Original Article

Risk factors for early lactation problems among Peruvian primiparous mothers

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Abstract

The aim of this study was to determine the incidence and risk factors for early lactation problems [suboptimal infant breastfeeding behaviour (SIBB), delayed onset of lactogenesis (OL) and excessive neonatal weight loss] among mother–infant pairs in Lima, Peru. All primiparous mothers who gave birth to a healthy, single, term infant at a government hospital in a peri-urban area of Lima during the 8-month recruitment period were invited to participate in the study. Data were collected at the hospital (day 0) and during a home visit (day 3). Infant breastfeeding behaviour was evaluated using the Infant Breastfeeding Assessment Tool; SIBB was defined as ≤ 10 score. OL was determined by maternal report of breast fullness changes; delayed OL was defined as perceived after 72 h. Excessive neonatal weight loss was defined as $\geq 10\%$ of birthweight by day 3. One hundred seventy-one mother–infant pairs participated in the study. SIBB prevalence was 52% on day 0 and 21% on day 3; it was associated with male infant gender (day 0), < 8 breastfeeds during the first 24 h (days 0 and 3), and gestational age < 39 weeks (day 3). Delayed OL incidence was 17% and was associated with infant Apgar score < 8 . Excessive neonatal weight loss occurred in 10% of neonates and was associated with maternal overweight and Caesarean-section delivery. Early lactation problems may be influenced by modifiable factors such as delivery mode and breastfeeding frequency. Infant status at birth and maternal characteristics could indicate when breastfeeding dyads need extra support.

Keywords: lactogenesis, infant suckling, neonatal weight loss, Peru, breastfeeding, lactation.

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Introduction

Behavioural observations have shown that, after an unmedicated delivery, healthy infants and their mothers are ready to interact in the first minutes of life and initiate breastfeeding within the first hour, when newborns typically follow an innate sequence of pre-feeding behaviours (Widstrom *et al.* 1987). As a consequence of modernization, the childbirth

experience has become a medical event, with an increasing number of medicated or surgical deliveries. This may disrupt the natural process of learning and adjustment required for establishing breastfeeding. Several studies have demonstrated that newborns' suckling behaviour is negatively affected by the use of labor pain medications (Riordan *et al.* 2000; Ransjo-Advirson *et al.* 2001). Suboptimal infant breastfeeding behaviour (SIBB) is common in

Acknowledgements, Sources of funding and Conflicts of interest added on 7 July 2009 after first online publication.

some populations: it was evident in almost half of the infants on the day of birth, and in 22% on day 3 in a study carried out in California (Dewey *et al.* 2003).

During the first days post-partum, the onset of copious milk secretion, known as lactogenesis stage II, takes place. The production of milk during the first day post-partum is low (<100 mL per day), but a substantial increase in milk volume occurs between 36 and 92 h post-partum (Neville & Morton 2001). Even though this process occurs in response to a predetermined set of hormonal changes, some women experience delayed onset of lactogenesis (OL). Prevalence of delayed OL, usually defined as OL after 72 h post-partum, seems to be high in developed countries (Chapman & Perez-Escamilla 1999a; Dewey *et al.* 2003), as well as in urban areas in developing countries (Grajeda & Perez-Escamilla 2002). Factors associated with an increased risk of delayed OL are primiparity (Chen *et al.* 1998; Hildebrant 1999; Dewey *et al.* 2003; Hilson *et al.* 2004; Scott *et al.* 2007); Caesarean-section delivery (Hildebrant 1999; Dewey *et al.* 2003; Scott *et al.* 2007), particularly if it is an urgent one (Chapman & Perez-Escamilla 1999a); stress during labour and delivery (Chen *et al.* 1998; Dewey 2001; Grajeda & Perez-Escamilla 2002); prolonged stage II labour (Chapman & Perez-Escamilla 1999a; Dewey *et al.* 2003), maternal overweight/obesity (Chapman & Perez-Escamilla 1999a; Rasmussen *et al.* 2001; Dewey *et al.* 2003), flat or inverted nipples (Dewey *et al.* 2003) and type 1 diabetes (Hartmann & Cregan 2001).

Another potential problem during the first days post-partum is excessive neonatal weight loss. Inadequate suckling technique and insufficient milk transfer to the infant can lead to excessive weight loss. In general, neonatal weight loss $\geq 10\%$ of birthweight

during the first days of life is considered indicative of a problem by clinicians (Academy of Breastfeeding Medicine Protocol Committee 2002). Studies in industrialized countries have reported prevalences of excessive neonatal weight loss ranging from 8 to 12% (Manganaro *et al.* 2001; Dewey *et al.* 2003). Not surprisingly, excess weight loss is associated with other early lactation problems such as delayed OL and SIBB (Dewey *et al.* 2003).

There is evidence that mothers who experience these early breastfeeding problems (i.e. delayed OL and poor suckling behaviour) are at higher risk for shorter breastfeeding duration (Chapman & Perez-Escamilla 1999b; Riordan *et al.* 2000; McLeod *et al.* 2002; Ceriani Cernadas *et al.* 2003; Hruschka *et al.* 2003; Mizuno *et al.* 2004). Thus, greater attention to lactation problems in the first week post-partum is needed.

Peru has one of the highest breastfeeding rates in Latin America. However, the prevalence of exclusive breastfeeding is much lower than that for any breastfeeding, and it appears to be decreasing during recent years, especially among urban and educated women (INEI *et al.* 2007). It is possible that the suboptimal prevalence of exclusive breastfeeding is related to early lactation problems linked with the increased medicalization of childbirth in Peru. Thus, the objectives of this study were to describe the incidence of early lactation problems (SIBB, delayed OL and excessive neonatal weight loss) and to identify the risk factors associated with these outcomes in a low-income urban population of first-time mothers and their infants. Our focus is on primiparous mothers because they are more likely to have difficulties establishing breastfeeding (Dewey *et al.* 2003), and the risk of early weaning with the subsequent infant increases

Key messages

- Early lactation problems were present among Peruvian primiparous mothers, although such problems were less common than in other populations.
- Male infants, those having lower gestational age or Apgar scores, or who were breastfed less frequently, as well as mothers who were overweight or underwent a Caesarean section, were at higher risk of experiencing early lactation problems.
- Results from this study highlight the need to provide appropriate lactation support to the breastfeeding dyad during the first week post-partum.

when the previous breastfeeding experience was negative (Hall *et al.* 2002).

Materials and methods

Study design and participants

We followed first-time mothers and their infants during the first 4 days after delivery. Primiparous mothers who gave birth at a baby-friendly government hospital in Canto Grande (a peri-urban area of Lima) between November 2005 and June 2006 were invited to participate if they (and their infants) met the eligibility criteria. In Peru, government hospitals generally serve low-income populations who mostly do not have access to the social security hospitals because they are either unemployed or have an informal job with no benefits. The study hospital is the only government hospital in Canto Grande, and it primarily serves women with low-risk pregnancies (women with high-risk-pregnancies are referred to a hospital in a central area of the city). During the year previous to the study there were 4169 deliveries at the study hospital, 421 of which were Caesarean-section deliveries. Most people living in the study area are first- or second-generation immigrants from less urbanized areas who migrated to the city and squatted on the piece of land they live on now. The local collaborating institution, the Instituto de Investigación Nutricional, had previously carried out research in this area of Lima, which made the setting favourable for conducting this research.

Subjects were recruited at the maternity ward within 24 h after delivery by a research assistant who administered an eligibility questionnaire to identify dyads who met the study criteria (mothers: primiparous, ≥ 18 years of age, had no serious medical condition and planned to stay in the study area for at least 1 month after delivery; infants: single, term and had no serious medical condition). Recruitment took place from Monday through Saturday during morning and afternoon hours. Eligible mothers were invited to participate and informed consent was obtained. A first interview and breastfeeding observation occurred at the hospital within 24 h post-delivery. On day 3 (defining 0–24 h as day 0, thus, day 3 is 72–96 h post-partum), subjects were visited in their homes

where a second interview and breastfeeding observation took place. The research protocol was approved by the Human Subjects Review Committee at the University of California, Davis, and the Ethics Committee at the Instituto de Investigación Nutricional.

Data collection

During the hospital interview on day 0 the mothers were asked about socio-demographic characteristics, breastfeeding intentions and early practices (early skin-to-skin contact, first breastfeeding, breastfeeding frequency, use of non-breast milk (NBM) fluids, pacifier use), and potential breastfeeding problems (e.g. nipple type and pain), using a structured questionnaire. A composite variable for socio-economic status (SES) was constructed based on six items (concrete wall material, concrete/wood floor material, access to potable water, electricity, phone service and possession of a refrigerator); each item added 1 point to the total SES score. The number of breastfeedings on day 0 was calculated by extrapolating the number of feedings that had occurred by the time of the interview to 24 h. Introduction of NBM fluids was defined as reported use of NBM fluids from any of the following three sources of data: medical record, maternal report on day 0 or maternal recall on day 3. Information on nipple type (both protrude vs. one or both flat/inverted) was collected by maternal report, usually confirmed through observation by the research assistant. Nipple and breast pain were assessed by asking the mother to rate the intensity of her pain using the Faces Pain Scale – Revised (Hicks *et al.* 2001), which shows a row of human faces reflecting increasing levels of pain from no pain (left-most face, score = 1) to very much pain (right-most face, score = 6).

During the hospital stay, a research assistant collected data from the medical records of both mother and infant. Information collected regarding the mother included labour duration (from the time regular contractions began to the time of delivery of the infant), stage II labour duration (from the time when a woman was fully dilated to the time of delivery of the infant), use of pitocin for induction (i.e. given before regular contractions began) or augmentation of labour (i.e. given after regular contractions

began), use of pain medications during labour and delivery, type of delivery, post-partum medications and complications. Information gathered about the infant included sex, gestational age, birthweight, Apgar score and use of oxygen support.

An observation of a breastfeeding episode was conducted at the hospital on day 0 and during the home visit on day 3 (if mother was still hospitalized, the second observation also occurred at the hospital). Two research assistants were trained on the use of the Infant Breastfeeding Assessment Tool (IBFAT) (Matthews 1988), which was used to rate the infant's breastfeeding behaviour. The IBFAT scores breastfeeding behaviour on a scale of 0 to 12 based on the observer's ratings for arousal, rooting, latch and suckling (each worth 0–3 points, from 0 = does not exhibit target behaviour, to 3 = readily exhibits target behaviour). As these behaviours are all necessary for effective feeding, once breastfeeding is established, an infant should score nearly perfectly (i.e. 11 or 12 points). After each observation, mothers were asked to evaluate the observed breastfeeding regarding suckling effectiveness, their own satisfaction with the feeding and how typical that feeding was.

On day 3, mothers and infants were visited at home (or if still hospitalized, at the hospital). During that interview, a research assistant collected information regarding childbirth experience, rooming-in, symptoms of OL, breastfeeding practices (i.e. breastfeeding frequency, use of NBM fluids, pacifier use), breastfeeding support, maternal and infant morbidity, and any breastfeeding difficulties (i.e. nipple and breast pain). Symptoms of OL were assessed by asking the mother to rate her breast fullness on a scale from 1 = no change, to 3 = noticeably fuller, to 5 = uncomfortably full, and the approximate time post-partum when her breasts first became noticeably fuller was recorded. We demonstrated the validity of this assessment in a US sample ($n = 23$, unpublished data) by studying several markers of the time post-partum when milk transfer to the infant first exceeded 15 g per feed (amount that tended to coincide with the inflection point in milk production) as assessed via test weighing for four feeds per day during days 1–6 post-partum. In this preliminary study, the time post-partum when breasts first

become noticeably fuller was closest to timing of intake reaching 15 g and showed the highest correlation ($r = 0.60$) with this indicator. Others have also demonstrated that maternal perception of the OL has a reasonable degree of sensitivity and specificity (71.4 and 79.3%, respectively) when it is compared to test weighing, the gold standard measurement of lactogenesis (Chapman & Perez-Escamilla 2000).

Maternal (weight and height) and infant (weight) anthropometric measurements were completed during the home visit using a portable stadiometer with readings precise to 1 mm, and a portable electronic floor scale precise to 0.1 kg that allowed weighing the infants while they remained in their mothers' arms (UNISCALE, UNICEF, Copenhagen, Denmark). Infants were weighed undressed wearing only a dry diaper. Because maternal weight was measured on day 3 post-partum when there is still substantial fluid retention, a higher body mass index (BMI) cut-off (27 kg/m^2) was used to define overweight (Dewey *et al.* 2003). Infants who lost $\geq 10\%$ of birthweight were referred to the paediatrician at the study hospital and were followed up by the principal investigator (PI) (S.L.M.) through phone calls or home visits to make sure that these infants received medical care promptly. Birthweight was obtained from the medical records; newborns were weighted using digital scales at the study hospital.

Maternal childbirth experience was evaluated by asking the mother to rate her childbirth experience as either better, about the same or worse than what she expected.

Quality-control procedures

Training of the two research assistants who collected the data included validation and standardization exercises. For observation of breastfeeding and use of the IBFAT, both research assistants practised until their independent assessment of an infant breastfeeding behaviour agreed with that of the PI 10 times in a row. The PI had previously been trained by one of the study co-investigators (L.A.N-R., who is an International Board Certified Lactation Consultant) in the use of the IBFAT in the same fashion. Standardiza-

tion for the collection of anthropometric measurements (weight and height) was carried out following the procedures described by the World Health Organization (1983).

During the start-up phase of the study, a pilot test was conducted with five mothers to test the proposed instruments and forms for the main study. Once data collection started, study forms were reviewed for completeness within 48 h. When possible, research assistants contacted participants to collect any missing information. Throughout data collection, the PI supervised the field work by 'shadowing' each research assistant at least once per month to monitor the interviews and assessments.

Data were entered into the computer using software that allows parameters to be set to prevent inconsistencies or illogical values (SPSS Data Entry Builder 4.00, SPSS Inc., Chicago, IL, USA). Data were double-entered to detect and correct data entry errors. When all data were entered, a final data cleaning was performed using standard procedures.

Variable definitions

The outcome variables were defined as follows:

- SIBB on days 0 and 3 post-partum was defined as an IBFAT score ≤ 10 .
- OL was considered delayed if it occurred after 72 h post-partum.
- Excess neonatal weight loss was defined as loss of 10% or more of birthweight by day 3.

Data analysis

All analyses were conducted using the SPSS Graduate Pack 15.0 for Windows (SPSS Inc., Chicago, IL, USA). Bivariate associations between the four outcome variables and the independent variables, shown in Table 1, were evaluated using chi-squared tests. Multivariate logistic regression analysis was used to identify the independent association of each risk factor with each outcome variable. Forward step-wise selection was used to construct the preliminary models using a *P*-value of 0.10 for inclusion or removal. Any independent variable that preceded the

occurrence of the outcome variable was considered for the preliminary models. Thus, in the case of SIBB on day 0, four variables were not included in the analysis because they did not precede the outcome: use of NBM fluids during the first 24 h, use of NBM fluids during the first 48 h, nipple type on day 3 and nipple pain on day 3. The final analyses were run including only those factors that showed some association with the outcomes ($P \leq 0.10$) in the preliminary models. The final logistic models included predictors significant at $P < 0.05$.

Results

In total, 767 mothers were screened for eligibility; 237 mother–infant dyads were eligible, 66 of whom refused to participate (25 of them did not consent because they did not receive 'approval' from their husband/partner within 24 h post-partum). The reasons for ineligibility were: moving within 1 month ($n = 71$), mother < 18 years ($n = 98$) and residing outside of the boundaries of the study area ($n = 361$). The analysis is based on the 171 mother–infant dyads who were enrolled in the study; 156 of them were interviewed on day 3. Fifteen subjects were lost to follow-up because their address could not be found ($n = 8$), they decided to drop out ($n = 4$), their husband did not want them to participate ($n = 2$) or the baby was hospitalized ($n = 1$). Subjects lost to follow-up did not differ significantly from participants who stayed in the study with regard to maternal age, education, SES, place of birth or language.

The characteristics of the subjects are shown in the frequency column of Table 1. Because we recruited first-time mothers, most were young women (Mean $\pm$ SD: 22.2 ± 3.6 years), with an average of 10.6 ± 1.8 years of education (completed high school = 11 years of education). Most mothers were born in Lima (60%) and Spanish was their primary language (90%). Average BMI was 25.9 ± 3.4 kg/m². Median total labour duration was 7.85 h; median duration of stage II labour was 0.15 h, and only three women had a stage II labour longer than 1 h (because of little variability this variable was excluded from further analyses). Few women had an induced labour (2.3%) or had their labour contractions augmented

Table 1. Independent variables and their association with early lactation problems

Independent variable	Frequency number (%)	Incidence of early lactation problem			
		SIBB day 0 (%)	SIBB day 3 (%)	Delayed OL (%)	Excess weight loss (%)
Maternal factors					
Age (year) [†]					
<22	87 (51)	54.3	16.2	17.3	12.5
≥22	84 (49)	49.4	24.7	17.3	7.5
Education					
Less than high school	44 (26)	48.8	18.4	19.5	5.1
High school or more	127 (74)	52.9	21.5	16.5	11.5
Born in Lima					
No	68 (40)	41.8*	19.6	16.9	8.9
Yes	103 (60)	58.9	21.3	17.5	10.4
Maternal language					
Native	17 (10)	41.2	15.4	21.4	7.1
Spanish	154 (90)	53.1	21.2	16.9	10.1
SES [‡]					
<4 points	29 (17)	51.9	29.6	25.9	11.1
≥4 points	140 (83)	52.6	19.0	15.7	9.8
BMI, day 3 (kg/m ²) [§]					
≤27.0	108 (70)	51.4	17.2	19.4	5.7*
>27.0	47 (30)	53.7	26.7	10.6	19.6
Labour and delivery					
Length of labour (h) ^{¶††}					
≤8	88 (57)	50.0	23.7	16.0	12.8
>8	66 (43)	54.8	14.3	21.0	8.2
Augmentation of labour					
No	146 (85)	52.5	22.0	15.0**	10.9
Yes	25 (15)	47.8	13.6	30.4	4.3
Delivery mode					
Vaginal	127 (74)	52.1	18.2	20.3**	6.0*
Caesarean section	44 (26)	51.2	28.6	7.9	22.9
Maternal childbirth experience					
Same/better than expected	106 (68)	64.6*	23.9	20.0	4.2
Worse than expected	50 (32)	45.5	19.2	16.0	12.5
Infant characteristics					
Sex					
Female	80 (47)	39.5*	21.5	17.6	11.1
Male	91 (53)	62.8	20.0	17.1	8.8
Gestational age (week) ^{¶¶}					
<39	30 (18)	44.4	40.0*	14.3	11.1
≥39	138 (82)	53.0	16.2	18.4	9.8
Birthweight (g) ^{‡‡}					
<3300	88 (52)	51.2	21.6	20.0	6.4
≥3300	83 (49)	52.5	19.7	14.5	13.5
Apgar score, 1 min ^{§§}					
<8	15 (9)	46.7	8.3	50.0*	0.0
≥8	156 (91)	52.4	21.8	14.6	10.7
Breastfeeding					
First BF					
After 1 h of birth	120 (70)	54.0	22.8	16.8	9.5
Within 1 h of birth	51 (30)	46.9	15.9	18.4	10.6
BF frequency, day 0					
<8 feeds/24 h	24 (14)	87.0***	42.9*	17.4	21.7**
≥8 feeds/24 h	147 (86)	46.0	16.9	17.3	7.8

Table 1. Continued

Independent variable	Frequency number (%)	Incidence of early lactation problem			
		SIBB day 0 (%)	SIBB day 3 (%)	Delayed OL (%)	Excess weight loss (%)
NBM fluids, first 24 h					
None given	86 (61)	–	14.6	15.1	8.2
Any given	54 (39)	–	20.4	20.4	11.8
NBM fluids, first 48 h					
None given	80 (57)	–	12.7	15.9	7.3
Any given	60 (43)	–	23.1	19.0	13.0
Nipple pain, day 3 [‡]					
≤4	117 (75)	–	21.5	17.9	8.8
>4	39 (25)	–	18.4	15.4	13.2
Breast pain, day 3 [‡]					
≤2	103 (66)	–	20.4	20.4	11.9
>2	53 (34)	–	21.3	11.3	5.9
Nipple type, day 0					
Both protrude	135 (85)	51.9	23.0	19.7	10.2
One/both flat/inverted	24 (15)	60.9	10.0	4.5	9.1
Nipple type, day 3					
Both protrude	134 (87)	–	19.2	18.7	10.0
One/both flat/inverted	21 (13)	–	26.3	9.5	4.8

SIBB, suboptimal infant breastfeeding behaviour; OL, onset of lactogenesis; SES, socio-economic status; BMI, body mass index; BF, breastfeeding; NBM, non-breast milk; * $P < 0.05$; ** $P < 0.10$; *** $P < 0.001$ by chi-squared test; [‡]Cut-off is the 75th percentile; [‡]Cut-off represents access to basic living conditions (potable water, electricity, and appropriate wall and floor materials); [§]Higher than usual cut-off used because women were measured at 3 days post-partum; [‡]Divided at the median value; rounded up/down to the closest integer when necessary; ^{††}Missing values $n = 17$; ^{‡‡}Divided at the median value rounded up to the closest 100 g; ^{§§}There was too little variability in Apgar score at 5 min to examine its association with the outcome variables.

with pitocin (14.6%). None of the women who delivered vaginally received any kind of labour pain analgesia or anaesthesia (which made it impossible to analyze its effect on the outcomes). Conversely, episiotomy was a common practice: 89% of women who had a vaginal delivery had an episiotomy. The percentage of Caesarean deliveries in this sample was 25.7%; most of these (40 out of 44) were urgent Caesarean deliveries. In the absence of post-partum complications, the hospital stay generally lasted 24 h for women who delivered vaginally, and 72 h for women who had Caesarean-section deliveries.

The infants had an average gestational age of 39.1 ± 0.9 weeks. The mean Apgar score was 8.4 ± 1.0 at 1 min after delivery, and 9.0 ± 0.3 at 5 min. The average birthweight was 3295 ± 405 g, and only three infants weighed <2500 g at birth. Resuscitation procedures were rare (nine infants needed oxygen support at birth; none required intubation or chest compressions).

Only 32 mothers (19%) spent some time (up to a maximum of 10 min) in continuous skin-to-skin contact with their babies immediately after delivery; because no woman spent at least 30 min in skin-to-skin contact, we did not analyze this variable further. After the initial separation, mothers and infants stayed together at the hospital sharing the same bed. All women initiated breastfeeding at the hospital, and the mean planned duration of exclusive breastfeeding was 5 months (as reported within 24 h after delivery). The first breastfeeding attempt occurred on average nearly 2 h after delivery (115 ± 76 min). Most mothers (97%) breastfed on demand (i.e. whenever their infant showed interest); breastfeeding frequency was high on day 0 (average feeds/24 h = 13 ± 5) and on day 3 (average feeds/24 h = 18 ± 8), and pacifier use was rare (only one infant used it). Thirty-nine per cent of infants received NBM fluids during the first 24 h (most of which was formula received in the hospital), this percentage increased to 41% by 48 h post-

Fig. 1. Time of onset of milk production. Frequency distribution for onset of lactation by hours post-partum, based on maternal report of when breasts were noticeably fuller as compared to before delivery. Percentages for each day post-partum are shown.

partum. The amount of formula given at the hospital (as recorded in the medical records) ranged from 8 to 190 mL (mean = 47 mL). As anticipated, nipple and breast pain worsened from day 0 to 3; average nipple and breast pain on day 0 were 2.0 ± 1.1 and 1.2 ± 0.6 (on a scale from 1 to 6), and increased to 3.6 ± 1.2 and 2.1 ± 1.3 , respectively on day 3.

Assessment of infant breastfeeding behaviour was completed for 99% of the infants on day 0, and for 96% of the infants on day 3. However, we excluded from the analysis infants who did not wake up sufficiently to nurse during the breastfeeding observation if they were breastfed successfully (as reported by mother) within 2 h before the observation (seven such infants were excluded on day 0, and five on day 3). Slightly more than half of the infants had SIBB on day 0 (52%); this prevalence decreased to 21% on day 3.

Timing of OL is shown in Fig. 1. For nearly half of the women (49%), OL occurred between 49 and 72 h post-partum; OL was delayed in 17% of women, and only three women (2%) had not yet experienced OL at the time of the day-3 visit.

Figure 2 shows the distribution of weight change between birth and day 3. On average ($n = 152$), infants lost $3.9 \pm 5.1\%$ of their birthweight by day 3, and for 10% of the infants weight loss was $\geq 10\%$ of birth-

weight; 16% of infants gained weight. Among infants who did not receive formula during the first 48 h ($n = 84$), the average weight loss per cent ($3.6 \pm 5.0\%$ of birthweight) and the proportion of infants who gained weight (15.5%) were similar to those of the whole sample, and although the incidence of excessive weight loss (7.1%) was lower than that of the whole sample, this difference did not attain statistical significance.

Bivariate associations between the independent variables and the four primary outcomes are shown in Table 1. For each of the outcome variables, the description of the multivariate results will follow the description of the bivariate results.

SIBB

In the bivariate analysis, SIBB on day 0 was significantly associated ($P < 0.05$) with having a mother born in Lima, being a male infant, having been breastfed < 8 times during the first 24 h and maternal childbirth experience worse than expected (Table 1). After controlling for infant age (in hours) at the time of the breastfeeding observation, multivariate analysis confirmed that male infants [adjusted odds ratio (AOR) = 3.0, 95% confidence interval (CI) 1.5–6.0,

Fig. 2. Neonatal weight change, birth to day 3. Frequency distribution for neonatal weight change by day 3, as a percentage of birthweight.

$P = 0.002$, $n = 162$) and those breastfed less frequently (AOR = 8.3, 95% CI 2.3–30.4, $P = 0.001$, $n = 162$) had higher odds of having SIBB on their first day of life (Table 2).

Bivariate (Table 1), as well as multivariate analysis (Table 2), indicated that the main predictors for SIBB on day 3 were the infant's gestational age and the number of breastfeedings during the first day of life. After controlling for infant age (in hours) at the time of the observation, infants who were less than 39

weeks of gestational age had a threefold increase in their odds of having SIBB on day 3 (AOR = 3.2, 95% CI 1.1–9.2, $P = 0.028$, $n = 131$), and those who were breastfed <8 times during the first 24 h had an almost fourfold increase in their odds of having SIBB on day 3 (AOR = 3.8, 95% CI 1.3–11.1, $P = 0.014$, $n = 131$). As SIBB on day 0 was marginally associated with SIBB on day 3 ($P = 0.07$) and strongly associated with breastfeeding frequency, we entered it into the model (Table 2), which attenuated the association between breastfeeding frequency <8 times during the first 24 h and SIBB on day 3 (AOR = 3.0, 95% CI 1.0–9.1, $P = 0.059$, $n = 131$).

Table 2. Logistic regression analyses for SIBB*

Variable	AOR	95% CI	P-value
SIBB on day 0 ($n = 162$)			
Male	3.0	1.5–6.0	0.002
<8 breastfeeds on day 0	8.3	2.3–30.4	0.001
SIBB on day 3 ($n = 131$)			
<8 breastfeeds on day 0	3.8	1.3–11.1	0.014
Gestational age <39 weeks	3.2	1.1–9.2	0.028
SIBB on day 3 with SIBB on day 0 in the model ($n = 131$)			
<8 breastfeeds on day 0	3.0	1.0–9.1	0.059
Gestational age <39 weeks	3.4	1.2–9.9	0.024
SIBB on day 0	1.9	0.7–5.3	0.197

SIBB, suboptimal infant breastfeeding behaviour; AOR, adjusted odds ratio; CI, confidence interval; *Adjusted by infant age (in hours) at the time of the breastfeeding observation.

Delayed OL

Results from the bivariate analysis (Table 1) indicated that delayed OL was significantly associated with Apgar score <8 (at 1 min), and it was marginally associated with augmentation of labour and, unexpectedly, with vaginal delivery. After adjusting for augmentation of labour, delivery mode and hours post-partum at time of assessment, multivariate analysis indicated that infant's Apgar <8 at 1 min was the main predictor for delayed OL in this population (AOR = 6.0, 95% CI 1.6–22.8, $P = 0.009$, $n = 147$).

Excess neonatal weight loss

In the bivariate analysis (Table 1), excess neonatal weight loss was significantly associated with Caesarean delivery and maternal BMI $>27 \text{ kg/m}^2$, and it was marginally associated with <8 feeds per 24 h on day 0. Because of the strong association between maternal overweight and risk of having a Caesarean-section delivery ($P = 0.001$), we examined the association between these factors and the outcome using a path analysis approach (Baron & Kenny 1986). Multivariate logistic regression, controlling for infant age (in hours) at the time of weight measurement, corroborated that Caesarean delivery was significantly related to excess weight loss among infants (AOR = 3.6, 95% CI 1.1–11.7, $P = 0.033$, $n = 146$). The overall effect of maternal overweight on the odds of excess neonatal weight loss (AOR = 3.8, 95% CI 1.3–11.7, $n = 146$) was attenuated by 29% when Caesarean-section delivery was entered into the model (AOR = 2.7, 95% CI 0.9–8.8, $n = 146$).

Relationships among outcome variables

The bivariate associations among the four dichotomous outcomes indicated that, compared with infants with optimal breastfeeding behaviour, infants with SIBB on day 0 tended to be more likely to have SIBB on day 3 (13.8% vs. 26.4%, $P = 0.07$), but they were not at higher risk for delayed OL ($P = 0.85$) or excessive weight loss ($P = 0.19$). The association between SIBB on day 3 and delayed OL was not significant ($P = 0.39$); however, infants with SIBB on day 3 were more likely to have lost $>10\%$ of their birthweight by day 3 (23.3%) than infants with optimal breastfeeding behaviour (6.1%, $P = 0.01$). Delayed onset of milk production was not related to excess neonatal weight loss ($P = 0.72$).

Discussion

The results of this study suggest that some early lactation difficulties are relatively common within this low-income urban population of primiparous women and their infants. SIBB on the first day of life was observed in 52% of infants, although this prevalence

decreased to 21% on day 3. Seventeen per cent of mothers had delayed OL, and 10% of infants lost $\geq 10\%$ of birthweight by day 3. These results underscore the necessity of exploring the relationship between these early lactation problems and optimal breastfeeding practices (i.e. exclusive breastfeeding during the first 6 months) in this population.

Prevalence of SIBB in our population was somewhat lower than that reported among Californian primiparous women in whom 57% of infants had SIBB on day 0, and 26% did so on day 3 (Dewey *et al.* 2003). The high percentage of infants with SIBB is alarming because of its negative association with subsequent breastfeeding duration (Righard & Alade 1992; Ceriani Cernadas *et al.* 2003). However, in this study, as well as in the US study, infant suckling behaviour improved over the first week post-partum.

Male infants were at higher risk of having SIBB on day 0. In this population infant sex was not significantly related to infant status at birth (i.e. gestational age, birthweight, Apgar score), labor duration, mode of delivery or early breastfeeding practices, including breastfeeding initiation and introduction of NBM fluids (when assessed by maternal report on day 0). Potential explanations for this association include: (1) sex-specific differences in infant suckling maturation, given that males exhibit delayed lung maturation (Khouri *et al.* 1985); (2) gender-based differential behaviours in mothers, which may facilitate or impede the breastfeeding learning process for the infant; or (3) the observed association may be because of chance.

Frequent suckling during the first 24 h of life has several beneficial effects on newborns, including increased rate of meconium passage, increased breast milk intake during the following days, less weight loss (Yamauchi & Yamanouchi 1990) and lower serum bilirubin levels (De Carvalho *et al.* 1982). In this study, breastfeeding frequency <8 times per 24 h during the first day of life was associated with SIBB on both days 0 and 3. We cannot rule out reverse causality as an explanation for the association between lower breastfeeding frequency and SIBB on day 0; however, lower breastfeeding frequency on day 0 was also associated with SIBB on day 3, and this association was attenuated by only 21% when SIBB day 0 was added to the model, which suggests that frequent feedings help the

infant to learn how to suck effectively from the breast. Accordingly, efforts should be made to ensure that first-time mothers breastfeed their infants at least 8–12 times per 24 h, as recommended by the American Academy of Pediatrics (2005), in order to minimize suboptimal breastfeeding behaviour during the first days post-partum.

Prevention and detection of SIBB during the first day of life are particularly important given its potential to increase the risk for SIBB on day 3, which in turn places infants at higher risk of excessive weight loss during the first few days of life.

Delayed OL was experienced by 17% of mothers in this population, which was lower than that observed among peri-urban Guatemalan women (27%) (Grajeda & Perez-Escamilla 2002), and half of the prevalence found in California among primiparous women (Dewey *et al.* 2003). Differences in maternal characteristics (e.g. age), as well as in hospital and cultural practices, might explain the differences in incidence of delayed OL. The only study on delayed OL among women from rural communities (conducted in Guatemala) showed an incidence of 10% (Hruschka *et al.* 2003). This low incidence of delayed OL observed in rural women suggests that urbanization and modernization play a role in the occurrence of early lactation difficulties.

The relationship between stress during labour and delivery and delayed OL has been well documented (Chen *et al.* 1998; Chapman & Perez-Escamilla 1999a; Dewey 2001; Grajeda & Perez-Escamilla 2002; Dewey *et al.* 2003); some studies measured biological markers (e.g. cortisol levels in mothers and fetus) and others measured aspects of the labour and delivery experience as indicators of stress (e.g. maternal pain and exhaustion, long labour, urgent C-section). In this population, a longer labour duration was not associated with delayed OL. Long stage II labour (usually defined as >1 h) in particular has been linked to delayed OL (Chen *et al.* 1998; Chapman & Perez-Escamilla 1999a; Dewey *et al.* 2003), but in this population only three women had a stage II labour longer than 1 h, which made it impossible to analyze the effect of a long stage II labour on OL. This may also explain why we observed a much lower incidence of delayed OL in this sample as compared with the

Californian sample (Dewey *et al.* 2003) in which 47% of primiparous women had a stage II labour longer than 1 h. However, infant Apgar score <8 was associated with delayed OL in this population. Among all the labour and delivery variables measured, only labour augmentation ($P = 0.01$) was associated with lower Apgar scores; thus, it is possible that the infant Apgar score reflected the level of stress that the fetus and mother experienced during labour and delivery.

In contrast to what has been reported in the United States (Chapman & Perez-Escamilla 1999a; Dewey *et al.* 2003), maternal overweight/obesity (defined as BMI > 27 kg/m² on day 3) was not related to delayed OL in this population. The lack of such an association was also recently reported among Australian women by Scott *et al.* (2007). The accuracy of BMI as an indicator of excess body adiposity is particularly limited for individuals with BMI values between 25 and 29.99 kg/m² (Romero-Corral *et al.* 2008). In our study, most women in the overweight/obesity category had a BMI lower than 30 kg/m² (31 out of 47). Given that excess body fatness, not high BMI, is hypothesized to impair lactogenesis (Rasmussen *et al.* 2001), it is possible that the lack of association with delayed OL is because of 'high BMI' being a poor proxy for excess adiposity.

Prelacteal feeding was associated with delayed OL in a cross-sectional study in Honduras (Perez-Escamilla *et al.* 1996a); however we did not find such an association in this population. Given that formula (the most common supplemental feeding) was mainly given at the hospital, the lack of association was possibly because of the feeding method used (with a syringe or a cup, rather than by bottle) or the minimal amount given (<2 oz on average).

In contrast to what we found in California (Dewey *et al.* 2003), delayed OL was not associated with excessive neonatal weight loss in this population. It is possible that this is because of more frequent breastfeeding in the first days of life in Peru (as compared with the California sample), which may have protected infants from excessive weight loss even if full milk production was delayed.

Excess weight loss occurred in 10% of the study infants; this prevalence was about 50% lower than that reported among Californian infants of primiparous

women (16%) (Dewey *et al.* 2003). However, we did not exclude from the analysis infants who received >2 oz of formula (as was carried out in the study in California) because information on amount of formula given was incomplete in several cases. Thus, it is possible that the prevalence of excess weight loss would have been different after excluding infants who received >2 oz of formula. Further analysis including only infants who did not receive *any* amount of formula resulted in a lower prevalence of excess weight loss in this population. Results from the bivariate analysis indicated that higher maternal BMI (>27 kg/m²) and Caesarean delivery were associated with the infant losing >10% of birthweight by day 3. Further analysis confirmed that maternal BMI was associated with neonatal weight loss mostly through Caesarean delivery. An association between type of delivery and neonatal weight loss has also been reported in Italy (Manganaro *et al.* 2001). In our population, Caesarean delivery was significantly associated with later initiation of breastfeeding and with introduction of NBM fluids during the first 2 days after delivery (data not shown). This was consistent with the current hospital practice of separating Caesarean-section mothers from their infants for at least 2–3 h after delivery. Maternal conditions after a Caesarean surgery may have interfered with optimal breastfeeding practices; this in turn could have impeded breast milk intake, especially if the infant was having difficulties suckling at the breast. Another potential explanation for the association between Caesarean delivery and neonatal weight loss relates to the intravenous fluids given to mothers during delivery. It is possible that these fluids were given earlier and in greater amount to mothers who underwent a Caesarean section (in these cases an intravenous line is always put in ahead of time); this could have caused ‘over hydration’ of the fetus resulting in more weight loss after birth. Evidence indicates that Caesarean section negatively affects breastfeeding initiation and duration in the short-term, but once lactation is established, it does not affect long-term breastfeeding duration (Perez-Escamilla *et al.* 1996b). Thus, mothers who undergo a Caesarean delivery but receive appropriate lactation support may overcome early breastfeeding difficulties.

This study has several limitations. We cannot rule out self-selection as a potential source of bias, because 28% of women refused to participate in the study, and it is possible that those who refused to participate did so because they were less committed to breastfeeding. If so, they may have been more predisposed to experience lactation problems and our results may have underestimated the true prevalence of early lactation problems in this population. Interviewer bias is also a possibility, but we attempted to minimize this by following standardized procedures for data collection and by having a different research assistant collecting data on day 3 (who was not aware of the mothers’ risk factor status at day 0). Maternal recall of the timing of OL could have introduced recall bias. However, Chapman and Perez-Escamilla (2000) reported that women can recall the time when their milk came in with reasonable sensitivity and specificity (71.4 and 79.3%, respectively). Finally, our results have limited generalizability because: (1) the study included a convenience sample, and self-selection might have occurred; (2) the study hospital served mainly low-risk pregnant women; and (3) the hospital was a baby-friendly hospital, so breastfeeding was especially promoted.

In summary, this study provides evidence that early lactation problems are present among peri-urban first-time mothers and their infants in Peru, even in a baby-friendly hospital setting, although such problems were less common than in other populations. Our results highlight the need to provide appropriate lactation support to the breastfeeding dyad during the first week post-partum. Future studies on early breastfeeding outcomes may benefit from a longer follow-up period (i.e. through at least the first 2 weeks post-partum) given the rapid changes in infant feeding patterns that occur during this time period. Efforts focused on preventing early lactation difficulties and evaluation of their impact on the rates of exclusive breastfeeding in this population are warranted.

Acknowledgments

The authors would like to thank all the women who participated in the study. We gratefully acknowledge

the thoughtful comments received from Dr. Caroline Chantry and Dr. Danielle Harvey during the preparation of the manuscript. We thank Eysy Mauricio and Iris Holguin for their assistance with data collection.

Source of funding

This project was supported by NIH Research Grant # D43 TW01267 funded by the Fogarty International Center and the National Institute of Child Health and Human Development and by a Graduate Student Research Award from the Gifford Center for Population Studies, at the University of California, Davis.

Conflicts of interest

No conflicts of interest have been declared.

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