2015

Weighing the Facts: A Systematic Review of Expected Patterns of Weight Loss in Full-Term, Breastfed Infants

Diane Thulier
University of Rhode Island, dianethulier@uri.edu

Citation/Publisher Attribution

Diane Thulier. (2015). Weighing the Facts: A Systematic Review of Expected Patterns of Weight Loss in Full-Term, Breastfed Infants. *Journal of Human Lactation, 32*(1), 28-34. doi: 10.1177/089033441559768
Available at: http://dx.doi.org/10.1177/0890334415597681

Weighing the Facts: A Systematic Review of Expected Patterns of Weight Loss in Full-Term, Breastfed Infants

Abstract

All breastfeeding infants lose some weight in the early days of life. Conventionally, 5-7% loss of birth weight has been accepted as the normal and expected amount of weight loss before infants begin to gain weight steadily. When infants lose more than 7% of their birth weight, breastfeeding adequacy is sometimes questioned and formula supplementation is often given. Despite the fact that 5-7% is well known and commonly cited, little reliable evidence exists that supports use of this figure as a guide to practice. A systematic review of studies that focused on infant weight loss was conducted. The main objective was to determine the mean amount of weight loss for healthy, full-term exclusively breastfed infants after birth. One previous review and nine primary studies, published since 2008 were examined. The reported mean infant weight loss ranged widely among studies from 3.79% to 8.6%. The point at which most infants have lost the most amount of weight occurs 2-4 days after birth. Close examination of the studies, however revealed significant methodological flaws in the research. Study limitations commonly included gaps in data collection, lack of documented feeding type, sample groups that lacked adequate numbers of exclusively breast fed infants, and the exclusion of breast fed infants who lost the most weight. Well-designed clinical studies that address these limitations are needed. In addition, the use of 5 well-defined, operationally useful infant feeding groups is suggested in order to assist researchers with this work.

Background

It is well established that some degree of early neonatal weight loss is normal. For the first two days of life, breastfeeding infants receive only small amounts of colostrum from the breast. After lactogenesis stage II (secretory activation) begins usually on the 3rd day of life, most infants will begin to gain weight steadily. For a small percentage of infants, too much weight loss may indicate a problem. Potential problems may include poor breastfeeding management, undiagnosed metabolic disorders, neurological disorders or other infant morbidities that cause poor feeding[1]. A serious outcome of unrecognized feeding problems and too much weight loss can be hypernatremic dehydration. Complications of hypernatremic dehydration may include renal and liver failure, disseminated intravascular coagulation, intracranial hemorrhage, seizure and death.[2]

For many years 5-7% loss of birth weight, has been considered the normal and expected amount of physiological weight loss for breastfed infants.[3,4,5] This figure is now being challenged. Researchers are suggesting that little is actually known about weight changes in term babies during the first two weeks of life.[6,7] Until recently, the growth of breastfed babies was judged by a standard that was derived from data collected on children who had largely been artificially fed.[6,8] It was not until 2010 that updated growth charts were disseminated by the World Health Organization (WHO)[9] and reflect growth patterns among children predominantly breastfed. Indeed, health differences between breast and formula fed infants have become increasingly clear. Breastfeeding is positively associated with fewer respiratory, gastrointestinal, and ear infections.[10,11] Later in life, breastfed infants experience less Type I and II diabetes, heart disease and

obesity.[12]

There are several well-documented factors associated with increased infant weight loss after birth. These factors include higher weight at birth, female gender, advanced maternal age and education, cesarean delivery, and jaundice.[13,14] Delayed lactogenesis has also been demonstrated to correlate strongly with increased weight loss[3]. Recently, studies have also shown that intravenous fluid given during the antepartum period can impact the amount of weight loss in the neonatal period.[1,15]

Currently, different opinions exist about what constitutes normal infant weight loss and when this weight loss is considered to be excessive. Controversy also exists about when interventions, such as formula supplementation, should be initiated.[1,7] The International Lactation Consultant Association[16] and the Academy of Breastfeeding Medicine,[17] both suggest that breastfeeding management should be evaluated in those infants who exceed a 7% loss. The 2012 American Academy of Pediatrics[8] policy statement 'Breastfeeding and the Use of Human Milk' also notes that breastfeeding infants should have a weight loss of no more than 7%.

Some researchers use $\geq$ 7% as a marker for excessive weight loss[18,19] while other use $\geq$ 10%.[15,20,21] In a systematic review of infant physiological weight loss, Noel-Weiss et al.[7] noted that the choice of 7 or 10% appears to be an arbitrary demarcation of substantial weight loss. Despite these differing professional opinions and lack of evidence, the percentage of weight lost after birth remains one of the most frequently used measures to assess infants' well being. What is well known however is that administering supplemental formula when not medically indicated interferes with the

establishment of effective breastfeeding.[22] This is especially true in the early days of life before lactogenesis is well established. Therefore, in order to prevent unnecessary formula supplementation, clinicians need to know the difference between normal and abnormal weight loss.[2]

Methodology

A systematic review of the literature was conducted to answer two research questions. The first, what is the mean amount of weight loss for healthy, full-term exclusively breastfed infants after birth? The second, when do most breastfed infants reach their nadir or greatest point of weight loss after birth?

To answer these questions, a database search was conducted through the University of Rhode Island Library. Four electronic databases were searched including the Cochrane Database of Systematic Reviews, MEDLINE, CINAHL and PupMED. Primary keywords included breastfeeding, infant, weight and weight loss. Inclusion criteria were English only, reviews and primary studies whose main objective was to determine normal patterns of weight loss for healthy, full-term infants. All research designs and all countries of origin were considered for inclusion. The last systematic review of the same topic was conducted in 2008[7] and therefore the search was limited to publications dated from 2008 – 2015. In addition to the review by Noel-Weiss, nine primary studies were found that met these inclusion criteria.

Results

In 2008 Noel-Weiss and colleagues[7] completed a systematic review on physiological weight loss in the breastfed neonate. The objective of that review was to

92 establish the reference weight loss in the first two weeks of life for exclusively breastfed
93 neonates. Authors included in this review primary research studies with weight loss data
94 for healthy, full-term, exclusively breastfed neonates. They found eleven studies that met
95 the criteria; six of the studies researched non-weight topics but provided data about
96 weight change patterns. The studies consisted of works from several different cultures;
97 the sample sizes varied from 21 to 937 with a median of 120 participants. Results
98 indicated that mean weight loss for healthy term infants ranged from 5.7% to 6.6%, with
99 a standard deviation around 2%. Day 2 and 3 following birth appeared to be the days of
100 maximum weight loss and the majority of infants regained their birth weight within the
101 first two weeks after birth.[7] Since 2008, nine primary studies with a focus on
102 determining normal patterns of infant weight loss in full-term infants have been published
103 (Table I).

104 In 2008, Crossland, Richmond, Hudson, Smith, and Abu-Harb[6] completed a
105 prospective study to explore weight changes in 253 healthy full-term, singleton infants.
106 Infants were born in the Sunderland Royal Hospital in the United Kingdom and cared for
107 by midwifery teams that routinely practice skin-to-skin care after birth and encouraged on
108 demand breast feedings. Infants in the study were born via vaginal and cesarean section
109 (CS) delivery. Weights were collected in the hospital and the mothers weighed infants
110 daily at home for 2 weeks or longer, until the infant returned to birth weight. A total of
111 46 infants were dropped from the study due to consecutive missing weights. Among the
112 breastfed infants who were dropped, 13 had switched to formula feeding. This resulted in
113 a total of 111 exclusively breastfed infants and 142 formula fed infants in the study.[6] Data
114 showed that the mean weight loss for exclusively breastfed infants was 6.4% (5.5 –

115 7.3%). The mean weight loss for formula fed infants was 3.7% (2.7- 4.7%). For both
116 groups, the nadir of weight loss was day 3 of life. A total of 85% of all infants regained
117 their birth weight by two weeks of age.

118 In 2010 Mulder, Johnson and Baker[18] studied excessive weight loss in 53
119 breastfed infants born at a mid-western community hospital in the United States (U.S.).
120 A secondary analysis of data from a psychometric study examining the Mother Infant
121 Breastfeeding Progress Tool was completed. This convenience sample included women
122 who were, "attempting" to breastfed and who delivered stable infants between 35-42
123 weeks gestation. A total of 31 (59.6%) infants in the study were born via vaginal delivery
124 and 20 (38.5%) were born via CS. Infant weights were collected for two days. The
125 reported mean weight loss that occurred on day 1-2 was $3.79 \pm 1.25\%$. The researchers
126 also reported that 20.8% of infants lost $\geq$ 7% of their birth weight by day 2 of life.[18]

127 Also in 2010, Flaherman, Bokser and Newman[23] evaluated the relationship
128 between weight loss at < 24 hours and subsequent in-hospital weight loss > 10%. The
129 authors described how targeting infants at risk for greater weight loss could allow for the
130 provision of more supportive care. A retrospective analysis was completed that included
131 1049 term infants born at the University of California, San Francisco. Exclusively
132 breastfed infants were categorized with mixed feeding infants and the reported mean
133 weight loss was $6.1 \pm 2.1\%$ and the mean time to weight nadir was 38.7 ± 18.5 hours. The
134 researchers were able to demonstrate that infants who lost $\geq$ 4.5% birth weight at < 24
135 hours were at greater risk for weight loss of $\geq$ 10%.[23]

136 A prospective study by Grossman et al.[24] sought to determine the weight-loss
137 nadir among infants born at a Baby-Friendly hospital in Boston, Massachusetts. The

objective was to identify predictors of weight loss in the first week of life. A total of 121 healthy, term infants born via vaginal and CS were included in the study. Hospital weights were recorded; in addition research assistants collected daily weights for one week following birth. Results indicated that exclusive breast milk fed infants (n = 32) lost 5.5 $\pm$ 2.0%, mainly breastfed infants (n = 66) lost 5.5 $\pm$2.1%, mainly formula-fed infants (n = 16) lost 2.7 + 1.7% and exclusively formula-fed infants (n=7) lost 1.2 + 1.0% ($P< 0.001$). The mean time to nadir was 2.5 days after birth and ranged from 0 to 7 days. Feeding category, gestational age, and insurance were the greatest predictors of percent weight-loss.[24]

In 2012, Preer, Newby, and Philipp[25] published a study of 200 infants delivered at a Boston Medical Center also designated as a Baby-Friendly facility. The objective of that study was to determine average weight loss among exclusively breastfed infants delivered by CS and to identify correlates of greater than expected weight loss. Hospital staff collected daily weights during the post partum stay, for 3-4 days. Researchers found the mean weight loss for full-term, exclusively breastfed infants was 7.2% $\pm$ 2.1%. A total of 75% of the infants reached their nadir of weight loss prior to discharge (day 3 or 4). In addition absence of labor prior to CS ($p = .0004$), lower gestational age ($p=.0004$) and higher birth weight ($p< .0001$) were all associated with greater than expected weight loss.[25]

A retrospective, chart review was completed by Davanzo, Cannioto, Ronfani, Monasta, and Demarini.[14] Researchers studied 1003 full-term infants who had been admitted to the regular newborn nursery of the Institute of Maternal and Child Health in Trieste, Italy. This is a level 3 maternity hospital where rooming in is practiced. The

objective was to assess the extent of neonatal weight loss and its association with selected clinical variables. Infants were weighed daily until discharge on day 2-4; infants born via vaginal and CS were included. A mean percent weight loss of 6.3% $\pm$ 2.0% for the breastfed group and 7.5 $\pm$ 2.4% for the formula fed group was reported. For all infants, the weight loss during hospitalization ranged from 0 – 13.2%. Any formula feeding, CS, hot season and jaundice were independently associated with neonatal weight loss $\geq$ 8%.[14]

Fonseca, Severo, Barros and Santos[13] also examined the determinants of weight changes for infants during the first 96 hours of life. They prospectively sampled 1,288 full-term infants born in 5 different metropolitan hospitals in Porto, Portugal. Infants were weighed twice, once at birth and then again before discharge in order to determine total weight loss. For 61% of the total sample (n= 1,288), this second weight was collected at or prior to 48 hours of life. Exclusively breastfed infants made up the breastfed category (n = 291, 52.2%); all other infants were part of the formula/mixed-feeding group. The mean weight loss for all infants was 6.7% SD $\pm$ 2.32; weight loss ranged between 0 and 18.2%. Excessive weight loss was positively associated with maternal age > 40 years, maternal education, cesarean delivery and phototherapy-treated jaundice.[13]

In 2014, Bertini, Breschi and Dani[20] published a retrospective chart review of data from 1760 infants. All healthy, full-term, singleton infants born via vaginal delivery at the Margherita Birth Center at the University Hospital in Florence, Italy were enrolled. The infant feeding policies and procedures at this hospital complied with the WHO's Ten Steps to Successful Breastfeeding. The objective of the study was to construct a percentile chart of neonatal weight loss. Weight was recorded at birth and every 12 hours

until discharge, which usually occurred between 48-72 hours of life. Results showed a mean weight loss of 5.95% ± 1.73 (range 0.0% - 9.9%). No infants in this study lost > 10% of their birth weight. The mean time to nadir was 43.72 ± 11.6 hours after birth and ranged from 12-72 hours.[20]

Most recently, Flaherman et al.[26] introduced early weight loss nomograms for exclusively breastfed newborns based on delivery mode. The researchers retrospectively extracted recorded weights from the charts of 108,907 singleton infants born ≥ 36 weeks gestation at Northern Kaiser Permanente hospitals. The authors found that differences in weight loss by delivery method became evident 6 hours after delivery and persisted over time. For infants delivered vaginally, the median weight loss was 4.2%, 7.1%, and 6.4% at 24, 48, and 72 hours of age. For infants born via CS, the median percent weight loss was 4.9%, 8.0% 8.6%, and 5.8% at 24, 48, 72, and 96 hours after delivery. Hour-by-hour nomograms were created to assist in early identification of infants who might be on a trajectory for excessive weight loss and associated adverse outcomes.[26]

Five of the primary studies presented in this review were conducted in the U.S and four were completed in Europe. Two of the U.S. studies took place in facilities that had earned the Baby Friendly award.[24,25] The Baby-Friendly Hospital Initiative is a global program supported by the World Health Organization and the United Nations Children's Fund that recognizes hospitals and birth centers that give optimal breastfeeding support. Many Baby-Friendly policies and practices impact the likelihood that a breastfed infant will not receive formula in the first two days of life.[27] Among the European studies, three of the authors described routine practices such as rooming-in and skin to skin care which are also known to improve breastfeeding outcomes.[6,14,20]

The sample sizes in the nine studies in this review ranged from 53 to 108,907 participants. The mean infant weight loss ranged from a low[18] of 3.79 ± 1.25 to a high[25] of 7.2% ± 2.1%. When reported in hours, time to nadir ranged from a low[23] of 38.7 ±18.5 to a high[20] of 43.72 ± 11.6 hours. Other researchers reported that the time to reach nadir was longer, taking on average 3-4 days[6,25]. Overall, as compared to the findings in the review by Noel-Weiss, there is a slightly greater amount of reported weight loss and a slightly longer time to nadir. Close examination of these nine studies, however, reveals several reasons why there is still insufficient evidence to determine normal physiological weight loss and time to nadir for breastfed infants.

Discussion

In 2008, Noel-Weiss and colleagues[7] reported consistent problems with methodology in the breastfeeding studies included in their review; specifically there were major gaps in data collection. In most of the studies infant weights were not measured daily after discharge. Lack of measurements made determining the lowest weight and normal patterns of weight loss impossible. Another limitation was a lack of clarity among feeding groups. Most of the studies in the 2008 review did not identify when infants received supplemental formula feedings. This is an important consideration as newborn infants who consume formula lose less weight compared to infants who are breastfed.

Unfortunately these same problems continue to be present in the current literature. Specifically, the gap in daily weight collections is a major limitation. In several of the studies, researchers reported that weights were measured for 2 to 4 days after birth. Yet,

229 the majority of infants in all of these studies had hospital weights collected for only two
230 days or less often.[13,14,20,25,26] Most of the infants were vaginally delivered and so were
231 discharged from the hospital by the first or second day of life. In the largest study,
232 published by Flaherman et al.[26], a total of 83,433 (76.6%) infants were born vaginally and
233 25,474 (23.4%) were delivered by CS. In this study 72% of the vaginally delivered
234 infants had only 1 weight recorded in addition to their birth weight. Additionally, 75% of
235 the infants delivered by CS had $\geq$ 2 weights recorded prior to discharge.[26] Interestingly,
236 in the work by Mulder et al.,[18] weights on all infants were only collected for two days no
237 matter the type of delivery. Not surprisingly, this study generated the lowest mean
238 percentage of weight loss (3.79% + 1.25%).[18] The majority of infants in that study had
239 probably not reached their nadir of weight loss before data collection ceased.
240 Lack of measurements also impacts the reported time to nadir. The only way to
241 accurately determine time to nadir is to weigh infants daily until they begin to gain
242 weight. Crossland[6] demonstrated this very strategy and weighed infants daily for a
243 minimum of 14 days after birth. These authors found that most infants reached the nadir
244 of weight on day 3, later than was reported by Bertini et al.[20] and Flaherman et al.[26]. If
245 weights are not recorded daily until the time when infants begin to gain, researchers are
246 left making best guesses as to when the maximum amount of weight loss has occurred.
247 Problems with the clear identification of infant feeding groups also continue to be
248 prevalent in the literature. Mulder et al.[18] included women who were "attempting" to
249 breastfed their infants. They did not indicate if breastfeeding was successful or if
250 formula was given. Similarly, in the large study (n= 1760) done by Bertini et al.,[20]
251 researchers described how the infant feeding policies and procedures at the hospital

complied with the WHO's Ten Steps to Successful Breastfeeding. They suggested that all infants in this study were exclusively breastfed but they did not collect data regarding feeding type. Unfortunately, birth in an environment supportive of breastfeeding is not an assurance that the infants born there are actually breastfed. It is very likely that many infants in both of these studies consumed formula in varying amounts.

Other researchers recorded infant feeding type but combined feeding groups for data analysis. Flaherman et al.[23] sampled 1049 infants, 853 (86%) were exclusively breastfeeding, 144 (14%) were given mixed feedings and 53 (5%) were given formula feeding. For data analysis, they collapsed the exclusive and mixed feeding infants, which resulted in a mean weight loss of 6.1 $\pm$ 2.1%. It is possible that the inclusion of infants who consumed supplemental formula decreased the total amount of weight loss. The study by Davanzo et al.[14] used a similar approach. The authors used the WHO breastfeeding definitions but combined exclusive and predominant breastfeeding infants together into one category. They also combined complementary breastfed infants together with formula fed infants. Interestingly, this was the only study that has ever reported a greater percent of mean weight loss among formula fed versus breastfed infants (7.5$\pm$2.4% vs. 6.3$\pm$2.0%, p = <.001)[14]. The combination of complementary (mixed) breastfed infants together with infants who were formula fed may have impacted the results. Some of the complementary breastfed infants were likely given formula due to excessive weight loss, which may have increased the total weight loss for that group.

Lack of clarity among infant feeding groups is a challenging problem, particularly for studies focused on infant weight. At first glance, the solution may appear simple; researchers must carefully control their sample and include adequate numbers of

exclusively breastfed infants. This seemingly simple solution, however, presents a complex set of challenges. If breastfed infants lose too much weight, they are often given formula supplementation. Yet, in order to determine patterns of weight loss among the exclusively breastfed, infants fed formula must be excluded from the sample group. After excluding supplemented infants, the end result may be a sample that is biased as it contains only those infants who did not lose much weight. This exact scenario was demonstrated in several of the studies[14,25,26].

Preer et al.[25] described how breastfeeding infants with excessive weight loss were given formula supplementation and excluded from their study. As described by the authors, this resulted in a sample that was not representative of the true population of breastfed infants[25]. Similarly, Davanso et al.[14] noted that when neonatal weight loss was $\geq$ 8%, supplemental feedings were often given. In the largest study, Flaherman[26] also described how 16,871 breastfed infants (15.4%) received formula supplementation and were removed from the study. In this study, formula was frequently given to treat excessive weight loss. As a result, the amount of weight loss in the exclusively breastfed population may have been underestimated. Flaherman et al. coped with this limitation by implementing a sensitivity analysis that matched censored to uncensored infants[26]. The nomograms were recreated based on this matching strategy and the results indicated that removing these infants from the sample group did not create a substantial source of bias. No other published studies have used this matching strategy.

In the end, it may not be possible to create large sample groups in which all infants are exclusively breastfed. Therefore, researchers must do the next best thing. Sample groups must be created that more accurately report what infants are consuming.

Table II outlines five definitions for infant feeding groups as proposed by this author in 2010. These definitions are operationally useful and allow for the inclusion of almost every infant into an appropriate sample group.[28] Mean weight loss can be established for each category. While the inclusion of five categories may seem cumbersome, the problem of infants losing too much weight is generally limited to breastfed infants. Therefore the main categories of interest are the exclusive and predominantly breastfed feeding groups. Care providers would benefit from knowing more information about expected weight loss patterns for infants in these feeding categories.

Conclusion:

In 2008 Noel-Weiss et al.[7] determined that the normal and expected amounts of infant weight loss after birth could not be accurately determined. In most of the eleven studies in their review, infant weights were not measured daily after discharge and infants were not clearly categorized into feeding groups. At the time, these two methodological flaws in the research made it impossible to determine a mean for normal physiological weight loss in term breastfed infants.

The systematic review presented by this author was completed to determine if, since 2008, more scientific evidence has become available. Specifically, this author sought to determine the mean amount of weight loss for healthy, full-term exclusively breastfed infants after birth. In addition a second objective of this review was to determine when infants reach their nadir of lost birth weight. Unfortunately, the current literature still does not provide enough evidence to accurately answer these questions.

The same methodological flaws reported in 2008 continue to be found in the current literature. A limited number of infant weights have been collected, feeding

methods have not always been well documented and infants feeding groups have been combined for data analysis. In addition, breastfed infants who lost the most amount of weight have been excluded from sample groups. As a result of these methodological flaws, an accurate mean percentage of infant weight loss and the time to nadir remain elusive. In fact, given that infants who received formula have been included while infants who lost the most have at times been excluded from sample groups, it is likely that the mean amount of infant weight loss for breastfeeding infants is higher than has ever been reported.

Professional guidance and care in the early weeks of life can enhance breastfeeding duration.[29] Alternatively, inaccurate information and ill-founded advice can easily derail breastfeeding efforts. Clinicians require accurate data in order to make sound decisions. Well-designed clinical studies are needed to determine the normal and expected patterns of weight loss for the breastfed infant. It is only when clinicians have this information that they can provide the best guidance and care in order to promote, protect and support breastfeeding infants.

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

344 References

345 1. Tawia S, McGuire L. Early weight loss and weight gain in healthy, full-term,
346 exclusively-breastfed infants. *Breastfeeding Review*. 2014; 22(1):31-42.

347 2. Van Dommele P, Boer S, Unal S, van Wouwe JP. Charts for weight loss to detect
348 hypernatremic dehydration and prevent formula supplementation. *BIRTH.* 2014; 41(2):
349 153-159.

350 3. Dewey KG, Nommsen-Rivers LA, Heinig MJ, Cohen RJ. Risk factors for suboptimal
351 infant breastfeeding behavior, delayed onset of lactation, and excess neonatal weight loss.
352 *Pediatrics*. 2003;112(3):607-619.

353 4. Hintz SR, Gaylord TD, Oh W, Fanaroff AA, Mele L, Stevenson DK, . . . NICHD,
354 Neonatal Research Network. Serum bilirubin levels at 72 hours by selected
355 characteristics in breastfed and formula-fed term infants delivered by cesarean section.
356 *Acta Paediatrica*. 2001;90(7):776-781.

357 5. Macdonald PD, Ross SRM, Grant L, Young, D. Neonatal weight loss in breast and
358 formula fed infants. *Arch Dis Child Fetal Neonatal Ed.* 2003;88:F472-F476.

359 6. Crossland DS, Richmond S, Hudson M, Smith K, Abu-Harb M. Weight change in the
360 term baby in the first 2 weeks of life. *Acta Paediatrica*. 2008;97:425-429.
361 7. Noel-Weiss J, Courant G, Woodend AK. Physiological weight loss in
362 the breastfed neonate: a systematic review. *Open Medicine*. 2008;2(4):e99-e110.
363 8. American Academy of Pediatrics. Breastfeeding and the use of human milk: policy
364 statement. *Pediatrics*. 2012;*129*(3):e827-e841. doi:10.1542/peds.2011-3552.

9. WHO Growth Standards Are Recommended for Use in the U.S. for Infants and Children 0 to 2 Years of Age. Centers for Disease Control and Prevention. http://www.cdc.gov/growthcharts/who_charts.htm. Updated Sept. 9, 2010. Accessed Nov. 10, 2014.

10. Duijts L, Jaddoe VW, Hofman A, Moll HA. Prolonged and exclusive breastfeeding reduces the risk of infectious diseases in infancy. *Pediatrics*. 2010;126(1), e18-e25. doi:10.1542/peds.2008-3256101.

11. Roth DE, Cauleld LE, Ezzati M, Black, R. E. Acute lower respiratory infections in childhood: Opportunities for reducing the global burden through111 nutritional interventions. *Bulletin of the World Health Organization*. 2008;86(5), 356-364.

12. Feig DS, Lipscombe LL, Tomlinson G, Blumer I. Breastfeeding predicts the risk of childhood obesity in a multi-ethnic cohort of women with diabetes. *Journal of Maternal-Fetal and Neonatal Medicine*. 2011;24(3):511-5. doi:10.3109/14767058.2010.500711.

13. Fonseca MJ, Severo M, Barros H, Santos AC. Determinants of weight changes during the first 96 hours of life in full-full-term newborns. *BIRTH.* 2014;41(2):160-168.

14. Davanzo R, Cannioto Z, Ronfani L, Monasta, L, Demarini S. Breastfeeding and neonatal weight loss in healthy term infants. *Journal of Human Lactation.* 2013;29(1): 45-53.

15. Chantry CJ, Nommsen-Rivers LA, Peerson JM, Cohen RJ, Dewey KG. Excess weight loss in first-born breastfed newborns relates to maternal intrapartum fluid balance. *Pediatrics*. 2011;*127*(1), e171-e179. doi:10.1542/peds.2009- 2663

16. Overfield ML, Ryan CA, Spangler A, Tully MR. *Clinical guidelines for the*

establishment of exclusive breastfeeding. Raleigh, NC. ILCA International Lactation Consultant Association. June, 2005.

17. Academy of Breastfeeding Medicine. ABM Clinical Protocol #3: Hospital guidelines for the use of supplementary feedings in the healthy term breastfed neonate. *Breastfeeding Medicine*. 2009;*4*(3). doi:10.1089/bfm.2009.9991.

18. Mulder PJ, Johnson TS, Baker L. Excessive weight loss in breastfed infants during the postpartum hospitalization. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*. *2010;39*(1):15-26. doi:10.1111/j.1552-6909.2009.01085.

19. Watson J, Hodnett E, Armson BA, Davies B, Watt-Watson J. A randomized controlled trial of the effect of intrapartum intravenous fluid management on breastfed newborn weight loss. *Journal of Obstetric, Gynecologic and Neonatal Nursing.* 2012; 41(1):24-32. doi:10.1111/j.1552- 6909.2011.01321.

20. Bertini G, Breschi R, Dani C. Physiological weight loss chart helps to identify high-risk infants who need breastfeeding support. *Acta Pediatrica*. 2014: 1-4. DOI:10.1111/apa.12820

21. Manganaro R, Mami C, Marrone T, et al. Incidence of dehydration and hypernatremia is exclusively breast-fed infants. *The Journal of Pediatrics*. 2008;97: 425-429.

22. Thulier D, Mercer J. Variables associated with breastfeeding duration. *Journal of Obstetric, Gynecologic and Neonatal Nursing*. 2009;*38*(3):259-268. doi:10.1111/j.1552-6909.2009.01021.x.

408 23. Flaherman VJ, Bokser S, Newman TB. First-day newborn weight loss predicts in-
409 hospital weight nadir for breastfeeding infants. Breastfeeding Medicine. 2010; 5(4): 165-
410 168. Doi:10.1089/bfm.2009.0047.

411 24. Grossman X, Chaudhuri JH, Feldman-Winter L, Merewood A. Neonatal weight loss
412 at a US Baby-Friendly hospital. *Journal of the Academy of Nutrition and Dietetics*.
413 2012;112(3):410-413.

414 25. Preer, GL, Newby PK, Philipp BL. Weight Loss in Exclusively Breastfed Infants
415 Delivered by Cesarean Birth. *Journal of Human Lactation*. 2012; 28(2):153-158.
416 26. Flaherman VJ, et al. Early weight loss nomograms for exclusively breastfed
417 newborns. *Pediatrics*. 2015;135(1):e16-e23.doi:10.1542/peds.2014-1532.

418 27. National Center for Chronic Disease Prevention and Health Promotion. Division of
419 Nutrition, Physical Activity, and Obesity. (2103). *Breastfeeding report card: United*
420 *States/2013*. http://www.cdc.gov/breastfeeding/pdf/2013BreastfeedingReportCard.pdf.
421 Accessed Jan. 1, 2015.

422 28. Thulier D. A call for clarity in infant breast and bottle-feeding definitions for
423 research. *Journal of Obstetric, Gynecologic and Neonatal Nursing*. 2010;39(6):627- 634.
424 doi:10.1111/j.1552-6909.2010.01197.x.10.
425 29. Britton C, McCormick FM, Renfrew MJ, Wade A, King SE. Support of
426 breastfeeding mothers. Cochrane Database of Systematic Reviews. 2007;1:CD001141.
427 doi: 10.1002/14651858.CD001141. pub3.

428