Weight monitoring of breastfed babies in the UK – centile charts, scales and weighing frequency

Magda Sachs BA, MA (Cantab)*, **Fiona Dykes** PhD, MA, Cert Ed, ADM, RGN, RM[†] and **Bernie Carter** PhD, PGCE, BSC, SRN, RSCN[‡]

*Department of Midwifery Studies, University of Central Lancashire, Preston, UK, [†]Midwifery Studies Research Unit, and [‡]Department of Nursing, University of Central Lancashire, Preston, UK

Abstract

Weighing infants during their first 6 months is an important focus of growth monitoring and a common activity of child health care services worldwide. In these same months, health workers provide support for breastfeeding and promote continued exclusive breastfeeding. The literature on the practice of weighing breastfed babies is reviewed, as it applies to the United Kingdom. The shape of the growth curves for breastfed babies differs from that of formula-fed infants and also from centile charts previously in use. The World Health Organization commitment to the production of a new growth reference has generated discussion of the implications of charts in use. The country-specific charts in use in the UK are examined and the data used to construct them discussed with reference to clinical use for breastfed infants. Recent UK discussions on charts, as well as on the frequency of routine weighing for babies in the community are considered, and the available evidence on the accuracy of weighing in practice is noted. The choices made in constructing different charts; the physical condition of scales and their use in practice have implications for plotted growth. This paper aims to present a wide range of evidence available in this area in order to encourage debate on practice. A companion paper will discuss issues of interpretation, conveying information to parents, and interventions.

Keywords: breastfeeding, breastfeeding style, growth monitoring, growth charts, weighing infants.

Introduction

Promoting and supporting breastfeeding is a public health goal in the United Kingdom. Monitoring

Correspondence: Magda Sachs, Department of Midwifery Studies, University of Central Lancashire, Preston PR1 2HE, UK. e-mail: magda@sachsdavis.clara.net

babies' weight gain by regular weighing and charting provides a focus for interactions between mothers and health care providers. The desirable frequency of routine weighing has been investigated and useful practice recommendations issued. Some aspects of weighing practice, such as the difference in shape of growth curves between breast- and non-breastfed

infants have received attention internationally, while a number of studies have been conducted on accuracy of scales. However, a wide-ranging consideration of the areas which affect routine growth monitoring of breastfed babies has not been undertaken. This review, and its companion (Sachs *et al.*, 2005), aim to do this with specific reference to practice in the UK.

Aims and methods of the review

A Cochrane Collaboration review sought evidence of benefits and harms of growth monitoring (Panpanich & Garner, 2003). Under the systematic review criteria of the Collaboration, only two papers were included. As White (2001) argues, reviews with restrictive inclusion criteria risk excluding evidence of value to the topic in consideration. This current review surveys a wide range of the literatures relevant to the practice of routine weighing of breastfed babies. Literature was gathered during the course of the doctoral studies of the first author. Many issues were identified as impacting on current understanding and practice. The literature included is disparate: population intervention studies, observational data, commentaries from clinicians and others, audit results, small-scale studies of an aspect of interest, reviews of research, and recommendations for practice. Ideally, original research evidence would be available for all aspects of interest, and for the way weight monitoring is conducted: in the absence of a consistent level of such evidence, this review is inclusive rather than prescriptive and seeks to investigate widely. Set inclusion and exclusion criteria were not established prior to the search. Much literature on growth monitoring has a global scope or pertains to other country contexts; this has been selectively included where it helps to illuminate questions relevant to the UK. A major conclusion of this review is that the potential literature is vast and covers many disciplines. This results in a review which does not provide answers to discrete questions, but rather 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 weighing breastfed babies in the UK?

Monitoring babies' weight is a long-established UK practice; many mothers attend frequently and value the activity.

However, there are anecdotal concerns that frequent weighing may undermine breastfeeding confidence and duration.

Frequency recommendations have been made for routine weighing in the UK, but many babies are weighed much more often. The shape of the centiles on charts constructed from breastfed baby data is different from that of conventional charts, including the UK90 chart.

A UK 'Breast from Birth' chart is available and was devised from a subset of the data used for the UK90 chart.

Practices which affect weighing accuracy have been examined in a number of small studies.

Growth monitoring/weight monitoring

Literature referring to 'growth monitoring' may at times discuss weight, length/height, head circumference, or a combination of all or some of these. In order to minimize confusion, this review will use the term 'weight monitoring' to mean the regular measurement of weight. It will further restrict its focus to infants in the first 6 months in the UK.

A 2002 survey by the World Health Organization (WHO) found that regular weighing is part of most Western well-baby care systems and 'growth charts are used universally in pediatric care', with all countries who replied to the survey using weight-for-age, and over half using this alone to assess infant and child growth (de Onis *et al.*, 2004, p. 461). Growth monitoring used at population level has been credited with amelioration of severe malnutrition in developing country contexts (Shrimpton, 2003), although it is acknowledged that the effect is not straight-forward (Shrimpton *et al.*, 2001). The success of growth monitoring has been questioned and the impetus for monitoring ascribed to the desires of international aid agencies (Gerein, 1988; Nabarro & Chinnock, 1988). In response to such critiques, UNICEF reviewed and refocused its commitment to growth monitoring in the early 1990s (Pearson, 1995), although acknowledging that while 'growth monitoring and breastfeeding are potentially complementary activities too often

opportunities are missed' (Greaves & Hendrata, 1990, p. 121).

Panpanich & Garner (2003) define growth [weight¹] monitoring of individual children as involving regular weighing, with weights charted, and interventions by health workers in concert with mothers where growth is of concern, and tracking of outcomes. The benefits of monitoring in the UK, within a national programme of health surveillance, are given as the detection of chronic disorders, health promotion, the gathering of information on public health trends, and because it is valued by parents (Elliman *et al.*, 2002; Hall & Elliman, 2003, pp. 170–176).

In the UK, babies are weighed regularly and their growth is plotted on charts contained in a parent-held child health record (PCHR). Every new mother is allocated a health visitor (a nurse with additional training, who weighs and measures babies at home and in child health clinics, discusses aspects of infant feeding and care, and delivers developmental checks).

Breastfeeding

Public health policy in the UK currently recommends that all babies be breastfed exclusively for 6 months; acknowledging 'proven health benefits to breastfeeding for both child and mother in the short and long-term' (Department of Health, 2003, p. 1), following the recommendation of the WHO (2002). Currently 69% of new mothers in the UK ever breastfeed, and 28% of all babies receive any breast milk at the age of 4 months (Hamlyn *et al.*, 2002).

Some small qualitative studies have suggested that a focus on weighing might have an undermining effect on women's confidence in their ability to nourish their babies (Dykes & Williams, 1999), or lead health professionals to suggest supplementation in response to small deviations from a centile line (Mahon-Daly & Andrews, 2002). Marchand & Morrow (1994) found quantifiable measures of breastfeeding success were the ones reinforced in encounters between women and health professionals.

¹The review uses the term 'growth monitoring', but the trials identified are on weight monitoring.

Alternatively, the reassurance of regular weight gain is suggested to be likely to encourage women to continue breastfeeding (Hall & Elliman, 2003).

Birthweight loss and regain

There has been debate over early neonatal weight loss and birthweight regain in breastfed babies (Oddie *et al.*, 2001). A recent overview examined research relevant to the UK (Sachs & Oddie, 2002). Midwives care for mothers and babies during the first 10–14 days after birth, care is then handed over to health visitors. The regain of any lost birthweight is an important first indicator that breastfeeding is effective and the baby is healthy, and should be considered before handing over of care. It should be noted that the growth charts available in the UK show smooth curves rising from the birthweight. Early weight loss, which is expected and considered physiological (Lawrence & Lawrence, 1999), is not reflected in the centile curves depicted on the UK (or other) growth charts, with implications for the interpretation of weight in the first postnatal weeks (Wright & Parkinson, 2004).

Weight monitoring

To ensure that weight monitoring in the UK provides useful information and supports infant well being, a range of elements need to be of a robust standard. These include:

- the tools used: centile growth charts, scales;
- how these tools are used, e.g. the frequency of weighing, the accuracy of weighing and charting;
- the interpretation of the meaning of charted weight trajectories by health professionals;
- the communication of the meaning of fluctuations shown on the chart from health professional to parent; and
- the type of interventions considered and implemented when there is concern.

This paper addresses the first two of these in the context of UK practice particularly as they relate to breastfed babies, with the other issues covered in a companion paper (Sachs *et al.*, 2005).

Monitoring tools

Growth charts – international perspective

Weight charts have been available for over a century (Brosco, 2001). The WHO adopted the US National Center for Health Statistics (NCHS) growth reference charts for international use, to aid in combating malnutrition (Hamill *et al.*, 1979; Garza *et al.*, 1994; Pearson, 1995). Data collected in Ohio, USA in 1929, where most infants had been formula-fed, and given early complementary foods ('solids') was used for the first year of the 1977 NCHS chart. Studies conducted in the 1980s on the growth of breastfed children showed a consistent mismatch between the shape of growth trajectories of healthy breastfed infants, in various settings, and the shape of the centiles on this chart. This difference, in which breastfed babies' weight rises more steeply than the reference curve in the early days, and then appears to gently 'falter' or dip below the chart centiles, was accepted to be 'physiologically determined' (Garza *et al.*, 1994, p. 6).

Use of the NCHS chart raised world-wide concerns that the 'the negative deviations [between the growth trajectory of breastfed babies and the curve of the chart centile] are large enough to lead health workers to make faulty decisions regarding the adequate growth of breastfed infants and thus to mistakenly advise mothers to supplement unnecessarily or to stop breastfeeding altogether' (de Onis *et al.*, 1997, p. e8). In response, a WHO Growth Study group proposed to collect prospective longitudinal data from seven countries, selecting babies from relatively advantaged families, with no socio-economic or environmental constraints on growth (Garza & de Onis, 1999; also WHO Working Group on the Growth Reference Protocol, 2000) and who were fed in accordance with (the then) WHO recommendations, including being exclusively breastfed for at least 4 months. Women whose babies were included were offered extra support for breastfeeding (de Onis & Victora, 2004). This chart is currently estimated to be available in 2005, and the next step envisaged is to develop guidelines to aid in interpretation for clinical use (WHO Working Group on Infant Growth, 1995; de Onis *et al.*, 1997; de Onis & Victora, 2004).

When collecting data, either a whole population is chosen, creating a growth 'reference', or infants are selected in order to create a 'standard', which shows optimal growth (Garza *et al.*, 1994; Cole, 1996). The selection criteria mean that the forthcoming WHO chart will come into the second category. Recent plotting of the growth of a sample of Swedish infants, from a background where socio-economic factors and general social support for breastfeeding helped to ensure optimal feeding patterns, confirmed that such a breastfed chart would reflect the growth pattern of predominantly, as well as exclusively, breastfed babies (Aarts *et al.*, 2003).

Growth data from a large randomized controlled trial on breastfeeding support in Belarus has provided some interesting insights. In this study, hospitals and their associated clinics were selected and randomized to receive staff training and implementation of the 'Ten Steps to Successful Breastfeeding' used by the WHO/UNICEF Baby Friendly Initiative (WHO/UNICEF, 1989). The outcomes of over 17 000 infants born in the hospitals, whose mothers had chosen to breastfeed, were monitored (Kramer *et al.*, 2001).

Taking the weights of babies in the study exclusively breastfed for at least 3 months, across both arms, Kramer *et al.* (2002) found that their growth showed the pattern of an early steeper rise and later 'dipping' down the centiles observed in previous studies. They observed that this never led to absolute weight 'faltering' below the WHO/CDC centiles, as found in other studies. This may be because of local factors, but led these authors to ask whether the previously observed 'faltering' is indeed biological or because of inherent biases in observational data collection. Three important possible sources of bias are suggested – these might affect any growth chart based on a cohort of breastfed babies. Firstly, there are likely to be differences (e.g. socio-economic factors) in any population between women who choose to breast or bottle feed. These may fully or partially account for differences in their babies' growth and be difficult to control for. Secondly, reverse causality may operate; when women whose babies are growing slowly may supplement and be excluded from the data on the chart, however, the slow growth may have been as a result of biological rather than feeding-

related factors. Finally, there is a theoretical possibility of selection bias, in which babies 'whose modest growth does not tax their mother's milk supply' are those most likely to continue being breastfed (Kramer *et al.*, 2002, p. 344), with the largest or fastest growing babies also supplemented and lost to the chart.

These are speculations, but if both the last two were to operate – removing both the slowest growing and the fastest growing babies from a breastfed data set – this would narrow the absolute spread of the centiles, without necessarily affecting the mean. Using a population chart based on such data for an individual baby in either category would then tend to suggest that this individual is on an extreme centile. This could lead to a predictive feedback effect, where babies who are lightest and heaviest are seldom breastfed without supplements, meaning they are not included in any further charting, and reinforcing concerns about breast milk adequacy for 'normal' weight gain. It would be helpful if any chart based on breastfed babies accounted for individuals who were originally recruited, but whose data was then not included in the chart.

Fomon (2004) raised concerns whether a chart based on data from breastfed babies is a suitable reference for measuring the growth of artificially fed babies. This was in the context of trialling the adequacy of a novel infant formula, but it may be only a matter of time that the use of a growth chart based on breastfed babies is queried for use in an individual baby fed on breast milk substitutes. De Onis & Victora (2004) explicitly laud the forthcoming WHO chart as it 'establishes the breastfed infant as the normative growth model' (p. 86).

Growth charts in the UK

UK charts have sparked their own debates. Country specific charts rather than international growth references are commonly used in Europe (de Onis *et al.*, 2004), with the Tanner Whitehouse chart in UK use from the 1960s (Goldstein & Tanner, 1980). In 1990 an updated UK chart was compiled and introduced, in response to concerns that the secular trend, or changes in growth over time, meant the whole popu-

lation was no longer well-represented by the chart (Fry, 1994; Freeman *et al.*, 1995; Hulse & Schilg, 1995). Data sampling for the Tanner Whitehouse chart was conducted in one geographical area and so was felt not to be nationally representative (Freeman *et al.*, 1995). Savage *et al.* (1998) prospectively measured the growth of 127 Scottish infants (39% of whom were breastfed for at least 2 months), using the new chart, and concluded that it was appropriate for clinical use. The Royal College of Paediatrics and Child Health, in a review of available charts, state that the 'UK90 reference ... is the only useable reference that can be recommended' (Wright *et al.*, 2002, p. 13). It is not known if every authority has adopted its use.

The section of the 1990 UK chart covering the first year of life is based on three data sets: Whittington birthweight data (one measurement taken on day 2, and not discussed further here), British Standards Institute (BSI) data, and Cambridge Infant Growth Study data (Freeman *et al.*, 1995; Cole *et al.*, 1998). The Cambridge study included 252 children recruited between 1984 and 1988. Their social class profile matched that of Cambridge, a relatively affluent area, and 98% were white. Infants were 'screened by midwives before recruitment, and those thought to be at risk were excluded', which would have the effect of increasing the homogeneity of the population (Cole, 1998, p. 2706). Babies were weighed every 4 weeks (Cole, 1998; Cole *et al.*, 2002). One hundred and twenty of the babies were breastfed for at least 24 weeks, with solids introduced at a mean of 15 weeks. The other 132 fell into two roughly equal groups, one wholly fed formula from 3 weeks (but possibly breastfed before that), and a mixed fed group, with some breastfeeding for up to 20 weeks (Cole *et al.*, 2002).

The British Standard data set is cross-sectional, and was collected for a syndicate of UK retailers and garment manufacturers (BSI, 1990). In order to collect a representative sample, a wide spread of geographic locations were used, and a spread of socio-economic and ethnic groups (BSI, 1990), although only the data for white children were used to construct the UK90 chart (Freeman *et al.*, 1995). No separate charts have been developed for monitoring growth in UK ethnic

minority populations, although use of a rule of thumb 'shift' in reading the centiles for different populations has been suggested (Chinn *et al.*, 1996). Length of time individuals have spent in the UK (which tends to bring child growth nearer the population norm) and interethnic relationships, however, confound simple adjustments (Fry, 1994; Chinn *et al.*, 1996).

Feeding method is not recorded for babies in the BSI survey, but there is no reason to think they do not represent both breast and bottle-fed. One hundred and sixty-three children from the age of 0–3 months, and 90 children from the age of 3–6 months were included, with sampling intended to provide a good spread across each age category (BSI, 1990, pp. 17–18). Thus at any one age, the Cambridge sample, in which three-quarters of babies were initially breastfed, is larger than the BSI sample, so that, as far as can be ascertained, the majority of babies used for the chart were breastfed in the early months. This challenges the popular perception that, as one distraught mother put it 'those evil weight charts health visitors worship as their bible, are only based on white babies who are bottlefed' (Saxby-Bridger, 2000, p. 10). This means that critiques of the pre-2000 international reference, as being unsuitable for assessing a breastfed baby's growth, because of being based predominantly on formula-fed babies, cannot simply be transferred to the UK chart. However, at some stage during the first 6 months it is possible that the numbers of breastfed infants included in the data of the chart are equal to or lower than the number not being breastfed. This is one of many details which might be of interest to have in documentation with the chart as provided for health professionals. It should also be noted that 'there were appreciable offsets between the data sets' and this necessitated adjustments (Cole *et al.*, 1998, p. 410).

Children for the BSI data set were recruited through a variety of means (Freeman *et al.*, 1995), and the possibility that the sample was somewhat self-selected – because some approached declined to participate – is acknowledged (BSI, 1990). No information is given on how many may have declined or for what reason. One could speculate that parents whose children's weight were already causing them concern might be less inclined to participate in inten-

sive anthropometric measurement. If so, this could particularly affect the 'outliers' of the data – the babies with most extreme body weight and size. The screening of infants for inclusion in the Cambridge Infant Growth Study noted above might have the same effect. Individuals who are most extreme can have a great effect on the highest and lowest centiles (Cole & Green, 1992).

In sum, the UK90 chart combines cross-sectional and longitudinal data; there was some selection of babies for inclusion; there is a mix of breastfed and non-breastfed infants; and an important part of the sample comes from one geographical area.

UK chart for breastfed babies

In 2002 a new UK 'Breast from Birth' chart, was announced (Fry, 2002). It was based on the data for the 120 Cambridge babies breastfed to a minimum of 24 weeks in the Cambridge Infant Growth Study (Cole *et al.*, 2002). It was presented as a tool to avert 'pressure on the mother to switch the child to formula or complementary food prematurely' (Cole *et al.*, 2002, p. 1296). Fry (2003) argues that these charts should become the norm in use for the UK for all babies, although he reports concern by 'senior paediatricians' about this. He asserts that formula-fed infants tracking along a higher centile is 'far more acceptable to most mothers than seeing their children's weight gain fall away from that of other babies' (Fry, 2003, p. 126). Whether this is currently universally the case, or if it will continue, as increasing attention is given to childhood obesity, remains to be seen². A senior neonatologist³ (Williams, 2002) welcomed the charts for clinical use, as a useful way to focus attention on the distinctive shape of breastfed baby's centiles, although he considers it may understate the extent of either the apparent 'faltering' from about 3 months or the 'accelerated' growth exhibited by exclusively breastfed babies in the early months. Those recommending the chart as a way of reassuring

²Obesity is discussed in Sachs *et al.* (2005).

³Dr Williams is chairman of the Maternal and Child Nutrition Sub-Group of the independent Scientific Advisory Group on Nutrition. See: <http://www.sacn.gov.uk/>

both parents and health professionals that apparent faltering of breastfed babies from 3 months is normal have not commented on any possible effects of the steeper upward growth trajectory shown in the first weeks. If babies do not attain early good growth, will this be a spur to early assessment of breastfeeding technique, or will it lead to earlier introduction of supplements for these babies?

The Royal College of Paediatricians and General Practitioners has expressed caution about whether the data represents the whole country, as it was all collected in Cambridge. They had further reservations as to whether babies whose mothers followed infant feeding recommendations of the 1980s are the best standard for breastfed babies of the 2000's (Elliman & Bedford, 2002); for instance, the mean age at introduction of solids was 15 weeks (Cole *et al.*, 2002). It is not clear whether those whose growth is charted on the 'Breast from Birth' chart were prospectively selected at birth, or whether they are the babies in the Cambridge study who 'stayed the course' to be breastfed for at least 24 weeks. If the latter is the case, babies of concern, either because their growth was faltering, or because they were 'too demanding' may have left this group if supplements were introduced. While still in the study, and represented on the UK90 chart, they would not remain in the data analysed for the 'Breast from Birth' chart. Theoretically, this could have the effect of narrowing the spread of the centiles, due to the biases suggested by Kramer *et al.* (2002). Further documentation clearly describing the data on which the chart is based would be welcome. So would a study such as that conducted by Savage *et al.* (1998) for the UK90 chart, in which a group of breastfed babies, prospectively recruited, had their weight charted on the 'Breast from Birth' chart.

As noted, the WHO investment in a new growth chart based on breastfed babies derives from consensus that interpretation using the previous chart led to inappropriate recommendations to supplement. However, no study has been discovered which compared the use of a conventional with a breastfed baby growth chart on outcomes such as duration of breastfeeding, use of supplements, or confidence in breastfeeding. Would a different chart improve care?

Smoothing the curves

Centile charts are constructed from the raw data and 'fitting smoothed centile curves has always been something of a subjective exercise' (Cole & Green, 1992, p. 1314). The placement of centile lines in the UK chart depends on assumptions made about the distribution of the data, and also on a series of mathematical procedures undertaken to ensure that the most extreme outliers (the lightest and heaviest babies) do not skew the chart (Cole & Green, 1992; Cole, 1998; Cole *et al.*, 1998). When an individual baby falls outside or near the extreme centiles, a referral is triggered, but these are also the centiles which have been most 'smoothed', and which rely on the fewest individuals in the data set.

Breastfeeding 'style' and growth

A small study by de Carvalho *et al.* (1983) found babies randomized to be fed on a 3–4 hourly schedule were lighter at 15 days than babies fed 'ad lib', although there was no difference by 35 days. Quandt (1985) in a study of 62 US babies, found a strong association between growth and breastfeeding 'style': a composite measure of feed frequency, feed length and feeding responsiveness to infant cues (Quandt, 1986; 1995). Babies who were exclusively breastfed longest both fed more often during 24 h and were fatter at 1 month. Woolridge (1995, 1996) explains this by proposing milk fat content rather than quantity as the key aspect of growth. A small study of the effects of different patterns of breast usage suggest that babies can regulate their own fat intake if mothers respond to their feeding cues and they can feed as they require (Woolridge *et al.*, 1988). Effective breastfeeding technique influences the ability of the baby to access optimal fat during a feed (Renfrew *et al.*, 2000). A growing understanding of milk production physiology (Daly & Hartmann, 1995a, 1995b; Hartmann *et al.*, 1996; Cregan & Hartmann, 1999; Mitoulas *et al.*, 2002) explains how biological differences between individual women may mean that culturally imposed patterns (for example avoiding night breastfeeds, and placing value on longer interfeed intervals) can adversely

impact on the milk production of women with relatively smaller breast capacity.

Hörnell *et al.* (1999) conducted a prospective, longitudinal study of 506 mothers committed to breastfeeding, in Sweden⁴. Daily records were kept of the number of feeding episodes and anything that was given other than breast milk, and fortnightly a record of timing and duration of feeds was made by the mother. Wide variations between mother-baby pairs were recorded, with an association between a longer duration of both exclusive breastfeeding, and any breastfeeding, with an increased frequency of feeds. At 4 months 159 of 189 exclusively breast milk fed infants were fed at night – 48% once, and one individual as many as five times. All the mothers considered that they fed ‘on-demand’, and the differing feeding patterns may reflect different physical storage capacities in different mothers.

Kramer *et al.* (2002), in the PROBIT study, found that the mean weight of all babies in the intervention group (breastfed babies born in hospitals randomized to provide ‘Baby Friendly’ care), was significantly higher at 1 month than for those in the non-intervention group; this difference increased to 3 months, and then declined. The intervention babies had a rate of exclusive breastfeeding of 43.3% at 3 months, compared to a rate of 6.4% for babies born in control hospitals. It is possible that the difference in weight was due to different biological responses of infants to human milk or breast milk substitutes. However it could be that support for practices which encourage the establishment and maintenance of exclusive breastfeeding for mothers of babies in the intervention hospitals resulted in differences in breastfeeding style, e.g. increased frequency and length of feeds, and toleration of night feeds, and resulted in this difference.

Future gathering and charting of weight in a group of breastfed infants that includes noting breastfeeding style could provide further insights into the effects of this on infant growth.

⁴These were the same babies whose weights were reported by Aarts *et al.* (2003), noted above.

Scales

Scales are the other main tool needed alongside growth charts, to monitor infant weight. In the UK electronic, self-zeroing scales are recommended (Hall & Elliman, 2003). It is unknown how many areas have provided these. There is also no information available on whether all authorities ensure that scales are checked and re-calibrated regularly, and how frequently this is carried out.

Some small studies provide clues to accuracy in use. A comparison between mechanical and electronic scales, when used for preterm babies in the US, found that the latter were more accurate (Kavanaugh *et al.*, 1990). A Canadian study of 30 scales (balance, spring and electronic) in hospitals, tested them with standard weights, and different weighers. This found that inter-rater agreement was weaker at higher weights and newer were more accurate than older scales, although this might relate to how recently the scales had been recalibrated. The authors conclude that inaccuracy ‘probably results from an interaction between human and mechanical error’ (Burke *et al.*, 1988, p. 248). In Nottingham all scales in community use for weighing babies – standard, balance and electronic – were tested using two large stones of known weight. In total, 91% of readings were deemed acceptable at within 30 g. The electronic scales were most accurate – but were also the newest. Local health visitors expressed concerns about accuracy of some scales, but these were not always the same scales identified as inaccurate through testing (Steiger & Polnay, 1995). In a Coventry study, three standard weights were used and 30% of the scales, of a variety of types, were found to be outside a range of ± 20 g for the 10 kg weight (Spencer *et al.*, 1996). These authors say ‘a survey of practice in the “everyday” clinical setting’ is essential to assess the level of error; no such survey has been found (Spencer *et al.*, 1996, p. 7).

Authors of these studies comment on difficulties of interpretation when babies are weighed on different equipment. In some areas several clinics may be available and clinic-based activities such as baby massage classes or breastfeeding support groups, which have the option of weighing, may mean mothers travel between scales. As Burke *et al.* (1988) remark,

inaccuracy could result not only in false identification of children who are considered to have weights of concern, but also in missing those who have inaccurate 'normal' readings.

Good practice in measuring and recording baby weights

When charted weight is used to make clinical decisions, accuracy of weighing and recording are important. If weight trajectories are misinterpreted, inappropriate reassurance or inappropriate interventions could result.

Hypothetically, professionals or others may encourage a breastfeeding mother with a baby who is deviating below an expected centile position to offer supplementary feeds, while not doing so for a formula-fed baby with an identical growth pattern. Therefore ensuring accurate weight information may be more crucial for breastfed babies.

Accuracy of measurement and accuracy of recording

A few small studies examining these issues were located; none focussed solely on breastfed infants. Alsop-Shields & Alexander (1997) tested weighing in Australian community clinics, similar to those in the UK. Seven babies were weighed naked, thrice daily over 48 h on (currently) standard baby scales. Weights taken at the same time between day 1 and day 2 in the same baby, varied between 5 and 100 g, and each baby's weight varied over the course of 24 h, with no universal tendency – some grew heavier, others lighter. Over time, women may attend one of several local clinics held at different times of day affecting weight measurements.

Naked weighing is recommended (Davies & Williams, 1983; Hall & Elliman, 2003) but it is not known how universally it is practised. Spencer *et al.* (1996) discovered that a number of clinic premises were not warm enough. Alsop-Shields & Alexander (1997) weighed nappies and clothing to show that estimating the effect of garments worn during weighing contributes to variation in recorded weight.

Charting the weight of a baby, in the current UK context, may involve weighing in pounds and ounces,

converting to kilos (this may be done automatically by the scale, although a conversion chart is provided in the PCHR (CGF/RCPCH, 2004), writing this down and then plotting on the chart. A simple transposition of digits, or an error in plotting is possible. The only published UK audit on plotting accuracy showed that a striking 28.55% of the 611 points for 50 premature infants during their first year, were incorrectly plotted (Cooney *et al.*, 1994). Most (94.7%) of the errors were with respect to age, either through failure to correctly adjust for gestational age or through misreading of calendar dates, the former of which would not apply to full term babies. A US retrospective chart review of 149 well-baby visits (for children up to 18 months old) revealed that for 15% of visits, weight was not documented (Chen & Shiffman, 2000). Hall & Elliman (2003) cite inaccurate measurement and charting as one reason for poor performance of monitoring. Wright (2002), in a review of using growth charts, reminds that 'plotting growth charts is difficult and should not be done in a rush while talking to parents' (p. 279).

Variation could come through different individuals weighing (Burke *et al.*, 1988; Hall & Elliman, 2003). In the small Australian community study five nurses were asked to weigh the same baby three times at intervals, and only small intra- and interobserver errors were noted (Alsop-Shields & Alexander, 1997); a larger study, including a range of those who weigh in practice, would be of interest.

Hall & Elliman (2003) suggest that weighing be done in consistent relation to feeding, e.g. just after a feed every time. As with weighing on the same scale at a consistent time of day, it is unknown if this information is consistently conveyed to parents.

The level of accuracy of recorded weights remains relatively under-examined. The interpretation of risk to an individual baby and decisions to refer for screening tests, or to supplement breastfeeding, may be closely based on these records.

Frequency of weighing

In the UK there has been debate on the minimum frequency with which babies' growth should be measured. This has been especially heated with regard to

measurement of height/length. Fry (1997, 2000a, 2000b, 2000c) has warned of possible legal action by parents of children with growth disorders which are not diagnosed. Fry (2000c) asserts that many health visitors will monitor 'because they intuitively know it to be of value' (p. 615). As chairman of the Child Growth Foundation, a charity which represents parents of, and those with, growth disorders, and which produces the UK growth charts, Fry writes frequently, and passionately, on the topic of growth monitoring, and also delivers training sessions (Fry, 2002).

In 1989 the first 'Hall' report (Hall, 1989) represented the ambition of co-ordinating practice over the UK; three further editions have been published (Hall, 1992; Hall, 1996; Hall & Elliman, 2003). A 1998 meeting of paediatricians produced the 'Coventry Consensus' recommendation that babies should be weighed at birth, and babies who are growing normally 'should only be weighed at immunization and surveillance contacts, and should not be weighed more than once every 2 weeks under the age of 6 months and once a month thereafter', so that there are fewer weighing episodes, but more attention is paid to measurements taken (Wright, 2000, p. 7). Two senior paediatricians, Hall (2000) and Wright (2000) reported the conclusions of the consensus, although Fry (2000c) has asserted that there was dissent on the recommended frequencies of measurement. The 'Coventry' frequency is incorporated in guidance (Hall & Elliman, 2003) but it is unknown how this may have affected practice. These frequencies apply to *routine* weighing; 'where ever there is clinical concern' a child should be weighed more intensively (Wright, 2000, p. 7)⁵. Alsop-Shields & Alexander (1997) weighed seven babies three times a day over 48 h, calculating that diurnal and other biological fluctuations mean that weights recorded more frequently than fortnightly, under 9 months of age, risk variation which is greater than true weight changes, and so confirm the suggested minimum.

⁵The Coventry meeting was arranged by The Child Growth Foundation and one of the supporting organizations was Cow and Gate, a company which manufactures infant formula milks, available in the UK (Hall, 2000).

Hall & Elliman (2003) acknowledge that parents 'will continue asking for facilities for their baby to be weighed or to weigh the baby themselves' (p. 180). In the most recent infant feeding survey, 9% of women took their baby to a child health clinic weekly, a further 34% once a fortnight, with another 45% attending monthly at 4–5 months (Hamlyn *et al.*, 2002), with attendance patterns similar for breast and bottle fed babies (B. Hamlyn, unpublished personal communication, 2004). It is likely that frequency is greater at earlier ages. In an audit of clinic records in Newcastle, Wright (1997) found that the babies who were lightest were most often brought for weighing; which she took to mean that services are most used by those who most need them, but could also reflect a general anxiety about any baby who is on a low centile. Further investigation of patterns of attendance might lead to an increased understanding.

A survey of parents using clinics in Kingston and Esher found that 93% of 564 parents who responded gave weighing the baby as their reason for attending clinic (Sharpe & Loewenthal, 1992). Davies (2000) notes that the practice of frequent weighing has become 'entrenched' and that 'it would take more than an Act of Parliament to stop it' (p. 201). Daws (1985), a psychotherapist, remarked 'bringing the baby to be weighed is the focus for the baby clinic. Parents can visit with no other ostensible reasons than to weigh the baby. This alone validates the visit'. (p. 79). Health visitors themselves acknowledge that the culture and the physical layout of clinics would need to be addressed if this is to be changed (Fulford, 2001; Normandale, 2001).

A review of literature on growth [weight] monitoring for the Cochrane Collaboration (Garner *et al.*, 2000; Panpanich & Garner, 2003) found only two studies which met their trial inclusion criteria: neither was in the UK or a western country. These authors expressed surprise at the paucity of research 'given the level of investment in growth monitoring worldwide' (p. 1). They also highlight the amount of health worker time invested in routine weighing. A cost analysis of UK child health surveillance showed health visitors spent an average 31.3 seconds (cost 11 pence) weighing babies and discussing feeding for 144 seconds (cost 53 pence) at the 6–8 week child

health check (Sanderson *et al.*, 2001). If such timings are repeated whenever women attend, and this is weekly or fortnightly, costs begin to add up. The brevity of feeding discussions observed raises concern about the quality of interaction with parents (Gerein, 1988). Panpanich & Garner (2003) further raise the issue of potential harm to parental confidence through weight monitoring, and note that this has scarcely been considered.

What this review adds

The review brings together a range of literature, examining weight monitoring practice and issues of 'breastfeeding style'. The UK90 and 'Breast from Birth' growth charts are discussed. Published information on the feeding patterns of the infants included is gathered together. This is compared with data collection for the forth-coming WHO breastfed growth standard.

Studies of weighing accuracy and frequency are reviewed.

Recommendations and conclusion

This review investigates the literature relevant to weighing breastfed babies in the UK, focussing on the issues of charts, scales, frequency of weighing and accuracy of weighing and plotting. Literature from a variety of disciplines has been brought together and a number of areas in which there is a paucity of evidence have been noted.

Monitoring infant growth is an important part of child health care services and regular routine weighing of babies is the most common manifestation of this in UK practice. Many parents bring their babies for weighing frequently. Parents, and even health professionals, may assume that it is a straightforward matter of weighing and plotting weights on the chart, which then yields a clear indication as to the well being of the baby. In reviewing the literature on the construction of the charts in use in the UK, as well as the chart being designed by the WHO, it can be seen that decisions taken in selecting which children to include in centile charts, how the data is collected, and how it is treated, colours the type of growth reference or standard obtained. This then affects the interpretation of the growth trajectory, plotted on the chart, of an individual baby. The relation of current growth charts to what is understood about the growth

patterns of breastfed infants also introduces a source of confusion. Misunderstanding may undermine confidence in breastfeeding, and lead to unnecessary intervention – either by health professionals or by parents who are anxious about weight.

All professionals who weigh babies and discuss the weight with parents should receive clear training and updates on these issues. Using the chart based on data from breastfed babies available in the UK might improve understanding, however, it has not been tested to see whether it improves referral accuracy and parental confidence or whether it affects breastfeeding duration. Investigation of such issues should be undertaken before this chart is adopted.

An audit of the magnitude of error in current weighing practice would be a welcome addition to the literature in this area. The 'technical' issues of scales used, accuracy of recording, when and how often to weigh, and the effect these have on the plotted result highlight infant weighing as a practice requiring skill in carrying out. Attention to good practice, including informing parents of the influence of such factors on recorded weights, should help give the best assessment of child well being, and for professionals to choose appropriately between intervention and referral or offering support and encouragement for current breastfeeding practice to continue. In particular there is a mismatch between common practice and recommendations in the frequency of routine weighing where infants give no other indication for concern, and it would be fruitful to investigate reasons parents have for frequent weighing visits. Action research may be one fruitful way of trying out methods of reducing frequency while providing sources of reassurance to parents about infant well being.

The effects of attempting to survey the literature relevant to the every-day practice of weighing breastfed babies, for these reviewers, gives a feeling of standing on a hill in fenland – a number of areas of firm ground are visible, however, the connections between them are often shrouded in low-lying fog, with speculation and assumption filling in the contours between. This review does not claim to have penetrated all areas of fog, but hopes to direct attention to where more study is needed in order to improve the quality and usefulness of weight monitoring.

Recommended topics for future research, audit and consideration:

National audits of UK clinical practice: what scales are in use; do all areas use the UK90 chart; how widely is the 'Breast from Birth' chart in use; what training do clinicians receive in weighing babies?

A study comparing the effects of the UK90 and the 'Breast from Birth' charts on breastfeeding mother's confidence and rates of breastfeeding duration.

Observational studies which note 'breastfeeding style' as well as growth patterns.

A survey of the accuracy of weighing in clinical conditions.

A survey of weight recording in a community setting.

Investigations of the reasons mothers attend for weighing with great frequency – with possible action research studies to reduce the perceived need for frequent weight monitoring in well babies.

Acknowledgements

The authors are grateful to two anonymous peer reviewers whose comments on an earlier draft were very useful.

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