# Breast-Feeding and Its Relation to Smoking and Mode of Delivery

Gabriel M. Leung, MD, MPH, Tai-Hing Lam, MD, and Lai-Ming Ho, PhD

**OBJECTIVE:** To examine the effects of cesarean and forceps or vacuum delivery and parental smoking habits on the initiation and duration of breast-feeding.

**METHODS:** We conducted a prospective, population-based birth cohort study in 1997. Data were collected on breast-feeding history, household smoking habits, method of delivery, and other demographic, obstetric, behavioral, and potential confounding variables via a standardized self-administered questionnaire. Multivariable logistic regression was used to examine the association between method of birth (cesarean versus forceps or vacuum delivery versus normal vaginal birth) and either not initiating breast-feeding or doing so for less than 1 month. Among women who breast-fed for 1 month or more, multivariable survival analysis was employed to study the relationship between method of delivery and breast-feeding duration. We repeated these analyses to examine the link between parental smoking habits and breast-feeding initiation and duration.

**RESULTS:** A total of 7825 mother-infant pairs were followed up for 9 months. Cesarean delivery was a risk factor for not initiating breast-feeding, for breast-feeding less than 1 month, and remained a significant hazard against breast-feeding duration. Assisted delivery with forceps or vacuum, although not associated with breast-feeding initiation, was a significant risk against breast-feeding duration. Conversely, current parental smoking habits only affected breast-feeding initiation but were unrelated to breast-feeding duration.

**CONCLUSION:** This study indicates a possible effect of forceps or vacuum delivery on breast-feeding and of cesarean on long-term breast-feeding duration. The findings provide additional evidence in support of the avoidance of unnecessary obstetric interventions. (Obstet Gynecol 2002;99:785–94. © 2002 by the American College of Obstetricians and Gynecologists.)

There has been convincing and accumulating evidence that breast-feeding is associated with lower rates of infant illness in both developing[1,2] and industrialized countries.[3–6] More recently, investigators have reported longer-term protective effects of breast milk, including lower incidences of diabetes mellitus,[7] recurrent wheeze at age 6,[8,9] and higher intelligence quotients[10,11] later in childhood. From an economic viewpoint, Ball and Wright estimated that each never-breast-fed baby cost the health care system between $331 and $475 during the first year of life.[12] The American Academy of Pediatrics has recommended exclusive breast-feeding for the first 6 months of life, and that breast milk be retained as an integral component of an infant's diet for at least 1 year.[13] Unfortunately, consistently fewer than 30% of infants born in Hong Kong are breast-fed at all, according to population-based estimates since the early 1980s.[14,15]

The impact of cesarean delivery on breast-feeding has been studied extensively.[16–31] However, the results are conflicting. Six studies suggest an inverse association between these two variables,[22,25,27–30] but ten have been unable to establish such a link.[16–21,23,24,26,31] Most studies have not distinguished between the initiation (ever versus never) and the duration of breast-feeding. Previous work in this area has stressed the importance of distinguishing between initiation and duration because it allows for greater conceptual clarity and better predictive possibilities.[32,33] The factors associated with the decision to breast-feed may not necessarily be the same as those affecting the duration of infants being nursed. There is also some evidence to suggest that the benefits of breast-feeding accrue with the duration an infant remains on the breast.[4,7,11,13] In addition, whether the potential link between cesarean and breast-feeding extends to assisted instrumental delivery has not been examined in the literature. Any empirical evidence about this newly hypothesized link would be of important public health interest. As vacuum and forceps techniques are a major avenue for reducing cesarean rates in difficult labors, this information also has strong clinical implications.

The relationship between maternal smoking and breast-feeding has also been studied previously. There appears to be solid evidence pointing to a negative relationship.[31–41] Fewer smoking mothers attempt breast-feeding than their nonsmoking counterparts,[31,34–36] and for those smokers who begin breast-feeding, they continue for a shorter period than women who do not smoke.[33,37–41]

To date, only four studies have attempted to examine the important effects of both cesarean and smoking, and control simultaneously for the known confounders of various demographic and maternal behavioral factors such as age, socioeconomic status, employment, and education level.[31,33,42,43] None of these studies covered Asian, and in particular Chinese, populations. In addition, two were not population based,[33,42] and among these, one suffered from a small sample,[33] whereas the other was based on data collected in the 1970s.[42] Of the two population-based studies, one found no association between the method of delivery and breast-feeding and reported exclusive breast-feeding as the sole outcome of interest, disregarding the potentially significant pool of women who supplement breast milk with formula feeds.[31] The other showed similar rates of breast-feeding between mothers who smoked and those who did not, as well as between infants delivered by cesarean and those born per vagina.[43]

The objective of this paper is to examine the effects of cesarean and instrument-assisted birth and parental smoking habits on the initiation and duration of breast-feeding in a population-based birth cohort of Hong Kong Chinese infants in 1997.

## MATERIALS AND METHODS

Data for this paper were drawn from a prospective birth cohort study conducted at all 47 Maternal and Child Health Centers of the Department of Health in 1997. For the index year, 92% of all infants born in Hong Kong attended a Maternal and Child Health Center at least once.[44] The source of subjects consisted of all infants brought to a Maternal and Child Health Center for their first visit after birth in April and May of 1997. The response rate to our study was 95%, accounting for 88% of all births in the period. There were 8327 mother-infant pairs in the final cohort. The main purpose of the birth cohort study was to investigate the effects of environmental tobacco smoke and breast-feeding on health services use because of respiratory illnesses during the first 18 months of life. Among other items, mothers provided information on breast-feeding history (exclusive breast-feeding, breast-feeding with formula milk supplements, exclusive formula feeding), household smoking habits,

method of delivery (normal vaginal, vaginal assisted with vacuum or forceps, cesarean), and other demographic, obstetric, behavioral, and potential confounding variables. This information was provided via a standardized self-administered questionnaire at their first Maternal and Child Health Center visit (baseline), then at subsequent well-baby visits 3, 9, and 18 months after birth. For clinic defaulters and those unable to complete the questionnaires, trained research assistants contacted them to conduct a telephone interview to obtain the information, thus ensuring optimal follow-up. The project received ethics approval from the University of Hong Kong's Research Ethics Committee.

We employed Pearson $\chi^2$ and multivariable logistic regression analyses[45] to study the association between cesarean and the initiation of breast-feeding (ever versus never breast-fed) ($n = 7266$, missing data for 559 [7.1%] mother-infant pairs). The same statistical techniques were used to examine the hypothesis that cesarean is a risk factor for short breast-feeding duration (ie, breast-feeding for less than 1 month versus 1 month or more) among mothers who elected to breast-feed ($n = 2344$, missing data for 276 [10.5%]). A multivariable survival analysis using the Cox proportional hazards model[46] was used to study the relationship between cesarean and breast-feeding duration ($n = 2344$). This model allows joint estimation of the effects of predictor variables on the "hazard," the risk of cessation of breast-feeding, rather than the duration itself. We only included mothers who breast-fed for at least 1 month because we wanted to determine whether there was any impact of cesarean beyond the period when lactation is usually established. For women who were still breast-feeding at the time of the 9-month follow-up, the duration of breast-feeding was calculated using the age of the infant at the time of the survey. In such cases (12.8%), breast-feeding duration was identified as a censored value in the Cox model. We selected 9 months as the cutoff to allow the study of long-term breast-feeding duration (ie, beyond the 3-month follow-up) but did not extend it to 18 months to minimize possible recall bias of mothers because of time lag and memory lapse. Further, there was little additional information to gain from extending the observation period to 18 months, as most (87.1%) breast-feeding mothers terminated the feeding practice by the end of 9 months. We based our analysis primarily on cumulative data from the first baseline recruitment visit up to the 9-month follow-up, but also used information from the 3-month visit to supplement missing values in cases ($n = 353$, 4.5%) where subjects were lost to follow-up after the 3-month appointment.

For the multivariable analyses, the main independent variable was method of delivery (normal vaginal, vagi-

nal assisted with vacuum or forceps, cesarean). Potential predictors were included if they were associated with a $P < .05$ at bivariate analyses, or were selected based on known confounders documented in previous reports.[16-41] The following independent variables were included in the multivariable models: gestational age (less than 37 weeks, 37–41 weeks, more than 41 weeks), birth weight (less than 2500 g, 2500–2999 g, 3000–3499 g, 3500–3999 g, 4000 g or more), mother's current smoking habit (yes versus no), father's current smoking habit (yes versus no), mother's age (24 or older, 25–29, 30–34, 35 or older), mother's and father's education level (grade 6 or less, grades 7–9, grade 10 or more), full-time job held by mother and father (yes versus no), birth order of infant (first, second, third or more), gender of infant (male versus female), and residential region (Hong Kong Island, Kowloon, New Territories).

Similarly, we repeated these analyses to examine the link between parental smoking habits (at first Maternal and Child Health Center baseline visit) and breast-feeding initiation and duration. We constructed Kaplan-Meier survival curves to examine breast-feeding duration at 9 months between women who had normal vaginal delivery, vaginal delivery with the assistance of forceps or vacuum, and those who underwent surgical delivery, and compared them using the log rank test. All analyses were conducted using Stata 6.0 (Stata Corp., Santa Monica, CA).

## RESULTS

A total of 7825 (loss to follow-up = 6.0%) mother-infant pairs were successfully followed (Table 1). Thirty-four percent initiated breast-feeding; however, at 9 months, only 355 (4.5% of total sample) infants were still on the breast. The median duration was 8 weeks. Vaginal delivery with assistance accounted for 16.7% of births, whereas 27.1% of infants were delivered by cesarean. Of the mothers, 2.7% were smokers, whereas 33.0% of fathers smoked at the baseline visit (ie, first Maternal and Child Health Center appointment). The majority of mothers (60.1%) and fathers (57.0%) continued formal education beyond the 9-year compulsory duration (ie, up to junior secondary level of grade 9) required and provided free of charge by the government. About half (47.0%) of the mothers and most (93.9%) fathers held a full-time job. Most (89.3%) infants were either the first or second child in the family.

Cesarean delivery was a risk factor for the noninitiation of breast-feeding in the bivariate (Table 2) and multivariable (Table 3) analyses (odds ratio [$OR_{adjusted}$] 1.52, 95% confidence interval [CI] 1.34, 1.73). However, breast-feeding initiation for infants delivered using for-

ceps or vacuum was not different from those born vaginally without instrument assistance ($OR_{adjusted}$ 1.09, 95% CI 0.95, 1.26). This observation was supported by the bivariate results in Table 2, which demonstrated no significant difference in the proportions of ever-breast-fed infants who were delivered vaginally without assistance compared with those who had forceps or vacuum assistance ($OR_{crude}$ 0.90, 95% CI 0.79, 1.03). Mothers and fathers who were current smokers at the first Maternal and Child Health Center visit contributed to not initiating breast-feeding ($OR_{current\ smoker-mother}$ 3.10, 95% CI 1.98, 4.85; $OR_{current\ smoker-father}$ 1.27, 95% CI 1.13, 1.42). Of the three factors linked to the noninitiation of breast-feeding, maternal smoking was the strongest risk factor for failing to breast-feed, followed by paternal smoking and cesarean delivery, respectively. Other predictors for not starting breast-feeding included maternal and paternal full-time employment, increasing birth order, and living in Kowloon and the New Territories. On the other hand, increasing maternal age ($P$ for trend $< .001$) and higher levels of education for both mothers ($P < .001$) and fathers ($P < .001$) were all positively associated with the initiation of breast-feeding.

Among those who had initiated to breast-feed, cesarean delivery remained positively associated with breast-feeding for less than 1 month among women who elected to breast-feed ($OR_{crude}$ 1.48, 95% CI 1.22, 1.80) (Table 2), even after adjusting for potential confounders ($OR_{adjusted}$ 1.25, 95% CI 1.00, 1.56) (Table 3). Similarly, an instrument-assisted birth was associated with breast-feeding for less than 1 month ($OR_{adjusted}$ 1.32, 95% CI 1.04, 1.68) despite its lack of association with breast-feeding initiation previously. In fact, bivariate analyses suggest there was no difference in the proportions of infants who were breast-fed for less than 1 month between those born with instrumental assistance and those delivered by cesarean (48.0% versus 44.7%, $P = .28$). However, smoking status of both mothers and fathers at the first Maternal and Child Health Center visit did not show a link with short-term (less than 1 month) breast-feeding duration. Women who attended school beyond grade 10 were more likely to breast-feed their children for less than 1 month ($OR_{adjusted}$ 1.67, 95% CI 1.12, 2.48), and so were mothers who had a full-time job ($OR_{adjusted}$ 2.98, 95% CI 2.43, 3.67). The trend regarding maternal education level was significant ($P = .009$). Older women also tended to breast-feed their infants for more than 1 month ($P = .044$).

In the Cox proportional hazards model, cesarean birth and, to a lesser degree, assisted delivery maintained their association with breast-feeding as risk factors against the duration of infants remaining on the breast (hazards ratio$_{cesarean}$ 1.16, 95% CI 1.04, 1.30, hazards ratio$_{assisted}$

**Table 1.** Mother-Infant Characteristics for the Total Sample, Those Who Ever Breast-Fed and Who Breast-Fed for at Least 1 Month

| | Total sample (n = 7825)* | | Ever breast-fed (n = 2620)* | | Breast-fed at least 1 month (n = 1508)* | |
|---|---|---|---|---|---|---|
| | n | (%) | n | (%) | n | (%) |
| Method of delivery | | | | | | |
| Vaginal | 4314 | (56.2) | 1494 | (57.9) | 920 | (62.1) |
| Vaginal with vacuum or forceps | 1279 | (16.7) | 473 | (18.3) | 238 | (16.1) |
| Cesarean | 2084 | (27.1) | 614 | (23.8) | 323 | (21.8) |
| Maternal smoking status at first MCHC visit | | | | | | |
| No | 7482 | (97.3) | 2560 | (99.1) | 1470 | (99.3) |
| Yes | 209 | (2.7) | 23 | (0.9) | 10 | (0.7) |
| Paternal smoking status at first MCHC visit | | | | | | |
| No | 5084 | (67.0) | 1849 | (72.2) | 1041 | (71.0) |
| Yes | 2503 | (33.0) | 711 | (27.8) | 426 | (29.0) |
| Mother's age (y) | | | | | | |
| ≤24 | 942 | (12.3) | 281 | (10.9) | 166 | (11.2) |
| 25–29 | 2363 | (30.8) | 765 | (29.7) | 446 | (30.2) |
| 30–34 | 2962 | (38.6) | 1045 | (40.5) | 572 | (38.7) |
| ≥35 | 1409 | (18.4) | 488 | (18.9) | 294 | (19.9) |
| Mother's education level | | | | | | |
| ≤Grade 6 | 932 | (12.1) | 249 | (9.7) | 182 | (12.3) |
| Grades 7–9 | 2133 | (27.8) | 591 | (22.9) | 401 | (27.1) |
| ≥Grade 10 | 4618 | (60.1) | 1740 | (67.4) | 895 | (60.5) |
| Maternal full-time employment | | | | | | |
| No | 4069 | (53.0) | 1337 | (51.8) | 931 | (63.0) |
| Yes | 3609 | (47.0) | 1244 | (48.2) | 547 | (37.0) |
| Father's education level | | | | | | |
| ≤Grade 6 | 928 | (12.1) | 258 | (10.0) | 172 | (11.7) |
| Grades 7–9 | 2374 | (30.9) | 663 | (25.7) | 433 | (29.4) |
| ≥Grade 10 | 4373 | (57.0) | 1657 | (64.3) | 870 | (59.0) |
| Paternal full-time employment | | | | | | |
| No | 468 | (6.1) | 162 | (6.3) | 110 | (7.5) |
| Yes | 7206 | (93.9) | 2417 | (93.7) | 1366 | (92.5) |
| Gender of infant | | | | | | |
| Male | 4035 | (52.5) | 1344 | (52.1) | 755 | (51.0) |
| Female | 3647 | (47.5) | 1237 | (47.9) | 725 | (49.0) |
| Birth weight (g) | | | | | | |
| <2500 | 408 | (5.3) | 120 | (4.7) | 700 | (47.4) |
| 2500–2999 | 1877 | (24.4) | 633 | (24.6) | 72 | (4.9) |
| 3000–3499 | 3580 | (46.6) | 1223 | (47.5) | 345 | (23.4) |
| 3500–3999 | 1552 | (20.2) | 524 | (20.3) | 311 | (21.1) |
| ≥4000 | 260 | (3.4) | 77 | (3.0) | 48 | (3.3) |
| Birth order | | | | | 722 | (48.9) |
| 1 | 3676 | (47.8) | 1350 | (52.2) | | |
| 2 | 3170 | (41.3) | 993 | (38.4) | 574 | (38.8) |
| ≥3 | 838 | (10.9) | 242 | (9.4) | 180 | (12.2) |
| Gestational age (wk) | | | | | | |
| <37 | 404 | (5.4) | 132 | (5.2) | 78 | (5.4) |
| 37–41 | 6110 | (81.4) | 2050 | (81.3) | 1157 | (80.3) |
| >41 | 992 | (13.2) | 338 | (13.4) | 206 | (14.3) |
| Residential region | | | | | | |
| Hong Kong | 1364 | (17.8) | 534 | (20.7) | 302 | (20.4) |
| Kowloon | 2328 | (30.4) | 794 | (30.8) | 482 | (32.6) |
| New Territories | 3978 | (51.9) | 1249 | (48.5) | 693 | (46.9) |

MCHC = Maternal and Child Health Center.

\* Subtotals within categories may not equal the overall sample size because of missing data.

1.12, 95% CI 0.99, 1.26) (Table 3). Maternal characteristics such as better education (*P* for trend = .012) and full-time employment (*P* for trend < .001) also remained important hazards against breast-feeding for a long period.

The hazards ratios related to parental smoking habits were close to unity in the Cox model.

Findings about the method of delivery being a significant risk for breast-feeding duration (*P* < .001

**Table 2.** Crude Odds Ratios of Independent Variables for the Initiation of and Short-Term Breast-Feeding Outcomes

| | Never breast-fed* (n = 7825) | | Breast-fed <1 month† (n = 2620) | |
|---|---|---|---|---|
| | OR | (95% CI) | OR | (95% CI) |
| Method of delivery | | | | |
| Vaginal | 1 | | 1 | |
| Vaginal with vacuum or forceps | 0.90 | (0.79, 1.03) | 1.69 | (1.37, 2.10) |
| Cesarean | 1.27 | (1.13, 1.42) | 1.48 | (1.22, 1.80) |
| Maternal smoking status at first MCHC visit | | | | |
| No | 1 | | 1 | |
| Yes | 4.21 | (2.72, 6.50) | 1.66 | (0.70, 3.93) |
| Paternal smoking status at first MCHC visit | | | | |
| No | 1 | | 1 | |
| Yes | 1.44 | (1.30, 1.60) | 0.84 | (0.70, 1.01) |
| Mother's age (y) | | | | |
| ≤24 | 1 | | 1 | |
| 25–29 | 0.89 | (0.75, 1.05) | 1.04 | (0.78, 1.39) |
| 30–34 | 0.78 | (0.67, 0.91) | 1.22 | (0.93, 1.62) |
| ≥35 | 0.80 | (0.67, 0.96) | 0.97 | (0.71, 1.33) |
| Mother's education level | | | | |
| ≤Grade 6 | 1 | | 1 | |
| Grades 7–9 | 0.95 | (0.80, 1.13) | 1.47 | (1.02, 2.10) |
| ≥Grade 10 | 0.60 | (0.52, 0.71) | 3.06 | (2.21, 4.24) |
| Maternal full-time employment | | | | |
| No | 1 | | 1 | |
| Yes | 0.93 | (0.85, 1.02) | 3.30 | (2.78, 3.90) |
| Father's education level | | | | |
| ≤Grade 6 | 1 | | 1 | |
| Grades 7–9 | 0.99 | (0.84, 1.18) | 1.08 | (0.78, 1.49) |
| ≥Grade 10 | 0.63 | (0.54, 0.74) | 1.93 | (1.45, 2.59) |
| Paternal full-time employment | | | | |
| No | 1 | | 1 | |
| Yes | 1.05 | (0.86, 1.28) | 1.85 | (1.28, 2.68) |
| Gender of infant | | | | |
| Male | 1 | | 1 | |
| Female | 0.97 | (0.89, 1.07) | 0.88 | (0.75, 1.03) |
| Birth weight (g) | | | | |
| <2500 | 1.25 | (1.00, 1.56) | 0.81 | (0.54, 1.22) |
| 2500–2999 | 1.02 | (0.91, 1.15) | 1.14 | (0.94, 1.39) |
| 3000–3499 | 1 | | 1 | |
| 3500–3999 | 1.02 | (0.90, 1.15) | 0.92 | (0.74, 1.14) |
| ≥4000 | 1.23 | (0.94, 1.62) | 0.84 | (0.52, 1.37) |
| Birth order | | | | |
| 1 | 1 | | 1 | |
| 2 | 1.27 | (1.15, 1.41) | 0.85 | (0.72, 1.01) |
| ≥3 | 1.43 | (1.21, 1.68) | 0.39 | (0.28, 0.54) |
| Gestational age (wk) | | | | |
| <37 | 1.04 | (0.84, 1.29) | 0.85 | (0.59, 1.24) |
| 37–41 | 1 | | 1 | |
| >41 | 0.98 | (0.85, 1.13) | 0.84 | (0.66, 1.07) |
| Residential region | | | | |
| Hong Kong | 1 | | 1 | |
| Kowloon | 1.24 | (1.08, 1.43) | 0.84 | (0.67, 1.06) |
| New Territories | 1.41 | (1.24, 1.60) | 1.06 | (0.86, 1.31) |

OR = odds ratio; CI = confidence interval; other abbreviation as in Table 1.

\* Outcome variable: ever (= 0) vs never breast-fed (= 1).

† Outcome variable: breast-fed for at least (= 0) 1 month vs < (= 1) 1 month (excludes women who never breast-fed or did not breast-feed exclusively).

for both normal vaginal versus vaginal with assistance, and normal vaginal versus cesarean) are confirmed by survival analysis using the Kaplan-Meier method (Figure 1). We did not find any significant difference between the vaginal with assistance and cesarean delivery survival curves (P = .90).

**Table 3.** Determinants of Short- and Long-term Breast-Feeding Outcomes: Multivariable Analyses

| | Never breast-fed* (n = 7266) | | Breast-fed <1 month† (n = 2344) | | Breast-feeding duration‡ (n = 2344) | |
|---|---|---|---|---|---|---|
| | OR | (95% CI) | OR | (95% CI) | HR | (95% CI) |
| Method of delivery | | | | | | |
| Vaginal | 1 | | 1 | | 1 | |
| Vaginal with vacuum or forceps | 1.09 | (0.95, 1.26) | 1.32 | (1.04, 1.68) | 1.12 | (0.99, 1.26) |
| Cesarean | 1.52 | (1.34, 1.73) | 1.25 | (1.00, 1.56) | 1.16 | (1.04, 1.30) |
| Maternal smoking status at first MCHC visit | | | | | | |
| No | 1 | | 1 | | 1 | |
| Yes | 3.10 | (1.98, 4.85) | 1.96 | (0.77, 4.95) | 1.05 | (0.65, 1.68) |
| Paternal smoking status at first MCHC visit | | | | | | |
| No | 1 | | 1 | | 1 | |
| Yes | 1.27 | (1.13, 1.42) | 1.07 | (0.87, 1.32) | 1.05 | (0.94, 1.16) |
| Mother's age (y) | | | | | | |
| ≤24 | 1 | | 1 | | 1 | |
| 25–29 | 0.93 | (0.78, 1.11) | 0.73 | (0.53, 1.01) | 0.96 | (0.81, 1.12) |
| 30–34 | 0.77 | (0.64, 0.92) | 0.69 | (0.49, 0.95) | 0.84 | (0.71, 0.99) |
| ≥35 | 0.72 | (0.58, 0.88) | 0.64 | (0.44, 0.93) | 0.84 | (0.70, 1.02) |
| Mother's education level | | | | | | |
| ≤Grade 6 | 1 | | 1 | | 1 | |
| Grades 7–9 | 0.90 | (0.75, 1.09) | 1.35 | (0.90, 2.00) | 1.11 | (0.91, 1.34) |
| ≥Grade 10 | 0.63 | (0.51, 0.76) | 1.67 | (1.12, 2.48) | 1.25 | (1.03, 1.52) |
| Maternal full-time employment | | | | | | |
| No | 1 | | 1 | | 1 | |
| Yes | 1.36 | (1.21, 1.53) | 2.98 | (2.43, 3.67) | 1.86 | (1.67, 2.07) |
| Father's education level | | | | | | |
| ≤Grade 6 | 1 | | 1 | | 1 | |
| Grades 7–9 | 1.04 | (0.87, 1.26) | 0.86 | (0.60, 1.23) | 1.14 | (0.95, 1.38) |
| ≥Grade 10 | 0.79 | (0.65, 0.96) | 0.97 | (0.67, 1.39) | 1.34 | (1.11, 1.62) |
| Paternal full-time employment | | | | | | |
| No | 1 | | 1 | | 1 | |
| Yes | 1.25 | (1.01, 1.55) | 1.28 | (0.85, 1.93) | 1.11 | (0.91, 1.36) |
| Gender of infant | | | | | | |
| Male | 1 | | 1 | | 1 | |
| Female | 0.99 | (0.90, 1.10) | 0.87 | (0.73, 1.04) | 0.94 | (0.86, 1.02) |
| Birth weight (g) | | | | | | |
| <2500 | 1.25 | (0.96, 1.64) | 0.73 | (0.43, 1.23) | 0.91 | (0.70, 1.18) |
| 2500–2999 | 1.05 | (0.93, 1.19) | 1.16 | (0.93, 1.44) | 1.05 | (0.94, 1.17) |
| 3000–3499 | 1 | | 1 | | 1 | |
| 3500–3999 | 1.00 | (0.87, 1.14) | 0.96 | (0.76, 1.22) | 0.99 | (0.88, 1.11) |
| ≥4000 | 1.11 | (0.84, 1.48) | 1.15 | (0.68, 1.94) | 1.00 | (0.77, 1.32) |
| Birth order | | | | | | |
| 1 | 1 | | 1 | | 1 | |
| 2 | 1.39 | (1.24, 1.56) | 1.21 | (0.99, 1.49) | 1.02 | (0.92, 1.13) |
| ≥3 | 1.52 | (1.25, 1.85) | 0.84 | (0.57, 1.24) | 0.84 | (0.70, 1.02) |
| Gestational age (wk) | | | | | | |
| <37 | 0.88 | (0.68, 1.13) | 1.04 | (0.64, 1.67) | 0.99 | (0.78, 1.26) |
| 37–41 | 1 | | 1 | | 1 | |
| >41 | 0.91 | (0.79, 1.06) | 1.01 | (0.77, 1.32) | 0.96 | (0.84, 1.10) |
| Residential region | | | | | | |
| Hong Kong | 1 | | 1 | | 1 | |
| Kowloon | 1.21 | (1.05, 1.40) | 1.02 | (0.79, 1.30) | 1.09 | (0.96, 1.23) |
| New Territories | 1.33 | (1.16, 1.52) | 1.14 | (0.91, 1.43) | 1.04 | (0.93, 1.17) |

HR = hazards ratio; other abbreviations as in Tables 1 and 2.
  * Multivariable logistic regression (outcome variable: ever vs never breast-fed).
  † Multivariable logistic regression (outcome variable: breast-fed for at least 1 month vs less than 1 month; excludes women who never breast-fed or did not breast-feed all the time).
  ‡ Cox multivariable regression (outcome variable: breast-feeding duration among women who breast-fed for at least 1 month).
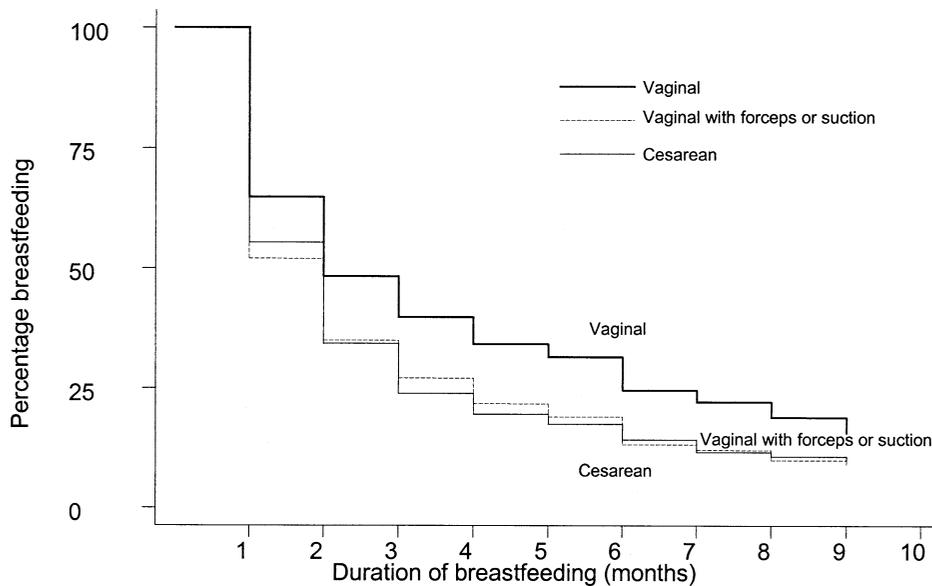
**Figure 1.** Kaplan-Meier survival estimates by method of delivery.

*Leung. Cesarean, Smoking, and Breast-Feeding. Obstet Gynecol 2002.*

## DISCUSSION

The present analyses provide evidence from a Chinese, postindustrialized population that cesarean is a significant risk factor for failure to initiate breast-feeding and remains an important hazard for a shorter duration of breast-feeding once lactation has been established. The adverse effects on both short- and long-term breast-feeding duration, but not initiation, also extend to assisted vaginal delivery with forceps and vacuum, demonstrating the important possibility of a dose-response relationship of obstetric interventions on breast-feeding. Smoking status of either parent also poses an important, independent risk to the noninitiation of breast-feeding. However, this deleterious effect does not apply to the duration of breast-feeding. The population base of the study, its prospective design, and the high rates of coverage and follow-up make it unlikely that the findings described are a result of selection or information bias. Unlike most similar previous studies, confounding factors were assessed and controlled for.

In two similar analyses of data from nationally representative samples in the United States and Mexico, investigators also reported cesarean as a risk factor for not initiating breast-feeding. However, neither demonstrated an association with long-term breast-feeding duration, although the Mexican study had found that surgical delivery remained a significant risk for short-term breast-feeding duration (ie, less than 1 month versus at least 1 month).[28,30] Prolonged mother-infant separation, an increased length of stay in hospital, as well as mater-

nal endocrinologic changes induced by surgery have all been postulated as reasons for failure to initiate breast-feeding in mothers who undergo a cesarean.[30] Our study confirmed these findings and extended the period of potential harm from surgical delivery to 9 months postpartum.

Interestingly, we found that assisted delivery did not affect the initiation of breast-feeding but posed a significant risk against the duration mothers nursed. This suggests that in addition to the usual factors (eg, rooming-in, early mother-infant contact) in the immediate postpartum period influencing the decision of whether to start breast-feeding, a separate mechanism is at work to determine the short- and long-term duration of breast-feeding once lactation has been initiated. This novel pathway also appears to be proportionately related to the degree of obstetric intervention, as shown by our trend analyses.

According to a search of MEDLINE (1966–2001) using key words/MeSH terms such as "cesarean" and "breast-feeding," the enduring effect of cesarean on long-term (more than 1 month) breast-feeding duration demonstrated in our study has not yet been described in the literature. However, the dose-response relationship observed across the three methods of delivery, the consistency with a previous study revealing an association between short-term breast-feeding duration and cesarean birth,[30] and the tight CIs around the point estimates in both multivariate models examining breast-feeding duration are all highly suggestive of a real link between

cesarean, or more broadly the degree of obstetric intervention in delivery, and the length of time infants remain breast-fed once the practice has been initiated. Again, this probably operates through the same pathway as noted for the effects of assisted delivery on breast-feeding duration.

Taking these two pieces of evidence together, we propose the mechanism whereby breast-feeding duration is curtailed may work through a delayed psychologic reaction of the mother to an eventful delivery. Although she may have started breast-feeding in the postpartum period, negative feelings about and, more generally, the adverse impact of an instrumental or surgical birth preclude long-term breast-feeding duration. The precise elucidation of this mechanism is beyond the scope of this report, and our data are insufficient to answer this question. Information on the indications for assisted or surgical deliveries as well as on maternal and neonatal peripartum complications would also be helpful in the delineation of the causal pathway. For example, one could postulate that mothers with significant complications from a difficult assisted vaginal delivery would be less likely to initiate or maintain breast-feeding compared with women with an elective cesarean. In addition, infants with significant intrapartum complications leading to an operative delivery might be less likely to be breast-fed because of the need for neonatal care. Our findings should be confirmed by additional studies in other populations. Future studies should distinguish between elective and emergency cesarean deliveries as well as prospectively collect more comprehensive information about a full range of potential risk factors associated with breast-feeding duration, with particular attention paid to the psychologic reactions of mothers to an eventful delivery.

As expected,[31–41] there was a strong association between maternal and paternal smoking and the failure to start breast-feeding, independent of other potential confounders. Smoking habits reflect a person's attitude towards health. Mothers who smoke are, therefore, potentially less knowledgeable and less enthusiastic about breast-feeding than their nonsmoking counterparts.[38] Similarly, fathers who smoke may be a proxy for a lower level of health consciousness in the household and, therefore, adversely affect their wives' decision about breast-feeding.[47] Our results support this hypothesis and suggest that maternal smoking is the strongest risk factor for the noninitiation of breast-feeding, even though our prevalence of maternal smoking is much lower than that reported in the West.[31,38,41]

However, we failed to identify a relationship between parental smoking habits and the duration of breast-feeding. The absence of such a relationship in our study

is not incompatible with previous documentation of a noncausal association. Eriksen suggested the observed link was probably a result of uncontrolled confounding by social and psychologic factors.[38] Given that only 0.9% of mothers who initiated breast-feeding smoked and the very widely associated CIs from the two breast-feeding duration multivariate analyses, we may not have had adequate power to detect a subtle difference. Further, it is also possible that the manner in which we recorded parental smoking habits (ie, through a single measurement at the first Maternal and Child Health Center visit) may have precluded us from detecting a true association between smoking behavior and the length of time infants were breast-fed. Recent studies from the United Kingdom and New Zealand have reported maternal smoking as a significant risk factor for a shorter duration of breast-feeding, and were also able to demonstrate a clear dose-response gradient.[31,41]

As shown previously,[31,38,41] maternal age and education attainment were positively associated with the initiation of breast-feeding in a dose-response manner. However, our results revealed that better education adversely affected breast-feeding duration, also demonstrating a clear inverse gradient. We postulate that more educated women are more aware of and receptive to the benefits of breast-feeding, and hence the decision to breast-feed. On the other hand, better educated women are also more likely to be in full-time jobs, which in turn is a major barrier for breast-feeding, especially in a culture like Hong Kong's where there is little sympathy and provision for nursing mothers. Therefore, breast-feeding duration was shortened for working mothers and those with more years of schooling in our sample. We searched for interaction between these two variables in the multivariable models, and significance testing yielded borderline but with insignificant $P$ values, suggesting that, though statistically not significant at the conventional .05 level, there might have been a moderate amount of interaction between maternal education and full-time employment.

To put our results into a broader population perspective, 12.4% of all infants who are never breast-fed in Hong Kong can be attributed to cesarean, irrespective of the indication or need for such a procedure. Similarly, the population-attributable risk for breast-feeding for less than 1 month was 6.3% (PAR = $P_e$[OR − 1]/{1 + $P_e$[OR − 1]}), where $P_e$ is the prevalence of cesarean in the overall sample. Assuming a reduction of cesarean rates to 15%, the upper limit recommended by the World Health Organization,[48] the two population-attributable risks would become 7.2% and 3.6%, respectively. If confirmed by other studies, results of the present report will support the avoidance of cesarean as a useful

adjunct for breast-feeding promotion. This is particularly relevant for Hong Kong, where cesarean delivery rates have climbed steadily from 17% to 28% between 1987 and 1999.[49] As vacuum extraction and the use of forceps are major substitutes for cesarean deliveries in difficult births, but both are also implicated as being independent risk factors against breast-feeding from our results, this poses a challenge to the obstetric community to come up with ways to reduce such instrument-assisted deliveries, and also drive down cesarean delivery rates and maintain good mother-infant outcomes. The answer may lie in strategies to mitigate their impact on breast-feeding initiation and duration, rather than in the reduction of absolute intervention rates. Although yet to be confirmed by evidence in the literature, women who deliver by cesarean or with instrument assistance should perhaps be specifically targeted for special breast-feeding counseling and support postpartum and throughout the first months after delivery. The government should also institute macroeconomic and policy strategies to encourage breast-feeding, paying particular attention to lowering cesarean delivery rates. Obstetric facilities in Hong Kong can follow successful examples of intervention programs such as the Baby Friendly Hospital Initiative,[50] promoting breast-feeding soon after birth, providing rooming-in facilities with infants for mothers, as well as giving psychosocial support from a doula.[18,30]

## REFERENCES

1. Cunningham AS, Jelliffe DB, Jelliffe EF. Breast-feeding and health in the 1980s: A global epidemiologic review. J Pediatr 1991;118:659–66.

2. Victora CG, Smith PG, Vaughan JP, Nobre LC, Lombardi C, Teixeira AM, et al. Evidence for protection by breast-feeding against infant deaths from infectious diseases in Brazil. Lancet 1987;2:319–22.

3. Howie PW, Forsyth JS, Ogston SA, Clark A, Florey CD. Protective effect of breast feeding against infection. Br Med J 1990;300:11–6.

4. Wright AL, Holberg CJ, Martinez FD, Morgan WJ, Taussig LM. Breast feeding and lower respiratory tract illness in the first year of life. Br Med J 1989;299:946–9.

5. Dewey KG, Heinig MJ, Nommsen-Rivers LA. Differences in morbidity between breast-fed and formula-fed infants. J Pediatr 1995;126:696–702.

6. Aniansson G, Alm B, Andersson B, Hakansson A, Larsson P, Nylen O, et al. A prospective cohort study on breast-feeding and otitis media in Swedish infants. Pediatr Infect Dis J 1994;13:183–8.

7. Mayer EJ, Hamman RF, Gay EC, Lezotte DC, Savitz DA, Klingensmith GJ. Reduced risk of IDDM among breast-fed children. The Colorado IDDM Registry. Diabetes 1988;37:1625–32.

8. Burr ML, Miskelly FG, Butland BK, Merrett TG, Vaughan Williams E. Environmental factors and symptoms in infants at high risk of allergy. J Epidemiol Community Health 1989;43:125–32.

9. Wright AL, Holberg CJ, Taussig LM, Martinez FD. Relationship of infant feeding to recurrent wheezing at age 6 years. Arch Pediatr Adolesc Med 1995;149:758–63.

10. Lucas A, Morley R, Cole TJ, Lister G, Leeson Payne C. Breast milk and subsequent intelligence quotient in children born preterm. Lancet 1992;339:261–4.

11. Horwood LJ, Fergusson DM. Breastfeeding and later cognitive and academic outcomes. Pediatrics 1998;101:E9.

12. Ball TM, Wright AL. Health care costs of formula-feeding in the first year of life. Pediatrics 1999;103:870–6.

13. American Academy of Pediatrics. Work group on breast-feeding: Breastfeeding and the use of human milk. Pediatrics 1997;100:1035–9.

14. Koo LC, Wong VC, Ho CH. Factors affecting breast-feeding among Hong Kong Chinese. Asia-Oceania J Obstet Gynaecol 1986;12:469–77.

15. Department of Community Medicine, University of Hong Kong and Department of Health, Government of Hong Kong. Study on breastfeeding, infant nutrition and birth spacing. Hong Kong: Department of Community Medicine, University of Hong Kong, 1990.

16. Ellis D, Hewat R. Factors related to breastfeeding duration. Can Fam Physician 1984;30:1479–84.

17. Gulick E. Informational correlates of successful breastfeeding. Maternal Child Nurs 1982;7:370–5.

18. Janke J. Breastfeeding duration following cesarean and vaginal births. J Nurs Midwifery 1988;33:159–64.

19. Kearney MH, Cronenwett LR, Reinhardt R. Cesarean delivery and breastfeeding outcomes. Birth 1990;17:97–103.

20. Kulski JK, Smith M, Hartmann PE. Normal and caesarean section delivery and the initiation of lactation in women. Aust J Exp Biol Med Sci 1981;59:405–12.

21. Loughlin HH, Clapp Channing NE, Gehlbach SH, Pollard JC, McCutchen TM. Early termination of breast-feeding: Identifying those at risk. Pediatrics 1985;75:508–13.

22. Samuels SE, Margen S, Schoen EJ. Incidence and duration of breast-feeding in a health maintenance organization population. Am J Clin Nutr 1985;42:504–10.

23. Lyon A. Factors influencing breast feeding. Acta Paediatr Scand 1984;73:268–70.

24. Tamminen T, Verronen P, Saarikoski S, Goransson A, Tuomiranta H. The influence of perinatal factors on breast feeding. Acta Paediatr Scand 1983;72:9–12.

25. Whichelow MJ. Factors associated with the duration of breast feeding in a privileged society. Early Hum Dev 1982;7:273–80.

26. Wright HJ, Walker PC. Prediction of duration of breast

feeding in primiparas. J Epidemiol Community Health 1983;37:89–94.

27. Rush D, Leighton J, Sloan NL, Alvir JM, Horvitz DG, Seaver WB, et al. The National WIC Evaluation: Evaluation of the Special Supplemental Food Program for Women, Infants, and Children. V. Longitudinal study of pregnant women. Am J Clin Nutr 1988;48:439–83.

28. Ford K, Labbok M. Who is breast-feeding? Implications of associated social and biomedical variables for research on the consequences of method of infant feeding. Am J Clin Nutr 1990;52:451–6.

29. Procianoy RS, Fernandes Filho PH, Lazaro L, Sartori NC. Factors affecting breastfeeding: The influence of caesarean section. J Trop Pediatr 1984;30:39–42.

30. Perez-Escamilla R, Maulen-Radovan I, Dewey KG. The association between cesarean delivery and breast-feeding outcomes among Mexican women. Am J Public Health 1996;86:832–6.

31. Clements MS, Mitchell EA, Wright SP, Esmail A, Jones DR, Ford RP. Influences on breastfeeding in southeast England. Acta Paediatr 1997;86:51–6.

32. Scott JA, Binns CW. Factors associated with the initiation and duration of breastfeeding: A review of the literature. Breastfeed Rev 1999;7:5–16.

33. Mansbach IK, Greenbaum CW, Sulkes J. Onset and duration of breast feeding among Israeli mothers: Relationships with smoking and type of delivery. Soc Sci Med 1991;33:1391–7.

34. Najdawi F, Faouri M. Maternal smoking and breastfeeding. East Mediterr Health J 1999;5:450–6.

35. Edwards N, Sims-Jones N, Breithaupt K. Smoking in pregnancy and postpartum: Relationship to mothers' choices concerning infant nutrition. Can J Nurs Res 1998;30:83–98.

36. Evers S, Doran L, Schellenberg K. Influences on breast-feeding rates in low income communities in Ontario. Can J Public Health 1998;89:203–7.

37. Haug K, Irgens LM, Baste V, Markestad T, Skjaerven R, Schreuder P. Secular trends in breastfeeding and parental smoking. Acta Paediatr 1998;87:1023–7.

38. Eriksen W. Breastfeeding, smoking and the presence of the child's father in the household. Acta Paediatr 1996;85:1272–7.

39. Hill PD, Aldag JC. Smoking and breastfeeding status. Res Nurs Health 1996;19:125–32.

40. Sayers G, Thornton L, Corcoran R, Burke M. Influences on breast feeding initiation and duration. Ir J Med Sci 1995;164:281–4.

41. Ford RP, Mitchell EA, Scragg R, Stewart AW, Taylor BJ, Allen EM. Factors adversely associated with breast feeding in New Zealand. J Paediatr Child Health 1994;30:483–9.

42. Ever-Hadani P, Seidman DS, Manor O, Harlap S. Breast feeding in Israel: Maternal factors associated with choice and duration. J Epidemiol Community Health 1994;48:281–5.

43. Riva E, Banderali G, Agostoni C, Silano M, Radaelli G, Giovannini M. Factors associated with initiation and duration of breastfeeding in Italy. Acta Paediatr 1999;88:411–5.

44. Department of Health. Annual Report 1997–8. Hong Kong, China: Government Printers; 1999.

45. Hosmer DW, Lemeshow S. Appid logistic regression. New York: John Wiley & Sons; 1989.

46. Cox DR, Oakes D. Analysis of survival data. New York: Chapman & Hall; 1984.

47. Kaufman KJ, Hall LA. Influences of the social network on choice and duration of breast-feeding in mothers of pre-term infants. Res Nurs Health 1989;12:149–59.

48. World Health Organization. Appropriate technology for birth. Lancet 1985;2:436–7.

49. Leung GM, Lam TH, Wan S, Thach TQ, Ho LM. Rates of cesarean births in Hong Kong: 1987–1999. Birth 2001;28:166–72.

50. Naylor AJ. Baby-Friendly Hospital Initiative. Protecting, promoting, and supporting breastfeeding in the twenty-first century. Pediatr Clin North Amer 2001;48:475–83.

Address reprint requests to: Gabriel M. Leung, MD, MPH, University of Hong Kong, Department of Community Medicine, 21 Sassoon Road, Pokfulam, Hong Kong, China; E-mail: gmleung@hku.hk.