Abstract

Background: Healthy, term, exclusively breastfed infants are expected to lose weight in the first days after birth, although weight loss might also indicate problems such as low milk supply or insufficient milk transfer. There are conflicting opinions about what constitute a normal neonatal weight loss and when interventions, such as supplementation, should be considered.

Objectives: To systematically review studies of normal physiological weight loss in exclusively breastfed neonates and establish the reference weight loss for the first two weeks of life.

Methods: Two researchers completed separate searches and data abstractions. Five electronic databases were searched from June 2006 to June 2007: the Cochrane Database of Systematic Reviews; Medline; CINAHL; EMBASE; and Ovid Healthstar. Inclusion criteria were primary research studies with weight loss data about healthy, full-term, exclusively breastfed singleton neonates in the first two weeks of life. Studies with preterm, near-term, multiples or supplemented infants were excluded. All research methodologies and report styles were considered.

Results: Eleven studies met the inclusion criteria. Only one study collected data for up to two weeks. Mean weight loss ranged from 5.5% to 8.11% with standard deviations hovering around 2%. Median percentage weight loss ranged from 3.2 to 8.27 with the majority around 6%. Most infants in these studies regained their birth weight within the first two weeks postpartum. The second and third days of life appear to be the days of maximum weight loss.

Interpretation: The results are inconclusive. Many studies did not collect daily weights and reports of measurement varied widely. The 7% maximum allowable weight loss recommended in four clinical practice guidelines appears to be based on mean weight loss and does not account for standard deviation. Further research is needed to understand iatrogenic neonatal weight loss, weight loss due to excess output, and the significance of morbidity or mortality statistics.

Introduction

Women and their infants benefit from breastfeeding and exclusive breastfeeding is recommended for the first six months of life.[1-8] Approximately 85% of Canadian women choose to initiate breastfeeding and ensuring infant health is a priority for lactation specialists and health care professionals who work with these breastfeeding dyads.[9] Optimum infant health requires adequate breastfeeding, and inadequate breastmilk intake poses hazards for the infant which might include dehydration, hypernatremia, or hyperbilirubinemia.[10,11] At the same time, there are risks associated with using artificial breastmilk substitutes (i.e. formula) such as exposure to foreign proteins, disruption of gut flora, and premature weaning.[12-15] Appropriate lactation and breastfeeding assessment in the first postpartum weeks is required to maintain infant health and to optimize breastfeeding support.

Infant weight measurement is one of the most frequent tools used to assess breastfeeding adequacy. It appears neonates receive only small amounts of fluids in the first days of life,[16] and they tend to lose weight before they begin to gain weight.[2] Excessive weight loss or inadequate weight gain may be more than a normal occurrence, they can also be indications of low milk production or insufficient milk transfer. To ensure adequate intake and, at the same time, avoid inappropriate supplementation, parents, families, and professionals need evidence to properly assess patterns of neonatal weight change and make decisions about infant feeding.

There are conflicting opinions and guidelines about what constitutes a normal neonatal weight loss. How much weight loss should be considered a red flag? What is the upper limit that indicates intervention is required? The goal of this systematic review is to bring evidence together to answer the research question, "What is a normal physiological weight loss for full-term exclusively breastfed infants in the first two weeks of life?"

For the purposes of this systematic review, we made three assumptions. First, neonatal weight loss in the first days of life is expected, and we therefore refer to such weight loss as physiological weight loss. Second, to define abnormal or pathological weight loss, we need evidence of what would be considered a normal or reference weight loss. Third, we did not expect to find randomized controlled trials (RCTs) regarding neonatal physiological weight loss. RCTs have their roots in pharmacology[17] and from these roots RCTs became the standard for intervention studies.[18] Since we sought evidence for parameters of weight loss, not for optimal interventions, we expected to find observational studies (e.g. cohort, case-control) and not RCTs.

Methods

Search Methods

Two researchers (JNW, GC) completed separate searches of the databases through their respective university libraries. Five electronic databases were searched from June 2006 to June 2007: the Cochrane Database of Systematic Reviews, Medline, CINAHL, EMBASE, and Healthstar. Boolean searches using alternate spellings of key words were run multiple times (see Table 1 for basic search string). Boolean searches were also completed using Google and Scirus search engines. Clinical practice guidelines were identified and reference lists from the guidelines and from retrieved articles were examined for potentially relevant studies. Dates, languages, and countries of origin were not restricted. All research methodologies and report styles were considered.

Inclusion Criteria

Primary research studies with data about weight loss in the first two weeks of life were included. Primary research is defined as research undertaken by the authors and could include systematic reviews or secondary analysis of a data set. This criterion included research studies

that collected data about weight loss as part of their protocol even if their research was not intended to be about weight change patterns. Conclusions based on cited research, narrative reviews, and papers that simply stated an acceptable weight loss were excluded.

Studies of healthy, full-term, singleton breastfeeding babies were eligible. Full-term is defined as more than 259 days (36 6/7 weeks).[19] Breastfeeding is defined as only breastmilk, whether at breast or by bottle, and no other food or liquids including water with the exception of medicines, vitamins or minerals (i.e. exclusively breastfed).[20] We excluded studies of formula-fed or supplemented infants and preterm, near-term, or multiples (e.g. twins, triplets), unless the full-term singleton exclusively breastfed infants' data were reported separately.

Data Abstraction and Analysis

Articles found during the searches were screened based on their titles and abstracts, and studies deemed relevant were retrieved for abstraction (see Table 2 for methodological steps). In the next step, two researchers (JNW, GC) used an abstraction form developed for this systematic review to analyze the screened studies and determine their eligibility for inclusion. The two researchers then compared their results to reach a consensus about studies that met the inclusion criteria. In several cases, the researchers contacted authors for clarification about their studies.

Results

Eleven studies met the inclusion criteria (see Table 3 for descriptions).[13,21-30] Ten of the studies were observational as opposed to experimental, and one study was a randomized controlled trial[13] intended to determine the effect of glucose supplements. With one exception, all were prospective studies. The one exception was a secondary analysis of data that had been collected prospectively.[22] Six of the eleven studies were researching non-weight topics but provided data about weight change patterns. Nine of the studies were in English, one in French,

and one in Croatian. They included populations from Bangladesh, France, India, Italy, Jamaica, Scotland, Serbia, Spain, Sweden, and the United States.

Authors of the included studies reported amount of weight loss and timing of weight loss using a variety of descriptive statistics (see Table 3 under Study Results). None of the studies considered morbidity or mortality statistics. Examples of excluded studies and rationales for their exclusion are provided (see Table 4).[10,31-43]

Amount of Weight Change

In 10 of the 11 included studies, weight change was measured as amounts of weight, and one study reports weight patterns based only on timing of change.[23] In the 10 studies reporting amounts of weight change, eight types of descriptive statistics are used to express the amount of weight change: 1) mean weight loss;[13,26,28,30] 2) median weight loss;[25,27,28] 3) range of weight change;[22,26,27] 4) number of subjects over or under a percentage;[21,22,26] 5) amount in grams or kilograms lost or gained;[13,24,,30] 6) centile data;[25] 7) mean change;[22] and 8) by parity or birth type.[29]

Mean weight loss ranged in the studies from 5.5% to 7.27% with standard deviations hovering around 2% (see Table 3 for specifics).[26,28,30] Whether mean percentage represented the average of maximum daily weight loss measurements (i.e. one measurement per neonate) or an average of all weights taken is not clear. Manganaro et al.[26] divided their subjects into two groups (<10% and ≥ 10%) and we pooled the results to determine the average for the group as a whole to be 5.94%. Median percentage weight loss ranged from 3.2 to 6.9 with the majority of reported medians around 6%.[25,27,28]

The authors who reported the range of weight change had collected data for 72 hours to 24 days and the range in these studies varied from a loss of 14.3% to a gain of 15.3%.[22,26,27] Authors of three papers grouped subjects according to the percentage of weight change. For

example, Bhat et al.[21] found 6.8% lost more than 10%; DeMarzo et al.[22] report 08.7% lost more than 7%; and Manganaro et al.[26] state 7.7% lost more than 10%.

Jolly et al.,[24] Martin-Calama et al.,[13] and Muskinja-Montanji et al.[29] report the number of kilograms or grams neonates lost or gained. Jolly et al.[24] report substantial weight gains with 90% of the study infants averaging a gain of 230 grams by day 3. Martin-Calama et al.,[13] describe mean weight losses that peaked at 48 hours and then mean gains begin, but they do not report the standard deviations. Muskinja-Montanji et al.[29] report weight loss in grams by parity, and in both of the study groups (nursery and rooming-in) infants of primiparous women lost more weight.

Three authors were unique in their reports. DeMarzo et al.[22] report the mean change between two weights measured at post-discharge clinical visits, average day 5 and day 10. MacDonald et al.[25] demonstrate the upper limit of weight loss in their study, by stating the 95% centile is 11.8%. Rodriguez et al.,[30] in their study of body composition, state average weights for three days, but they do not provide data about the change.

Timing of Weight Change

Some of the researchers looked at the day neonates regained their birth weight and the nadir of weight loss. Six approaches were used to describe the timing of weight change: 1) day infants regained birth weight;[22,23] 2) day of lowest weight; [28,29] 3) percentage of infants who gained or lost on a particular day;[23,24] 4) first day they began to regain;[31] 5) by parity or birth type;[26] and 6) median for both number of days losing weight and days to regain birth weight.[25]

When time to regain birth weight is reported in the findings, the majority of infants in these studies regained their birth weight within the first two weeks. Hossain et al.[23] found

91.57% had regained initial weight by day 14, and DeMarzo et al.[22] state that 88.7% infants were back to birth weight by the second clinic visit (average day 10).

The day of lowest weight is reported by Michel et al.[28] as days 1 and 2, and by Muskinja-Montanji et al.[29] as day 2 and 3. In both studies, the two combined days account for about 90% of the sample. The discrepancy seems to be a matter of counting the day of birth as day zero or day one and then the second 24 hours day 1 or day 2. We assume that a child born on a Monday in either study would show the weight loss on Tuesday and Wednesday.

Hossain et al.[23] and Jolly et al.[24] identify the day infants began to gain weight, and they have very different results: 56.25% by day 5 and 90% on day 3 respectively. This discrepancy is an outstanding feature, and with only two studies describing weight change in this manner, it is difficult to determine which is the outlier.

Two authors have unique methods of reporting. MacDonald et al.[25] report the median number of days of weight loss and the median day to regain birth weight as 2.7 and 8.3 respectively. Manganaro et al.[26] note that infants born vaginally in their study reached their lowest weight between day three and four, and C-section neonates between day four and five.

Review of Clinical Practice Guidelines

Clinical practice guidelines (CPGs) are defined as "systematically developed statements [based on best available evidence] to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances".[44,p38] Four key CPGs, among others, were found during searches for this systematic review.[45-48] Three of the guidelines[45-47] are about overall breastfeeding and one deals specifically with supplementation.[48]

These breastfeeding CPGs advise against supplementation (i.e. replacement breastfeeds) as a standard or casual practice, and they recommend limits for weight loss. The American

Academy of Pediatrics[45] states, "Weight loss in the infant of greater than 7% from birth weight indicates possible breastfeeding problems and requires more intensive evaluation of breastfeeding and possible intervention to correct problems and improve milk production and transfer."[p.499] The International Lactation Consultant Association[46] and The Registered Nurses Association of Ontario[47] specify that a loss of more than 7% of birth weight, continued loss after day three, or failure to regain birth weight within a minimum number of days (i.e. 10 days[46] or 2-3 weeks[47] respectively) are signs of ineffective breastfeeding. The Academy of Breastfeeding Medicine[48] advises "Possible indications for supplementation in term, healthy infants [include] weight loss of 8% to 10% accompanied by delayed lactogenesis (day 5 or later)"[p.2]

These guidelines presume some weight loss is expected and too much weight loss is a sign of inadequate milk intake due to low supply or ineffective milk transfer. The consensus indicates a weight loss in excess of 7% is cause for further assessment and possible intervention. Several of the studies initially screened for this systematic review are referenced in these CPGs.

Interpretation

Quality of Studies Regarding Weight Loss

Our initial criteria for inclusion did not include elements of quality, but the articles that met the inclusion criteria required analysis and synthesis and, as a result, we critiqued the quality of the studies. Generally, sample size was adequate and descriptions of research methods were sufficient. The sample sizes ranged from 21 to 937 with a median of 120. All but one study had more than 40 subjects. Most studies had convenience, not random, samples. Research methodology was defined in all studies.

Definitions, frequency of weighings, and inconsistencies in approaches and report methods for descriptive statistics were problematic. Generally the studies did not specify a definition for breastfeeding. In one case, the term "exclusively breastfed" was used, but later in the report we found that infants who received water or glucose water were included.[40] Neonates frequently had substantial weight loss and supplementation might be expected, but researchers rarely identified when subjects were supplemented. Without a clear definition of breastfeeding, it is difficult to discern supplemented from exclusively breastfed neonates (ie nothing by mouth except breastmilk and, possibly, medicines or vitamins).

There are some inconsistencies about whether the day of birth is counted as day zero or day one and this detail may cause confusion regarding expectations about when infants should begin to gain weight . Health status and whether or not the infants were singletons were often not clear and we contacted authors to clarify when necessary. If the subjects were referred to as dyads (i.e. mother and infant) we presumed singleton neonates and we assumed healthy subjects if infants were discharged to home.

The frequency of weighings was inconsistent. For example, six of the studies infants were weighed at least daily while in hospital,[13,21,27-30] and three studies measured weight sporadically.[22,24,25] In the final two studies, weights were measured daily while in hospital and then on day 5 and 10 while at home in one study, while the other continued daily weights until birth weight was regained.[23,26] Some of the variations can be explained by the fact that the research study was not primarily intended to study weight. In some cases, infants were weighed at home as part of regular postpartum routines or only when access and funding allowed. The wide range of data descriptions makes comparison or combining of study results difficult. DeMarzo et al.[22] report maximum weight loss even though daily weights had not been measured.

With only two weights measured in two weeks, it is not possible to determine the lowest weight or when it was reached.[22]

Among the 11 studies found in our searches, 1 study stands out. MacDonald et al.'s[25] study followed infants for 14 days. The infants were weighed daily while in hospital but intermittently after discharge. The researchers took this factor into account by reporting changes as medians. Based on these results of this study, it appears a maximum weight loss of up to 12% of birth weight is experienced by about 95% of neonates.[25] Within a range, the first day to begin regaining is around day four and infants regain birth weight around day nine.[25] Although the longer follow up period is a strength, the lack of daily weights weakens the findings.

Conclusions

Overall, the results of the systematic review were inconclusive. There is not enough concrete evidence to answer the question, "What is a normal physiological weight loss for full-term breastfed infants in the first two weeks of life?" There are gaps in relevant data collection and reporting, for instance, when daily measurements of weight stopped at time of discharge from hospital or when weights are not measured daily after discharge.

Given the data provided by these studies, there are problems with assigning a single, absolute number to the maximum weight an infant could lose. One must be cautious about using a mean as an absolute number to establish the maximum amount of weight an infant could 'safely' lose. For example, it appears that when a clinical practice guideline recommends interventions for an infant who has lost in excess of 7% of birth weight, this recommendation is based on observations of mean weight loss. Assuming a normal distribution, a mean weight loss of 6.86% with a standard deviation of 2.97, as Maisels et al.[36] state in their study, indicates a 95% confidence interval of 0.92 to 12.8. Specifically, 68% of all infants would experience a weight

loss of between 3.89 and 9.83% and 95% of all infants would experience a weight loss between 0.92 and 12.8%.

There is a second reason why a single number is a problem. When discerning a physiological from a pathological weight loss, an absolute number may cause health care professionals to miss red flags. For example, a three-day old infant with a 7-10% weight loss is probably reaching his or her lowest weight before gaining, and this child would be in a different situation than a five-day old infant who weighs 10% less than his birth weight. Not only has the five-day old infant lost weight, but s/he has not regained, thereby being further behind than the 3-day old infant. An absolute number in this case might be deceiving.

Recommendations for Further Research

The data does not provide information about the implications of a 7% weight loss or a 10% weight loss. We found evidence of patterns of weight loss, but we did not identify a relationship to morbidity or mortality. No studies were found to provide evidence suggesting a point, by weight or time measurement, when weight loss presents a health risk. Weight loss did not always have clinical indications. For example, substantial weight losses are not always paired with hypernatremia.[21,26,34,43] These findings raise question about the point when interventions are required to prevent illness and protect health.

Assessment of effective breastfeeding and decisions about supplementation must be based on more than weight loss. The underlying assumption is that weight loss is directly related to inadequate intake, due to either a lack of milk supply or ineffective milk transfer. There appears to be confounding factors (e.g. factors that are not natural or biological imperatives) as evidenced by the variations in mean weight losses. There also appears to be iatrogenic weight

loss, since we found studies that demonstrate that hospital routines and birth experiences affect the amount of weight lost.

Morbidity and mortality rates and their relationship to weight loss must be established. Recognizing weight change patterns helps clinicians identify red flags, but assessment cannot stop there. Implications of the weight loss must be researched and understood. Evidence from such research would ensure that interventions, for example supplementation, will not be based solely on maintaining an infant's weight within pre-established norms.

The effect of birthing practices and hospital routines on infant weight loss needs to be explored. For example, Odent[49] found one third of infants born at home (n=100) did not lose weight, and we found hospital routines affected weight loss.[29,33] These findings raise the question of iatrogenic weight loss. All reasons for weight loss should be explored, and research to understand and prevent iatrogenic loss is needed.

Research is also needed to determine if weight loss is due solely to inadequate intake. We should consider the amount of stooling and voiding that might also contribute to neonatal weight loss. For instance, there is some evidence that infants born to mothers who received IV fluids during parturition experience greater weight loss, and excess diuresis could be the reason.[50,51] Such research could contribute to a better understanding of neonatal weight loss.

This systematic review was completed to determine the reference weight loss in the first two weeks of life. Although there is some strong, consistent evidence regarding weight loss patterns in the first few days, the results of this systematic review suggests further questions need to be answered before a normal range for neonatal physiological weight loss can be established, and indications for interventions can be determined.

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Tables for Neonatal Weight Loss Systematic Review

Table 1: Basic search string for systematic review

1. (infant or neonate or newborn or baby or neonatal).mp. [mp=ti, ot, ab, nm, hw]
2. (breastfeeding or breast-feeding or breast feeding).mp. [mp=ti, ot, ab, nm, hw]
3. (full-term or fullterm or term).mp. [mp=ti, ot, ab, nm, hw]
4. (weight or weight loss or "birth weight" or birthweight).mp. [mp=ti, ot, ab, nm, hw]
5. (postnatal or post natal).mp. [mp=ti, ot, ab, nm, hw]
6. weight.m_titl.
7. 4 or 5 or 6
8. 1 and 2 and 3 and 7

Table 2: Methodological steps

1) Independent searches by two authors through two university libraries using five databases: Cochrane Database of Systematic Reviews, Medline, CINAHL, EMBASE, Healthstar

2) Results of basic search string:

Cochrane Database of Systematic Reviews - 107
Medline - 539
CINAHL - 129
EMBASE - 407
Healthstar - 360

3) Boolean searches with Google search engine using search string terms

4) Initially screened articles by title and abstract to determine if the study met inclusion criteria

Initial screening - 69 articles pulled for detailed abstraction

5) Used reference lists from retrieved articles and clinical practice guidelines for additional searches and screening

6) Articles were abstracted independently by two authors using an abstraction form developed for this review

7) Authors compared their results and reached consensus about studies that met the inclusion criteria

8) Authors of studies and articles were contacted to clarify details of their studies

11 articles met inclusion criteria

Table 3: Studies that met the inclusion criteria

Reference	Study Methodology	Purpose of Study	Study's Primary Purpose Weight Change?	Sample Size	Measurements	Study Results
Bhat SR, Lewis P, David A, Liza SM. Dehydration and hypernatremia in breast-fed term healthy neonates. *Indian J Pediatr* 2006;73:39-41.	Prospective, observational study conducted for 6 months	To determine the incidence of significant weight loss, dehydration, hypernatremia and hyperbilirubinemia in exclusively breastfed term healthy neonates and compare incidence in warm versus cool months	no	496 infants of a possible 832 births	Daily weights Birth to discharge (3-8 days) Reports 1) percentage of infants by weight loss group Note: significant weight loss defined as wt loss >10% and/or wt loss of >5% in a 24 hour period	1) Percentage of infants by weight loss group: >10% weight loss = 06.8% >05% weight loss in 24 hr period = 24.7% weight loss considered not significant = 68.4%
DeMarzo S, Seacat J, Neifert, M. Initial weight loss and return to birth weight criteria for breast-fed infants: challenging the 'rule of thumb' [conference proceeding]. *Am J Dis Child* 1991;145:402.	Secondary analysis of data from a prospective study	To explore the patterns of initial weight loss and return to birth weight among healthy, term, breastfed infants specifically the validity of the clinical criteria of 10% as an acceptable weight loss	yes	264 neonates (236 were exclusively breastfed at day 10)	Birthweight, then 1st weight at mean of 5 days and 2nd weight at mean of 10 days Reports 1) % weight change from birthweight to 1st weighing, including range, mean, median and S.,D> 2) % of infants whose weight loss exceeded 7% at 1st weighing 3) % infants above birthweight at 2nd weighing (n=236)	1) Range = -14.3 to +15.3% Mean = -01.76% ; Median = -1.80% SD = 4.24) 2) >7% weight loss = 08.7% 3) Regained birthweight by 2nd visit = 88.7%

Hossain MA, Islam MN, Shahidullah M, Akhter H. (2006). Pattern of change of weight following birth in the early neonatal period. *Mymensingh Med J* 2006;15:30-2.	Prospective, observational study conducted for 6 months	To determine postnatal weight change in early neonatal period in relation to gestational age and birth weight.	yes	48 full term infants of 185 births (Includes 3 low birth weight babies)	Daily weight until infant regained initial birth weight Reports 1) duration of weight loss (days) 2) time in days to regain initial weight	1) 56.25% began to regain by Day 5 43.75% began to regain by Day 10 2) Regained initial weight: 1-10 days = 56.16% 11-14 days = 35.41% 15-21 days = 8.33% > 21 days = 2.08%
Jolly PE, Humphrey M, Irons BY, Campbell-Forrester S, Weiss HL. (2000). Breast-feeding and weight change in newborns in Jamaica. *Child: Care, Health & Development* 2000;26:17-27.	Prospective	To examine weight change of exclusively breastfed infants through the first 24 days of life and to evaluate the effect of breastfeeding factors and maternal characteristics on early weight change in the infants	yes	21 neonates	Weights on day 1 (day of birth) and days 3, 7, 10, 17, 24 Reports 1)mean and median amounts of weight gained and lost in kilograms 2) % of infants who gained or lost weight for days 1, 3, 7, 21	1) Change of weight from birth in kilograms Mean (SEM) Day 3 0.23 (±0.06) Day 7 0.56 (±0.09) Day 24 1.22 (±0.14) Median Day 3 - 0.16 Day 7 - 0.49 Day 24 - 1.16 2) % of infants who gained Day 3 - 90% Day 7 - 95% Day 24 - 100%

Macdonald PD, Ross SR, Grant L, Young D. (2003). Neonatal weight loss in breast and formula fed infants. *Arch Dis Child Fetal Neonatal Ed* 2003;88:F472-76.	Prospective observational cohort study	To define the range of neonatal weight loss in a population relative to feeding method.	yes	937 infants 45% breastfed (n=420) 42% formula-fed 13% combined	Weighed at birth, at discharge (~48 hrs), ~day 5, 7, 10, 14 (weighing stopped when birthweight regained) Reports median for 1) % of weight loss 2) timing of maximum wt loss in days 3) days to regain birth weight 4) centile data of above	1) % weight loss (n=420) Median = 6.6 (6.3-6.9) 95th centile 11.8 (11.2-12.9) 2) Timing of loss (days) (n=420) Median = 2.7 (2.5-2.8) 95th centile 9.1 (7.7-10.2) 3) Regain birth weight (days) (n=395) Median = 8.3 (7.7-8.9) 95th centile 18.7 (16.7-20.8)
Manganaro R, Mami C, Marrone T, Marseglia L, Gemelli M. (2001). Incidence of dehydration and hypernatremia in exclusively breast-fed infants. *J Pediatr* 2001;139: 673-75.	Prospective observational study	To verify the incidence of hypernatremic dehydration in exclusively breast-fed, term infants and identify possible maternal and/or infant factors that interfere with successful breast-feeding.	no	686 infants of 782 births ≥10% weight loss (n=53) <10% weight loss (n=633) No supplements first 3 days 26% received formula supplement due to weight loss (≥10%)	Daily weights in hospital and at home on day 5 (vaginal birth) and on day 10 (both vaginal and c-sec) Reports by group (≥10% & <10% weight loss) 1) mean % wt loss & range of % wt loss for those who lost >/= 10% 2) range of days of max wt loss for type of birth	Percentage of subjects ≥10% weight loss = 7.7% <10% weight loss = 82.3% 1) Mean weight loss in ≥10% group = 11.3±1.1 (range 10-14.8%) <10% group = 5.5±1.2 no range stated 2) vaginal birth - lowest weight at 3-4 days c-sec birth - lowest weight at 4-5 days

Marchini G, Fried G, Östlund E, Hagenäs, L. Plasma leptin in infants: relations to birth weight and weight loss. *Pediatrics* 1998;101:429-32.	Prospective, observational study	To investigate whether plasma leptin was related to birth weight or weight loss during the neonatal period	no	120 infants during first four days Four groups (n=30 each) according to timing of bloodwork	Daily weights Reports 1) % median weight loss with range	1) % of weight loss median (range) Group 1 = 3.2 (0.4-5.7) Group 2 = 6.0 (2.1-8.2) Group 3 = 6.4 (0.1-12.6) Group 4 = 5.7 (0.3-15.7)
Martin-Calama J, Buftuel J, Valero MT, Labay M, Lasarte JJ, Valle F, et al. The effect of feeding glucose water to breastfeeding newborns on weight, body temperature, blood glucose, and breastfeeding duration. *J Hum Lact* 1997;13:209-13.	Randomized Controlled Trial	To compare the use of glucose water and exclusive breastfeeding on weight loss, serum glucose level, temperature and breastfeeding duration	no	87 infants in the exclusively breastfed group followed for 72 hours	Weights at 6, 12, 24, 48, and 72 hours Reports 1) weight loss in grams 2) weight loss as percentage of birth weight	1) Weight loss in grams (SD) 6 hours = 46.4±19.1 12 hours = 86.4±30.4 24 hours = 140.6±42.4 48 hours = 197.8±73.2 72 hours = 141.9±89.1 2) % of birth weight lost 6 hours = 1.4% 12 hours = 2.6% 24 hours = 4.2% 48 hours = 5.9% 72 hours = 4.2%

Michel M-P, Gremmo-Feger G, Oger E, Sizun J. (2007). Pilot study of early breastfeeding difficulties of term newborns in maternity: incidence and risk factors. [French]. *Arch Pediatr* 2007;14(5):454-60.	Prospective, descriptive study	To identify incidence and risk factors for breastfeeding difficulties in maternity ward using three indicators: excess neonatal weight loss, delayed onset of lactation, and suboptimal infant breastfeeding behaviour	no	118 infants "20.3% of infants received formula supplements" (p. 456)	Daily weights while in hospital Reports 1) Weight loss as mean	1) Weight loss mean = 6.62 (SD±1.84) in exclusively breastfed (shown in text-not table)
Muskinja-Montanji G, Molnar-Sabo I, Vekonj-Fajka G. [Physiologic neonatal body weight loss in a "baby friendly hospital"]. [Croatian]. *Medi Pregled* 1999;52:237-40.	Prospective, descriptive study	To determine the effect of rooming in on the initiation of lactation, and physiological weight loss.	no	200 infants 100 in nursery and 100 in Baby Friendly Hospital Initiative™ hospital (ie rooming-in)	Daily weights Reports 1) average weight loss in grams by parity 2) day of lowest weight 3) % of weight loss by parity	1) Average weight loss (gms) Nursery Para 1 = 205 P.2 = 178.82 P.3 = 190 BFHI Para 1 = 191.7 P.2 = 171.95 P.3 = 178 2)Day of lowest weight (combined, n=200) Day 1 - 2, Day 2 - 93 Day 3 - 90, Day 4 - 14 Day 5 - 1 3) % of weight loss by parity Nursery Para 1 = 6%, P.2 = 5.2%, P.3 = 5.34%, P.4 = 7.27%

						BFHI Para 1 = 5.5%, P.2 = 5.15%, P.3 = 5.04%, P.4 = 5.66%
Rodriguez G, Ventura P, Samper MP, Moreno L, Sarria A, Perez-Gonzalez JM. Changes in body composition during the initial hours of life in breast-fed healthy term newborns. (2000). *Biol Neonate* 2000;77:12-6.	Prospective, observational study	To investigate the nature of the weight changes (ie fluid versus solid) which accompany early physiological weight loss	no	43 neonates	multiple anthropometric variables including weight at birth and days 1, 2, 3 Reports 1) mean weight in grams 2) mean weight loss	1) Mean birthweight: 3297.7 +/- 381.39 Mean daily weight (SD) Day 1 - 3252.1 gm (±389) Day 2 - 3146.7 gm (±380) Day 3 - 3111.4 gm (±371) 2) Mean weight loss (SD) 5.67% (±1.98)

Table 4: Examples of studies excluded from systematic review

Reference	Used as a reference in a Clinical Practice Guideline	Relevant weight data or rationale for consideration	Study details and reason for exclusion
Avoa, A. & Fischer, P. R. (1990). The influence of perinatal instruction about breast-feeding on neonatal weight loss. *Pediatrics, 86,* 313-315.		Intervention group (n=162) Weight loss = 3.8% (SD=2.3) Non-intervention group (n=142) Weight loss = 6.2% (SD=3.1)	Study to determine the effect of a breastfeeding education session provided in labour and delivery on infant weight loss. Supplemented and "low birth weight infants" (not defined) infants are pooled with exclusively breastfed infants.
Benson S. What is normal? A study of normal breastfeeding dyads during the first sixty hours of life. *Breastfeed Review* 2001; 9: 27-32.		Title suggests relevant weight data would be part of study.	Study of breastfeeding patterns during first 60 hours. No data about weight.
Bystrova, K., Matthiesen, A. S., Widstrom, A. M., Ransjo-Arvidson, A. B., Welles-Nystrom, B., Vorontsov, I. et al. (2007). The effect of Russian Maternity Home routines on breastfeeding and neonatal weight loss with special reference to swaddling. *Early Human Development, 83,* 29-39.		Infants were weighed daily as part of study.	Aim was to study effects of different combinations of ward routines: skin-to-skin vs. clothed, rooming-in vs. nursery, and swaddling vs. loosely dressed. Lack of data for weight change patterns of exclusively breastfed infants.

Çağlar MK, Özer I, Altugan FŞ. Risk factors for excess weight loss and hypernatremia in exclusively breast-fed infants. *Braz J Med Biol Res* 2006; 39: 539-44.		Title suggests primary study about weight loss.	Aim of study was to identify risk factors for weight loss. No primary data regarding weight loss
Dewey, K. G., Nommsen-Rivers, L. A., Heinig, M. J., & Cohen, R. J. (2003). Risk factors for suboptimal infant breastfeeding behavior, delayed onset of lactation, and excess neonatal weight loss. *Pediatrics, 112,* t-19.		Weight change by day 3 average weight loss of 5.5% (±3.8) 5% gained weight 82% lost <10% of birth weight 12% lost ≥ 10%	To determine the incidence of and risk factors for suboptimal infant breastfeeding behavior (SIBB), delayed onset of lactation, and excess neonatal weight loss Not all infants exclusively breastfed
Livingstone VH, Willis CE, Adbel-Wareth LO, et al. Neonatal hypernatremic dehydration associated with breast-feeding malnutrition: a retrospective survey. *CMAJ* 2000; 162: 647-52.		States, "It is normal over the first week of life for the neonate to lose as much as 7% of its birth weight through normal diuresis. Neonates should start to gain weight within a few days and regain their birth weight by the tenth day of life. Either rapid weight loss or loss greater than 7% of birth weight is a cause for concern." (p. 647)	Retrospective study of neonates with hypernatremia. No primary data regarding weight loss. No references or data to support 7% weight loss limit statement.

Maisels, M. J., Gifford, K., Antle, C.E., et al. (1988). Jaundice in the healthy newborn infant: A new approach to an old problem. *Pediatrics, 81,* 505-11.		States "breast-fed infants lost an average of 6.86 ±2.97% of their birth weight" (p. 508)	Compares a group of infants with jaundice (n=147) with a control group of infants (n=147) randomly chosen from a pool of 2,269 healthy infants, but only 46.9% were breastfed. Retrospective chart review for data about weight patterns Insufficient detail about breastfed infants to meet inclusion criteria for systematic review
Powers NG, Slusser W: Breastfeeding update. 2: Clinical lactation management. [Review]. Pediatr Rev18:147–161, 1997.		Suggests a weight loss of 8-10% accompanied by delayed lactogenesis is a possible indication for early supplementation	Clinical information intended for pediatricians. No primary data regarding weight loss. No references or data to support 8-10% weight loss limit statement.
Shrago LC. The relationship between bowel output and adequacy of breastmilk intake in neonates. Proceedings of the 1996 Association of Women's Health, Obstetric, and Neonatal Nurses Conference, Anaheim, CA.		States "Normal weight loss in breastfed neonates should not be >7% of birth weight."	Conference proceeding comprised of PowerPoint® slides Not primary data Used secondary citations to establish normal weight loss.

Tjon, A. T. W., Kusin, J. A., & de, W. C. (1986). Early postnatal growth of Basotho infants in the Mantsonyane area, Lesotho. *Annals of Tropical Paediatrics, 6,* 195-198.		Daily weights for up to seven days or as long as in hospital Reports 1) mean percentage of birthweight over six days 2) days to regain birthweight	Study to determine the percentage of weight lost by Basotho infants after birth and the time to regain birth weight, n=814 neonates over a four year period Only 289 of 814 infants assessed for gestational age. Results included data for preterm and small for gestational age infants pooled together with data for term infants.
Wright CM, Parkinson KN. Postnatal weight loss in term infants: What is "normal" and do growth charts allow for it? Arch Dis Child Fetal Neonatal Ed 2004; 89: 254-7.		Title suggests relevant weight data would be part of study.	To determine maternal socioeconomic factors that affect infant weight gain or faltering Only 51% of the neonates were breastfed Exclusively breastfed data not reported separately
Yaseen H, Salem M, Darwich M. Clinical presentation of hypernatremic dehydration in exclusively breast-fed neonates. *Indian J Pediatr* 2004; 71: 1059-62.		Control group of 58 healthy, term infants aged 4-7 days	To identify the clinical presentation of dehydration related to failure of lactation in exclusively breastfed term infants Only 74% of control group was exclusively breastfed and data was pooled