed', and 'often babies were just weighed' without time for 'meaningful consultation' (p. 386).

Interventions

Health professionals need to balance messages about the importance of adequate growth (bearing in mind all the complexities in assessing this) and the importance of breastfeeding. In the UK cultural setting where bottle-feeding with infant formula is seen as normal (Renfrew *et al*., 2000; Dykes, 2003a, 2003b), UK mothers perceive formula as benign and its use as part of normal progression (Shaw *et al*., 2003). Breastfeeding is framed as having 'advantages' rather than providing the measure against which infant formula is judged (Wiessinger, 1996). A growing list of studies provides evidence that there are immediate and long-term differences in health outcomes between breastfed and never breastfed babies (Heinig & Dewey, 1996; Nicoll & Williams, 2002), while a recent review revealed the paucity of research evidence on safety of formula-feeding (Renfrew *et al*., 2003); this has not passed into popular understanding.

Supplementation with formula milk

During clinic participant observations, Mahon-Daly & Andrews (2002) saw that 'simply falling off the percentile trajectory was often a lone reason for breastfeeding to be discouraged' by health visitors, and mothers were 'encouraged to bottle feed almost for their babies [sic] safety' (p. 68). Smale (1996), who studied 10 years of contacts between mothers and a volunteer breastfeeding counsellor, found that 'the bottle appeared to be the first line of defence for medical advisors, against weight gain problems' (p. 219). The message mothers receive appears to be that only solution to faltering of charted weights relative to the centiles is the introduction of formula and that breastfeeding is an extra which can be dispensed with in view of the imperative for the baby to put on weight.

Some infants will require supplements, but Renfrew *et al*. (2003), in a major evidence review, found that there is 'insufficient research to guide practice in making decisions about which babies may genuinely need additional feeds' (p. 43). This lack leads to a tension for professionals between the need to support women's trust in the biological system of breastfeeding, and the need to ensure baby well being (Brown, 2000). The possibility of a threat from poor weight is likely to be more evident in our culture than any threat of formula-feeds. In some cases where growth is of concern, supplementation with the mother's own expressed milk is an alternative option (Powers, 2001), although where the mother doubts her own ability to sustain her baby, this may require intensive support.

Breastfeeding interventions

Renfrew *et al*. (2000) emphasise that establishing effective and pain-free feeding will prevent many breastfeeding difficulties, including poor weight gain. Vinther & Helsing (1997), in a WHO manual for health workers, state that rather than supplementation, what needs to be addressed if the baby is slow to gain weight, is the attachment and positioning and the pattern and duration of feeding. A good understanding of the physiology of breastfeeding may also be important in preventing a perception of insufficient milk and improving effective breastfeeding (Alexander *et al*., 1994; Renfrew *et al*., 2000).

Positioning and attachment

Various studies of interventions to improve positioning and attachment soon after birth have been conducted (Righard & Alade, 1992; Henderson *et al*., 2001; Ingram *et al*., 2002; Woods *et al*., 2002a, 2002b; Labarere *et al*., 2003), but no study was found which assessed such interventions when used with women whose babies' weight was of concern. A number of

clinicians suggest that attention to positioning and attachment is crucial in ameliorating breastfeeding difficulties, including poor weight gain (Newman, 1996; Inch & Fisher, 1999; Powers, 1999, 2001; RCM, 2002).

Health visitors monitor routine weight and often provide first suggestions for interventions. However, the training they receive in practical breastfeeding skills has been deemed lacking (UNICEF UK Baby Friendly Initiative, 2002). Shaw-Flach (1998), a health visitor, comments on the deficit of practical breastfeeding skills within her profession. Ker (2002) conducted qualitative interviews with 25 breastfeeding women who generally did not perceive breastfeeding help as within the role of the health visitor. Referrals of babies whose weight is of concern in the UK are currently made to paediatricians. If breastfeeding difficulties are contributing to poor weight gain, which the mother's own health visitor is unable to address, there is no system of specialist breastfeeding evaluation routinely available (Renfrew *et al*., 2000), although in some areas there may be a midwife, a specialist clinic or lactation consultant who give specialist support (Inch & Fisher, 1999; Brown, 2000).

Breastfeeding style

Breastfeeding 'style' is a domain of behaviours such as frequency of feeding, duration of feeds and exclusivity (Sachs *et al*., 2005). Flexible feeding patterns responsive to infant cues are suggested as having a positive effect on the effectiveness of breastfeeding (Renfrew *et al*., 2000). Recent work has shown that breast milk fat composition varies throughout an individual feed and between feeds throughout 24 h and is related to interfeed interval. The shorter the interval, the higher the fat content of the milk at the start of the next feed (Daly & Hartmann, 1995a, 1995b; Hartmann *et al*., 1996; Mitoulas *et al*., 2002). Differing milk storage capacities between women imply different physiological limits to flexibility for mothers to increase the length of this interval.

Increasing the number and frequency of feeds are practices suggested as interventions in cases of poor weight gain (Newman, 1996; Powers, 1999, 2001) but the evidence that these work is from clinical observation rather than randomized or controlled trials (Powers, 1999). Blisset *et al*. (2002) include in a general discussion of interventions for faltering growth aimed at health visitors the recommendation that food be offered every 2 h. This is not explicitly related to breastfeeding, but is intriguing. Parents are often interested in spacing out milk feeds and 'breastfeeding took too long', which may relate to feed frequency, is a reason given by more than 10% of women who stopped breastfeeding in the first 4 months (Hamlyn *et al*., 2002, p. 134). Explanation about the importance of feeding in response to baby's hunger cues rather than breastfeeding 'according to a clock-oriented bottle-fed regimen' is critical (Rowland *et al*., 1981, p. 81).

Research investigating the individual physiology of women, their baby's growth and the impact of interventions such as supporting flexible breastfeeding patterns would be welcome.

What this review adds

The quality of professional and parental interpretation and assessment of charted infant weight gain has been little studied.

The lack of evidence base and protocols for good practice for the use of formula supplements is noted. Interventions which change breastfeeding frequency or physical feeding position also rest on a scanty evidence base.

The challenge of conveying information on infant growth patterns to parents is highlighted, as is the lack of quality information or training for health professionals in doing this.

Conclusions and recommendations

This review of the practice of weight monitoring of breastfed babies in the UK has brought together a number of issues from a wide variety of disciplines. Current understanding of different growth patterns and growth problems as they relate to breastfed babies have been explored. Interpretation of the growth of an individual baby relies on a good understanding of the tools (Sachs *et al*., 2005) and how they relate to what is known about the growth patterns of breastfed babies. Suggestions have been made throughout of a number of areas which would be of particular interest for further research. Population audits of the proportion of babies identified as caus-

ing concern either to parents or to health visitors would be useful, along with documented case studies of interventions and outcomes. Qualitative studies investigating parental understanding of charted infant growth and relation to confidence in breastfeeding could provide crucial insight.

Formula supplementation is likely to continue to be used as an intervention for infants in the UK whose growth is of concern. Currently there is little to guide recommendations for appropriate amounts and duration of supplementation. A sample care plan for re-transitioning to breastfeeding would be a useful addition to the literature. Case studies and larger studies of interventions which aim to improve breastfeeding technique or advise on frequency are needed. Such interventions are offered to some women in the UK – depending on their location and on the chance of meeting a professional who can offer this. Faith in their efficacy varies from practitioner to practitioner and documentation of their outcomes is scarce.

Although breastfeeding is a major health recommendation, a universal minimum level of practice capability has not been set for the professions. Nor are there explicit referral pathways within health authorities. This should be remedied.

The Hall report (Hall & Elliman, 2003) is widely, possibly universally, used in community practice. A companion manual with a more in-depth discussion of issues of interpreting infant growth for community professionals would be an invaluable addition. Inclusion of sample protocols and decision diagrams could aid interpretation. A discussion of the merits of adopting a growth chart based on breastfed baby data, and if so, which chart, would benefit from being formally called, and from inclusion of a wide range of practitioners, including breastfeeding specialists (professional and volunteer). However, the introduction of a new chart should not be seen as sufficient unto itself; research needs to be undertaken as to what information could usefully accompany any chart to aid parental understanding of the charted growth curve of their child.

Weight monitoring offers a seemingly simple method of tracking the well-being of infants; however, the tools used, technical practice and interpretation all need to be of a good standard. Attention to elements covered in this, and the companion review (Sachs *et al*., 2005), offer the chance for routine weighing to offer good detection of babies of concern, and robust support for breastfeeding.

Our current understanding was compared by Sachs *et al*. (2005) to standing on a hill in fenland – some 'islands' of firm ground are visible, but the connections between these islands are often shrouded in low-lying fog, with speculation and assumption filling in the contours between. This review aims to map what is known and to suggest where paths might be constructed, to ensure greater clarity for future professional practice and for parental understanding.

Recommended topics for future research, audit and consideration:

Audits of practice, including: evaluating rates of appropriate referrals made for weight gain issues in clinical practice; changes in referral rates when 'Thrive Lines' are used; rates of formula supplementation in response to faltering growth; and outcomes of supplementation.

Re-evaluation of notes for parents on issues of expected infant weight gain patterns. Particular consideration should be given to how to present the pattern of the growth curve exhibited by breastfed babies.

An evaluation of the effects of using the 'Breast from Birth' chart for breastfed babies in comparison with the UK90.

Creation of a standard teaching package for health visitors on weighing practice.

A study evaluating an improvement in positioning and attachment of the baby at the breast as an intervention in cases of faltering growth.

An observational study examining relationships between 'breastfeeding style', breastfeeding technique and growth patterns.

Development of a protocol for assessing infant growth and using appropriate interventions, which includes interventions centred on improving breastfeeding effectiveness as well as others.

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