Inequality and Mother's Age as Determinants of Breastfeeding Continuation in Bangladesh

G.M. Rabiul Islam,[1] Isao Igarashi[1] and Koichi Kawabuchi[1]

[1]Department of Health Care Economics, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University, Tokyo, Japan

The World Health Organization recommends continuing breastfeeding up to 2 years of age or beyond for sound growth and development of children. In Bangladesh, continuation rates for breastfeeding have recently decreased and effective measures are required to counter this downward trend. Although recent years have seen economic development and reductions in poverty, Bangladesh still has the highest rate of child marriage worldwide. Thus, we aimed to clarify the factors influencing breastfeeding continuation, especially from the perspective of inequality and mother's age in Bangladesh, using data from the Bangladesh Demographic and Health Survey 2011. Event history analyses were performed during a 24-month follow-up period on 7,041 mothers with duration of breastfeeding as the outcome variable, with wealth index (an indicator for inequality) and mother's age used as the main explanatory variables. The results showed that poorer mothers were on the whole more likely to continue breastfeeding through 24 months after childbirth, and younger mothers were less likely to continue breastfeeding particularly past the first year. However, both younger and older mothers continued breastfeeding to the same extent within the first year after childbirth. Mother's age had time-varying effects on breastfeeding continuation, meaning that the effects on breastfeeding continuation were affected by the child's age. These findings imply that policymakers should be aware that efforts to reduce child marriage may increase the rate of breastfeeding continuation beyond the first year after childbirth. In contrast, efforts at poverty alleviation, aimed at preventing child marriage, may decrease the rate irrespective of the child's age.

Keywords: breastfeeding continuation; event history analysis; inequality; mother's age; time-varying by child's age
Tohoku J. Exp. Med., 2018 September, **246** (1), 15-25.

Introduction

The World Health Organization (WHO) recommends continuing breastfeeding up to 2 years of age or beyond (WHO 2018). Breastfeeding promotes the cognitive and socioemotional development of children (Prado and Dewey 2014) and leads to higher intelligence, educational attainment, and subsequently higher incomes (Victora et al. 2016). Breastfeeding may also contribute to the community and country's economic development (Rollins et al. 2016). The rates and duration of breastfeeding varies greatly by country. According to the website of United Nations Children's Fund (UNICEF 2018), continued breastfeeding rates—defined as those for children aged 20-23 months—vary from less than 10% to approximately 90% around the world. The countries with the highest rates in the world are Bangladesh and Nepal. The breastfeeding rate in Bangladesh was 90.8% in 1993-1994, 93.6% in 1996-1997, 89.9% in 1999-2000, 94.0% in 2004, 91.0% in 2007, 89.6% in 2011, and 87.3% in 2014; it decreased after 2004 and recently fell below the 1990s level (UNICEF 2018). In addition, the duration of breastfeeding is shorter in higher- than in middle- and lower-income countries (Victora et al. 2016); Bangladesh is currently in transition from a lower- to a middle-income country (World Bank 2016). Hence, effective measures are required in Bangladesh to maintain the breastfeeding rate and counter its current downward trend.

In addition to inter-country inequality, previous studies have investigated the impact of intra-country inequality on breastfeeding practice in many countries; however, some findings have been incompatible. Some studies have shown that mothers from low-income populations cease breastfeeding earlier (Bailey et al. 2004; Coulibaly et al. 2006), but another study has reported that poorer mothers tend to breastfeed longer than richer mothers (Victora et al. 2016). However, to our knowledge, the factors leading to the downward trend in the breastfeeding rate in Bangladesh have not been studied from the perspective of inequality. For example, Akter and Rahman (2010) analyzed breast-

Received June 18, 2018; revised and accepted August 20, 2018. Published online September 13, 2018; doi: 10.1620/tjem.246.15.
Correspondence: Isao Igarashi, Department of Health Care Economics, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University, 1-5-45 Yushima, Bunkyo-ku, Tokyo 113-8549, Japan.
e-mail: igarashi.hce@tmd.ac.jp

feeding practice in Bangladesh and its contributing factors, but did not include wealth- or income-related inequality. Therefore, for the sake of promoting breastfeeding continuation conforming with WHO standards, it is necessary to investigate how breastfeeding patterns are influenced by inequality, i.e., the poverty issue.

Moreover, previous studies have reported that younger mothers cease breastfeeding earlier than older mothers (McKechnie et al. 2009; Thulier and Mercer 2009). Bangladesh's child marriage rate is one of the highest in the world, with 52% of girls getting married before the age of 18 (Barr 2016). While Bangladesh's government has committed to taking steps to end child marriage, amendments to the Child Marriage Restraint Act in 2017 reduced the legal age of marriage for girls from 18 to 16 years in special cases. If cessation of breastfeeding before 24 months of age is observed more often in younger than in older mothers, the lowered marriage age for girls may be reconsidered from the perspective of breastfeeding continuation. However, it is thought that child marriage is the result of several factors, including poverty, social norms, and natural disasters (Human Rights Watch 2015). Thus, countermeasures for such factors may be more complex than raising the legal age of marriage to prevent the early cessation of breastfeeding. In other words, we should consider the confounding relations between such factors and the age of mothers, i.e., mother's juvenility.

Taking countermeasures for each factor separately and concurrently may be effective if multivariate analysis demonstrates that both poverty and mother's juvenility lead to a shorter breastfeeding duration. If one factor leads to a shorter duration, but another leads to a longer, the countermeasures to be taken may be more complicated. Therefore, the purpose of the present study was to clarify the influence of inequality and mothers' age on breastfeeding continuation after adjusting for potentially relevant determinants.

Materials and Methods

Data

We used data from Demographic and Health Surveys (DHS), which were nationally-representative household surveys implemented in over 90 countries by ICF (formerly the "Inner City Fund") International under the financial support of the United States Agency for International Development to understand health and population trends in developing countries. We obtained approval from ICF International and downloaded anonymous datasets for the Bangladesh Demographic and Health Survey (BDHS) 2011, in which a questionnaire survey was conducted from July 8 to December 27, 2011 in collaboration with the National Institute of Population Research and Training (NIPORT) of the Ministry of Health and Family Welfare of Bangladesh, and Mitra and Associates, a Bangladeshi research firm. In that survey, a two-stage stratified sampling strategy was adopted. In the first stage, 600 primary sampling units (207 from urban areas and 393 from rural areas) were selected from the sampling frame created for the 2011 Bangladeshi census. In the second stage, households were randomly nominated from each primary sampling unit. Next, of 17,964 households selected, interviews were successfully completed in 17,141. Finally, within these households, a total of 18,222 currently- or formerly-married women aged 12-49 years were identified, 17,842 of whom were interviewed. The response rate was 98% (NIPORT et al. 2013).

Among all respondents, 7,127 answered that their last child ("last" is omitted hereinafter) born in the preceding 5 years was still alive at the time of the interview. They were then asked about their breastfeeding practice with that child. Thirty-six respondents provided no answer or internally inconsistent information about the practice and 50 replied that they had never breastfed their child. In total, our event history analyses included 7,041 respondents.

In the BDHS 2011, informed consent was orally obtained from the participants and recorded by interviewers at the beginning of the interviews (NIPORT et al. 2013). This study involving secondary analyses of the dataset was approved by the Institutional Review Board of Tokyo Medical and Dental University (Approval No. D2016-070).

Outcome

In the present study, the key issue was whether mothers continued breastfeeding until the child reached 24 months of age. We used duration of breastfeeding from the datasets as the outcome variable. Technically speaking, we prepared two variables from the outcome variable. The first was a binary variable that had a value of 1 if the mother stopped breastfeeding before the 24th month (as 0th month just after birth; the same hereinafter), and 0 otherwise. For example, if the child was breastfed at the time of the interview regardless of age, the value was 0. The value was also 0 if breastfeeding was stopped at the 24th month or later in the case that the child's age was 24 months or older at the time of the interview. These examples represent cases of censored observation. The second variable was analysis time, defined as the month of the child's age when the mother stopped breastfeeding or was asked in an interview if she still breastfed. The value was the same as that for the duration of breastfeeding if it was 24 or less, but 24 if higher.

Explanatory variables

As a key explanatory variable, we chose the wealth index from the datasets to analyze the association between inequality and breastfeeding continuation. In many DHS, the wealth index was created using data on the possession of household assets through principal components analysis, and was used as a proxy indicator for household economic status (NIPORT et al. 2013). It was shown in the datasets as quintile categories from poorest to richest. Another key explanatory variable was the respondent's age at childbirth. We calculated this by month by subtracting the child's from the respondent's age at the interview. In addition, we used the following 15 other kinds of variables available in the dataset: (i) mother's educational level, (ii) religion, (iii) frequency of reading newspapers or magazines, (iv) frequency of listening to the radio, (v) frequency of watching television, (vi) place of residence, (vii) affiliation with microcredit organizations, (viii) sex of child, (ix) currently living with husband, (x) person who usually decides on the respondent's healthcare, (xi) number of antenatal care visits during pregnancy, (xii) place of delivery, (xiii) whether qualified doctor assisted delivery, (xiv) delivery by caesarean section, and (xv) time of first breastfeeding. We created the variable "affiliation with microcredit organizations" by combining eight relevant variables.

Statistical analyses

We carried out event history analyses to identify the distribution of the duration of breastfeeding and its determinants. In the present study, we use the term 'event history analysis', which is well known as survival analysis, because the outcome was the cessation of breastfeeding as opposed to mortality. First, we nonparametrically estimated the Kaplan-Meier breastfeeding continuation function and graphed the curve. Second, we performed Cox regression analysis, which was semiparametric and representative of the event history analyses, to clarify the determinants. Third, we attempted a parametric event history analysis. We used Stata version 13 for all analyses (StataCorp, College Station, TX, USA).

Before the second analysis, we tried a preliminarily Cox regression with the 17 explanatory variables listed above and made sure of departures from the proportional-hazards (PH) assumption on seven kinds of variables with PH tests with Schoenfeld residuals ($p < 0.10$). The Cox model is typically based on the PH assumption, for which the hazards of any two subjects are proportional throughout the analysis time. The seven kinds of variables were religion, place of residence, respondent's age at childbirth, sex of child, currently living with husband, number of antenatal care visits during pregnancy, and time of first breastfeeding. Thus, we added the interaction terms of the variables with analysis time (≥ 12th month) to the Cox model to cope with non-proportional hazards. In addition, we used the Breslow method to handle tied records of breastfeeding cessation in the Cox regression. As the follow-up period was 24 months, the analysis time was set as up to 24 months to examine whether breastfeeding was continued in accordance with WHO recommendations.

In addition, we graphed the preliminary baseline cumulative hazard function from the 0th to the 60th month after the preliminary Cox regression to choose a parametric event history model. This procedure for estimating a baseline hazard only aimed to choose a parametric event history model rather than attempting to directly estimate the hazard from breastfeeding cessation because baseline hazard is already a part of the entire hazard. Then, the curve monotonically increased throughout the entire period and it broadly appeared to be convex downward before around the 30th month, but convex upward after that (Fig. 1); furthermore, we found that it rose sharply every 6 months. Thus, we assumed that the Gompertz distribution was the most similar to the shape of the curve during the 24-month follow-up period among the three baseline hazard distributions of parametric event history PH models that Stata provided, i.e., exponential, Weibull and Gompertz distributions. In determining a suitable distribution, exponential distribution may be assumed if the curve linearly increased. A Weibull distribution might be assumed if the curve monotonically increased and was convex upward during the follow-up period. Therefore, a parametric model with a Gompertz baseline hazard distribution was selected. Moreover, to reflect the sharp rise of the curve that is observed every 6 months, we used three month dummies—the 6th, 12th, and 18th month—whose values were 1 if the analysis time was 6, 12, or 18, respectively, and 0 otherwise.

First, we assumed the Gompertz model, whose baseline hazard was a function of the analysis time, comprising all 17 explanatory variables and their ancillary terms to examine whether the PH assumption was satisfied for each variable. Each ancillary term was defined as the product of an explanatory variable and analysis time. As a result, the coefficients (γ) of the ancillary terms were statistically significant regarding the seven kinds, which was the same as the case of the Cox model, whose effects on outcome varied with analysis time. In other words, the other 10 kinds of variables having insignificant γ satisfied the PH assumption. Therefore, we constructed a final Gompertz model with all explanatory variables, three month dummies, and the ancillary terms of all seven kinds.

Hazard rate in the PH model is expressed as:

$$h(t) = h_0(t)\exp(\mathbf{X}\boldsymbol{\beta}_x) \quad (1)$$

where t is analysis time (month of child's age) and $h_0(t)$ is the baseline hazard. $\mathbf{X}\boldsymbol{\beta}_x$ is the linear component of the model and $\mathbf{X}$ and $\boldsymbol{\beta}_x$ denote the matrix of explanatory variables and the coefficients' vec-

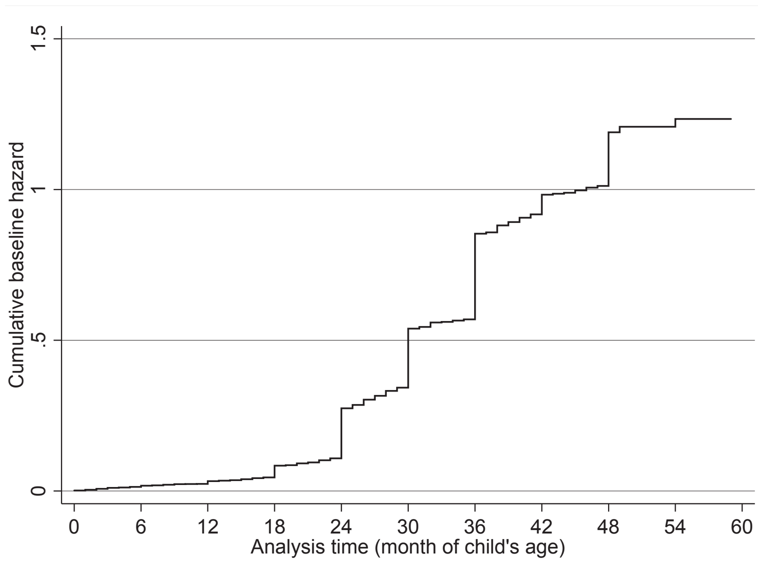

Fig. 1. Cumulative baseline hazard estimates after preliminary Cox regression including no interaction term with analysis time.
The curve monotonically increased throughout the entire period and it broadly appeared to be convex downward before around the 30th month, but convex upward after that. The shape of the curve implied a Gompertz baseline hazard distribution during the 24-month follow-up period after childbirth.

tor, respectively. β_x is the coefficient of a certain explanatory variable x and exp(β_x) represents the hazard ratio (HR) of x. In the case of the Cox model, the baseline hazard is not typically estimated; however, it is assumed in the case of the Gompertz model with the following general formula:

$$h_0(t) = \exp(\gamma t)\exp(\beta_0) \quad (2)$$

where γ is an ancillary parameter estimated from the data and β_0 is the intercept of the linear component in a logical sense (Cleves et al. 2016). Moreover, out of explanatory variables **X**, letting **Z** in particular be those assumed to have non-proportional hazards, the baseline hazard of the Gompertz model can be written from equation (2) as follows:

$$h_0(t) = \exp((\gamma_0+\mathbf{Z}\boldsymbol{\gamma}_z)t)\exp(\beta_0) \quad (3)$$

where γ_0 is the ancillary constant and $\boldsymbol{\gamma}_z$ is the ancillary coefficients' vector of **Z** in the baseline hazard. From equations (1) and (3), the hazard function of the Gompertz model in the present study is expressed as:

$$h(t) = \exp((\gamma_0+\mathbf{Z}\boldsymbol{\gamma}_z)t)\exp(\beta_0)\exp(\mathbf{X}\boldsymbol{\beta}_x+\mathbf{Z}\boldsymbol{\beta}_z)$$
$$= \exp(\gamma_0 t+\beta_0)\exp(\mathbf{Z}(\boldsymbol{\gamma}_z t+\boldsymbol{\beta}_z))\exp(\mathbf{X}\boldsymbol{\beta}_x) \quad (4)$$

Then, the HR of some specific z in substance equals $\exp(\beta_z) * (\exp(\gamma_z))^t$ in the Gompertz model.

Results

The basic statistics of the explanatory variables are shown in Table 1. Among all respondents, 28% had no education and 90% were Muslim. Moreover, 84% and 91% did not read newspapers/magazines or listen to the radio,

Table 1. Basic statistics of explanatory variables (currently- and formerly-married women, n = 17,842).

Variable	n (%)[a]	Variable	n (%)[a]
Wealth index		**Sex of child**[b]	
Poorest	3,096 (18.3)	Male	8,607 (53.6)
Poorer	3,345 (19.6)	Female	7,418 (46.4)
Middle	3,428 (20.1)	**Currently living with husband**[c]	
Richer	3,777 (20.6)	Yes	14,686 (87.8)
Richest	4,196 (21.3)	No	2,015 (12.2)
Respondent's educational level		Missing	3 (0.0)
None	4,639 (27.7)	**Person who usually decides on respondent's healthcare**[c]	
Primary	5,332 (30.0)	Respondent alone	2,224 (12.9)
Secondary	6,406 (35.0)	Respondent and husband	8,456 (50.1)
Higher	1,465 (7.3)	Husband alone	4,951 (30.6)
Religion		Someone else	1,022 (6.0)
Muslim	15,845 (90.0)	Other	33 (0.2)
Hinduism	1,913 (9.5)	Missing	18 (0.1)
Other	84 (0.5)	**Antenatal care visits during pregnancy**[d]	
Reading newspapers		None	2,445(35.4)
Not at all	14,800 (84.4)	Once	1,030 (15.3)
Less than once a week	1,788 (9.2)	Twice	985 (13.4)
At least once a week	1,238 (6.3)	Three times or more	2,858 (35.9)
Missing	16 (0.1)	Missing	7 (0.08)
Listening to the radio		**Place of delivery**[d]	
Not at all	16,243 (90.7)	Respondent's home	5,209 (73.5)
Less than once a week	749 (4.5)	Hospital or other	2,115 (26.5)
At least once a week	845 (4.7)	Missing	1(0.0)
Missing	5 (0.0)	**Doctor's assistance with delivery** [d]	
Watching television		Yes	1,612 (20.6)
Not at all	6,807 (39.2)	No	5,713 (79.4)
Less than once a week	2,140 (12.3)	**Caesarean section**[d]	
At least once a week	8,891 (48.4)	No	6,146 (84.8)
Missing	4 (0.0)	Yes	1,168(15.1)
Area of residence		Missing	11 (0.1)
Urban	6,196 (26.0)	**First breastfeeding**[e]	
Rural	11,646 (74.0)	Within 1 h	3,411(46.4)
Affiliation with microcredit organizations		1-24 h	3,173 (44.4)
No	11, 556 (65.1)	After 24 h	603 (9.0)
Yes	6,286 (34.9)	Missing	18 (0.2)
Respondent's age (y) at childbearing[b]			
12-17	1,775 (11.2)		
18-23	6,021 (38.0)		
24-29	4,995 (30.7)		
30-35	2,525 (15.7)		
36-41	662 (4.1)		
42-47	47 (0.3)		
(Mean: 24.9)			
(Standard deviation: 5.87)			
(Range: 12.83 (12 y 10 m) to 46.92 (46 y 11 m))			

[a]Adjusted for individual sample weight (NIPORT et al. 2013).
[b]Applicable for 16,025 respondents who had given birth to one or more children.
[c]Applicable for 16,704 respondents who were currently married at the time of the interview.
[d]Applicable for 7,325 respondents who had given birth to one or more children within the previous 5 years from the interview.
[e]Applicable for 7,205 respondents who had breastfed their last child within the previous 5 years from the interview.

respectively, but 61% watched television at least once a week. Further, 74% of the respondents resided in a rural area and 35% were affiliated with a microcredit organization. In addition, 11%, 38%, and 31% bore their children at the ages of less than 18, 18-23, and 24-29 years, respectively. Regarding sex, 54% of the children were boys. Further, 88% of the respondents reported lived with their husbands, and 50% and 13% reported that healthcare decisions were usually made by her and her husband jointly and by herself alone, respectively. In addition, 65% of the respondents reported receiving antenatal care at least once during pregnancy. Regarding childbirth, 73% of the respondents delivered their child at home, 21% were assisted by a qualified doctor, and 15% gave birth by Caesarean section. In total, 46% of the respondents reported breastfeeding their child within 1 h after birth.

As shown in Table 2, out of 7,041 mothers, 3,018 were breastfeeding their child aged 23 months or younger at the time of the interview, and 3,347 were breastfeeding their child at the beginning of the 24th month. However, 676 mothers had ceased breastfeeding their child aged 23 months or younger before the interview. A Kaplan-Meier estimation indicated that 98.2% of the mothers had continued breastfeeding at the end of the 5th month, 96.9% at the end of the 11th, 94.2% at the end of the 17th, and 86.6% at the end of 23rd (just before the child reached 2 years of age). The rate of breastfeeding dropped by 1.1% and 4.8% at the 12th and 18th months, respectively (Fig. 2).

The results of the multivariate event history analyses are shown in Table 3. Regarding the 10 kinds of explanatory variables with the PH assumption, the HRs and p-values were almost the same between the Cox and Gompertz models. The HRs of the wealth index were significant and showed that the poorest, poorer, middle, and richer mothers were less likely to discontinue breastfeeding than the richest by 43%, 53%, 42%, and 24% / 23% (in the case of the Cox/Gompertz model), respectively ($p < 0.05$; the same hereinafter except otherwise noted). Mothers who did not read newspapers or magazines, or who only read them less than once a week, were 32% and 40% less likely to cease breastfeeding than those who read them at least once a week, respectively. Mothers who listened to the radio less than once a week were 35% less likely to cease breastfeeding than those who listened at least once a week ($p < 0.10$). Mothers whose healthcare was decided by someone else were 38% less likely to discontinue breastfeeding than those who decided on healthcare by themselves.

On the other hand, the results of the seven kinds of explanatory variables with non-proportional hazards were as follows. The results of the Cox model showed that both Muslim and Hindu mothers stopped breastfeeding equally in year 0 of the child's age (0-11 months), but Muslim mothers were more likely than Hindu mothers (HR 3.2) to stop breastfeeding in year 1 (12-23 months). The results of

Table 2. Frequency of the mothers' breastfeeding practices.

Analysis time[a] (child's age)	Censored[b]	Failure[c]	Total
Months			
0	98	18	116
1	168	21	189
2	138	31	169
3	130	24	154
4	128	13	141
5	128	17	145
6	126	31	157
7	130	10	140
8	136	16	152
9	138	15	153
10	144	4	148
11	147	3	150
12	140	61	201
13	147	13	160
14	130	10	140
15	108	20	128
16	111	20	131
17	128	14	142
18	109	219	328
19	106	9	115
20	91	32	123
21	121	15	136
22	108	34	142
23	108	26	134
Sub-total	3,018	676	3,694
24	3,347	0	3,347
Total	6,365	676	7,041

[a]Analysis time, Child's age at the time of the interview in the case of censored; at the time of breastfeeding cessation in the case of failure.
[b]Censored, Continuation of breastfeeding at the time of the interview.
[c]Failure, Cessation of breastfeeding before the time of the interview.

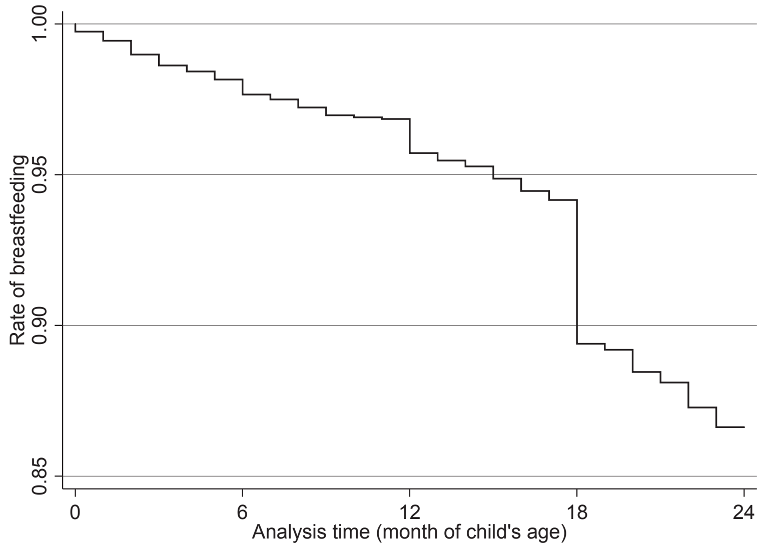

Fig. 2. Kaplan-Meier breastfeeding continuation estimates.
In total, 98.2%, 96.9%, 94.2%, and 86.6% of the mothers had continued breastfeeding at the end of the 5th, 11th, 17th, and 23rd months, respectively. The rate of breastfeeding dropped by 1.1% and 4.8% at the 12th and 18th months, respectively.

the Gompertz model showed that Muslim mothers were less likely than Hindu mothers (HR 0.4) to stop breastfeeding at month 0 of the child's age, but the HR raised by 12% every month after that. Similarly, mothers residing in urban compared with rural areas were more likely (HR 1.8) to stop breastfeeding in year 0, but the HR decreased by 36% in year 1 in the Cox model. In addition, mothers in urban compared with rural areas were more likely (HR 2.3) to stop breastfeeding at month 0, but the HR declined by 4.2% every month after that in the Gompertz model. Although mother's age at childbirth was not a significant factor in year 0 of the child's age, the HR significantly decreased by 2.9% ($p < 0.10$) for each 1-year increase in mother's age in year 1 of the child's age in the Cox model. Moreover, mother's age at childbirth was not significant at month 0 of the child's age, but the HR significantly decreased by 0.2% for each 1-year increase in mother's age, and for each month of the child's age in the Gompertz model. Mothers having a boy compared with a girl were more likely (HR 1.5) to stop breastfeeding in year 0 of the child's age, but the HR declined by 40% in year 1 in the Cox model. In addition, mothers having a boy compared with a girl were more likely (HR 1.8) to stop breastfeeding at month 0, but the HR decreased by 4.0% every month in the Gompertz model. Mothers living both apart from and together with their husbands stopped breastfeeding equally in years 0 and 1 in the Cox model and at month 0 in the Gompertz model, but the HR increased by 5.1% every month in the Gompertz model. The results of the Cox model showed that mothers who both did and did not receive antenatal care once, twice, and three times or more during pregnancy stopped breastfeeding equally in year 0, but those who did receive antenatal care once, twice, and three times or more were less likely by 39% ($p < 0.10$), 60%, and 46%, respectively, to stop breastfeeding in year 1 compared with those who did not. The results of the Gompertz model showed that mothers who received antenatal care twice and three times or more compared with those who did not were more likely (HRs 1.9 and 1.6, respectively; $p < 0.10$ for both) to stop breastfeeding at month 0, but the HRs decreased by 6.2% and 4.0%, respectively, every month. Mothers who first breastfed their child 24 h after delivery were more likely than those who first breastfed their child within 1 h (HR 2.0) to stop breastfeeding in year 0, but the HR declined by 51% in year 1 in the Cox model. In addition, those who first breastfed their child from 1-24 h and 24 h after delivery in the same reference group were more likely (HRs 1.4 and 2.9, respectively; $p < 0.10$ for only the group from 1-24 h) to stop breastfeeding at month 0, but the HR of those who did so 24 h after delivery decreased by 6.2% every month in the Gompertz model. The Gompertz model also showed that mothers were 1.9, 3.8, and 12.5 times more likely to stop breastfeeding at the 6th, 12th, and 18th month, respectively, compared with the other months.

Discussion

The main findings of the present study were that both inequality and mother's age were significant determinants of breastfeeding continuation until 24 months of age in children in Bangladesh; poorer mothers were on the whole more likely to continue breastfeeding for 24 months after childbirth, but younger mothers were less likely to continue past the first year after childbirth. In addition, some factors, such as mother's age, affected breastfeeding practice differently based on the age of the child. Indeed, mother's age was not so significant a factor when their child was less than 1 year old.

Table 3. Results of multivariate event history analyses (failure: cessation of breastfeeding).

	Cox model		Gompertz model	
	Hazard ratio	P-value	Hazard ratio (Exponential of β)	P-value
Wealth index (ref. Richest)				
Poorest	0.567	0.001	0.570	0.001
Poorer	0.470	0.000	0.471	0.000
Middle	0.582	0.000	0.584	0.000
Richer	0.764	0.024	0.767	0.027
Respondent's educational level (ref. Higher)				
No education	0.758	0.157	0.758	0.157
Primary	0.815	0.227	0.815	0.228
Secondary	0.936	0.647	0.938	0.657
Religion (ref. Hinduism)				
Muslim	0.751	0.194	0.401	0.002
Other	0.788	0.816	0.299	0.467
Reading newspapers (ref. At least once a week)				
Not at all	0.680	0.010	0.683	0.011
Less than once a week	0.600	0.002	0.601	0.002
Listening to the radio (ref. At least once a week)				
Not at all	0.775	0.137	0.775	0.137
Less than once a week	0.652	0.090	0.648	0.085
Watching television (ref. At least once a week)				
Not at all	1.005	0.965	1.007	0.948
Less than once a week	1.076	0.593	1.071	0.619
Area of residence (ref. Rural)				
Urban	1.755	0.000	2.305	0.000
Affiliation with microcredit organizations (ref. Yes)				
No	1.115	0.224	1.117	0.215
Respondent's age at childbirth	1.003	0.833	1.013	0.440
Sex of child (ref. Female)				
Male	1.473	0.009	1.796	0.003
Currently living with husband (ref. Yes)				
No	0.984	0.941	0.616	0.110
Person who usually decides the respondent's healthcare (ref. Respondent alone)				
Respondent and husband	0.871	0.267	0.872	0.273
Husband alone	0.854	0.245	0.859	0.263
Someone else	0.616	0.019	0.617	0.020
Other	0.540	0.542	0.543	0.545
Antenatal care visits (ref. None)				
Once	1.508	0.116	1.366	0.369
Twice	1.493	0.118	1.888	0.057
Three times or more	1.402	0.112	1.592	0.083
Place of delivery (ref. Respondent's home)				
Hospital or other	0.908	0.552	0.905	0.540
Doctor's assistance with delivery (ref. No)				
Yes	1.175	0.421	1.187	0.394
Caesarean section (ref. Yes)				
No	1.214	0.243	1.223	0.227
First breastfeeding (ref. Within 1 h)				
1-24 h	1.253	0.153	1.420	0.093
After 24 h	2.006	0.002	2.868	0.000
Month dummy				
6th month	–	–	1.931	0.001
12th month	–	–	3.783	0.000
18th month	–	–	12.524	0.000
Constant	–	–	0.003	0.000
	Interaction with t (≥ 12th month)		Baseline hazard	
	Hazard ratio	P-value	Exponential of γ	P-value
Religion: Muslim	3.227	0.000	1.120	0.000
Religion: Other	1.482	0.786	1.108	0.375
Place of Residence: Urban	0.642	0.016	0.958	0.002
Respondent's age at childbirth	0.971	0.054	0.998	0.044
Sex of child: Male	0.605	0.004	0.960	0.002
Currently living with husband: No	1.410	0.160	1.051	0.007
Antenatal care visits: Once	0.608	0.096	0.981	0.387
Antenatal care visits: Twice	0.405	0.003	0.938	0.004
Antenatal care visits: Three times or more	0.540	0.009	0.960	0.014
First breastfeeding: 1-24 h	0.901	0.573	0.986	0.292
First breastfeeding: After 24 h	0.487	0.012	0.938	0.003
Constant	–	–	1.067	0.110
Number of respondents	6,878		6,878	
Number of failures	648		648	
Log-likelihood	–5,376.1245		–2,168.1256	

ref, Reference category; t, Analysis time (month of child's age).

Table 4. Non-proportional hazard ratios calculated from estimates of the Cox/Gompertz models without considering p-values.

	Religion		Area of Residence		Sex of child	Living with husband	Antenatal care visits			First breastfeeding	
Child's age	Muslim	Other	Urban	Respon-dent's age	Male	No	Once	Twice	Three times or more	1 to 24 h	After 24 h
(Cox model) Year											
0	0.751	0.788	1.755	1.003	1.473	0.984	1.508	1.493	1.402	1.253	2.006
1	2.424	1.168	1.126	0.973	0.890	1.387	0.917	0.604	0.758	1.129	0.978
(Gompertz model) Month											
0	0.401	0.299	2.305	1.013	1.796	0.616	1.366	1.888	1.592	1.420	2.868
1	0.449	0.332	2.208	1.011	1.725	0.648	1.341	1.771	1.528	1.400	2.691
2	0.503	0.368	2.115	1.009	1.656	0.681	1.315	1.661	1.466	1.380	2.525
3	0.563	0.408	2.026	1.006	1.591	0.716	1.290	1.559	1.407	1.360	2.369
4	0.631	0.452	1.941	1.004	1.528	0.753	1.266	1.462	1.350	1.341	2.223
5	0.707	0.501	1.859	1.002	1.468	0.792	1.242	1.371	1.295	1.321	2.086
6	0.792	0.555	1.781	0.999	1.410	0.832	1.219	1.286	1.243	1.302	1.958
7	0.887	0.615	1.706	0.997	1.354	0.875	1.196	1.207	1.192	1.284	1.837
8	0.994	0.682	1.634	0.995	1.301	0.920	1.173	1.132	1.144	1.265	1.724
9	1.113	0.756	1.565	0.993	1.249	0.968	1.151	1.062	1.098	1.247	1.618
10	1.247	0.838	1.500	0.990	1.200	1.017	1.129	0.996	1.053	1.229	1.518
11	1.397	0.929	1.437	0.988	1.152	1.070	1.108	0.934	1.011	1.212	1.424
12	1.565	1.029	1.376	0.986	1.107	1.125	1.087	0.876	0.970	1.194	1.336
13	1.753	1.141	1.318	0.983	1.063	1.183	1.066	0.822	0.931	1.177	1.254
14	1.964	1.264	1.263	0.981	1.021	1.243	1.046	0.771	0.893	1.160	1.177
15	2.200	1.401	1.210	0.979	0.981	1.307	1.027	0.723	0.857	1.144	1.104
16	2.464	1.553	1.159	0.977	0.942	1.375	1.007	0.679	0.822	1.127	1.036
17	2.761	1.722	1.110	0.974	0.905	1.445	0.988	0.637	0.789	1.111	0.972
18	3.092	1.908	1.063	0.972	0.869	1.520	0.969	0.597	0.757	1.095	0.912
19	3.464	2.115	1.019	0.970	0.835	1.598	0.951	0.560	0.726	1.079	0.856
20	3.880	2.344	0.976	0.968	0.802	1.680	0.933	0.525	0.697	1.064	0.803
21	4.347	2.598	0.935	0.966	0.770	1.766	0.916	0.493	0.669	1.049	0.754
22	4.869	2.880	0.896	0.963	0.740	1.857	0.898	0.462	0.642	1.034	0.707
23	5.454	3.192	0.858	0.961	0.710	1.953	0.881	0.434	0.616	1.019	0.664

Poverty and mother's age

Globally, the rate of continued breastfeeding has been declining, especially in poor populations (Rollins et al. 2016). Some studies have indicated that low-income mothers breastfeed their children for shorter periods in Canada and the UK (Bailey et al. 2004; Coulibaly et al. 2006), but another reported that poorer mothers in many countries tend to breastfeed longer than their richer counterparts (Victora et al. 2016). The results of the present study showed that mothers in poorer households were on the whole less likely to cease breastfeeding before their child was 24 months of age, although the order was reversed between the poorest and the poorer. A probable explanation for this is that breastmilk substitutes such as infant formula are not affordable for low-income mothers, who consequently continue breastfeeding longer than high-income mothers (Chia 1992; Roy et al. 2002).

Previous studies have shown that younger mothers are likely to terminate breastfeeding early (Feinstein et al. 1986; McKechnie et al. 2009). Our study showed the same results, particularly when children were 1 year of age. This association was estimated separately from the effect of the wealth index through multivariate analyses. In other words, we assumed that wealth inequality and mother's age separately affected breastfeeding practice, rather than assuming that poverty led to childhood marriage and subsequently affected breastfeeding practice. If a pathway from poverty to earlier age of mothers at childbirth to their breastfeeding practices can be established, poverty alleviation might be more effective for promoting breastfeeding than child marriage prevention. However, as mentioned above, poor mothers tend to continue breastfeeding; this finding is consistent with the idea that inequality and mother's age separately affect breastfeeding practice rather than the notion of a serial pathway, despite the assumption that poverty is a factor in childhood marriage. Besides, logically, our significant result for the variable of mother's age does not negate the possibility that raising the legal age of marriage for girls could directly promote breastfeeding continuation. Indeed, adolescents are not fully developed in terms of physical maturity, cognitive capacity, and social skills (Bearinger et al. 2007). It should also be noted that the international standards regarding the minimum age of marriage are set at 18 years (Human Rights Watch 2015).

In addition, child marriage blocks access to education (Human Rights Watch 2015). In the present study, mother's educational level was not significant; however, the effect was estimated separately from those of age and wealth inequality. Thus, it is thought that education alone did not significantly affect breastfeeding practice. Besides, the results of our study showed that mothers who received antenatal care, especially twice and three or more times during pregnancy, were less likely to discontinue breastfeeding, particularly at year 1 of their child's age, compared with those who did not. Some studies have suggested that antenatal breastfeeding education increases the rate of exclusive breastfeeding at 1 and 6 months (Dhandapany et al. 2008; Lin et al. 2008). However, in this context, we cannot conclude that antenatal education is effective in promoting breastfeeding continuation because the BDHS 2011 did not ask respondents whether they received breastfeeding education at antenatal care visits. Indeed, a previous meta-analysis found no evidence that antenatal education improves breastfeeding practices in high-income countries, and indicated that further studies are required in low- and middle-income countries (Lumbiganon et al. 2016).

Unfortunately, we could not analyze the effects of social norms or natural disasters (such as river erosion) on breastfeeding, which are regarded as factors of childhood marriage. Moreover, we should note that we used mother's age at childbirth for the "last" child in our analyses, not the age at (first) marriage, because the BDHS 2011 investigated mothers' breastfeeding practices for their "last" child. Therefore, larger disparities likely exist between both ages for older mothers, which is one of reasons that such interpretations are difficult.

In short, preventing child marriage may promote breastfeeding continuation, but this may be hindered by Bangladesh's economic development and poverty reductions, while poverty alleviation may prevent child marriage. Besides, education promotion may not be effective in preventing the early cessation of breastfeeding, even though it can reinforce countermeasures for poverty and juvenility among mothers.

Comparison between the Cox and Gompertz models

The Cox model is semiparametric and does not require assuming the shape of the baseline hazard, while the parametric model, including the Gompertz model, always requires such a task, and a well-specified parametric model provides more efficient estimates than the Cox model. Both the Cox and Gompertz models are PH models, in which it is assumed that the HR is time-invariant between any two subjects (Cleves et al. 2016). However, preliminarily, we saw non-proportionality for the seven kinds of explanatory variables. To allow for non-proportionality, we divided the follow-up period by year in the Cox model and by month in the Gompertz model, and then put the interaction terms of the variables with time in the Cox model and the ancillary coefficients of time in the Gompertz model. If we do not consider p-values, despite the difference in the follow-up period units (year vs. month), the non-proportional HRs calculated from the results of the regression analyses look nearly the same between the Cox and Gompertz models, as shown in Table 4. Therefore, the two models are considered basically the same in terms of the interaction of the variables with time and provide similar results.

In the Cox model, in addition to dividing by year, we attempted to divide the follow-up period by 1 and 6 months; however, we chose the model with two periods from the results of PH tests using Schoenfeld residuals. In addition, we did not add month dummies in the Cox model because this did not change any HRs, p-values of other explanatory variables, or log-likelihoods, but it significantly improved model fitness in the Gompertz model. This is the advantage of using a parametric model like the Gompertz model.

On the other hand, we limited the follow-up period of the statistical models to up to 24 months in consideration of WHO recommendations. However, the Cox model is capable of handling extended periods of data availability if necessary; as far as the datasets used in the present study, the upper limit was the 59th month. By contrast, this limit could not be extended beyond around the 30th month in another model because we chose Gompertz distribution considering the shape of the preliminarily estimated cumulative baseline hazard. This is the advantage of the Cox model, which does not require assuming baseline hazards. Besides, the exponential of the constant in the baseline hazard of the Gompertz model was not statistically significant, and γ_0 in substance equaled 0 in equation (4); i.e., the overall baseline hazard was constant even though the shape indicated that it had monotonically increased, the rate of which also increased before around the 30th month. This finding suggests that a better specified parametric model may be possible.

In addition to the lack of a decisive advantage or disadvantage for both models, we could not compare model fitness between the two because partial likelihood is used for estimating the Cox model, while full likelihood is used for parametric models. Therefore, we employed both models.

Implications

As discussed above, breastfeeding practice is affected by mother's age, wealth inequality, and other factors. Unexpectedly, we found that some factors are time-varying; that is, the effects of such factors on breastfeeding vary depending on the age of the child. Researchers should note that employing event history analyses requires paying attention to the time-varying characteristics of some factors to avoid a time-dependent bias (Zhao et al. 2017). For example, Thu et al. (2012) reported that the exclusive breastfeeding rate was higher in rural than in urban areas at 1 and 3 months of age, but the reverse relation was observed at 6 months of age in Vietnam; this is similar to our results regarding the mother's residential area. In addition, they conducted Cox regressions separately in urban and rural mothers. However, to our knowledge, most of the previous studies on breastfeeding practice have not necessarily considered such characteristics. Regardless, the relationship between breastfeeding continuation and its determinants remains substantially complicated. Especially, poverty alleviation and the prevention of child marriage, both of which are serious issues in Bangladesh, may promote and discourage breastfeeding continuation, respectively. Policymakers should carefully and multi-dimensionally formulate policy designs for promoting breastfeeding practice conforming to WHO recommendations, taking potential factors and complications, as well as their potential changes based on the child's age, into account.

Limitations

The present study did have some limitations. First, the datasets included 7,325 records in which the respondents bore their last child within the past 5 years. However, 198 lost their child before the interview, and breastfeeding practices for deceased children were not queried in the BDHS 2011. Second, some respondents described their ongoing breastfeeding practice in the interviews, but others had to describe their practice from nearly 5 years previously; thus, some answers potentially contained a recall bias. Third, the dataset contained no information regarding whether the respondent resided in an urban slum area, where respondents would be expected to differ from those in other parts of urban areas. Fourth, both the Cox and Gompertz models used in the present study are better than the multivariate event history models that we tried; however, they may not be the best among all potential models at present or in the future. In contrast to these weak points, the sampling procedure and questionnaire design were well organized. In addition, the response rate was high and the sample size was relatively large. Therefore, the dataset is considered to have provided reliable information and the chance for minute analyses.

Conclusions

The results of the present study showed that both inequality and mother's age were significant determinants of breastfeeding continuation until 24 months of age in children in Bangladesh. In addition, some factors, including mother's age, affected breastfeeding practice differently based on the age of the child. Specifically, mothers who lived in richer households, read newspapers or magazines at least once a week, and listened to the radio at least once a week (compared with those who listened less than once a week) were more likely to cease breastfeeding from birth to 24 months of their child's age, but those whose healthcare was usually decided by someone else were less likely to cease breastfeeding during the same period. Mothers who lived in urban areas, had boys, and initiated breastfeeding 24 h after giving birth were more likely to cease breastfeeding, particularly at year 0 of their child's age. In addition, mothers who were younger, Muslim, lived away from their husbands, and did not receive antenatal care were more likely to cease breastfeeding, particular at year 1 of their child's age.

Acknowledgments

We are grateful to ICF international for giving us permission to conduct this secondary analysis.

Conflict of Interest

The authors declare no conflict of interest.

References

Akter, S. & Rahman, M.M. (2010) Duration of breastfeeding and its correlates in Bangladesh. *J. Health Popul. Nutr.*, **28**, 595-601.

Bailey, C., Pain, R.H. & Aarvold, J.E. (2004) A 'give it a go' breast-feeding culture and early cessation among low-income mothers. *Midwifery*, **20**, 240-250.

Barr, H. (2016) Huge Step Backwards on Child Marriage in Bangladesh. https://www.hrw.org/news/2016/12/01/huge-step-backwards-child-marriage-bangladesh [*Accessed*: May 4, 2018].

Bearinger, L.H., Sieving, R.E., Ferguson, J. & Sharma, V. (2007) Global perspectives on the sexual and reproductive health of adolescents: patterns, prevention, and potential. *Lancet*, **369**, 1220-1231.

Chia, S.F. (1992) A survey of breast feeding practices in infants seen in general practice. *Med. J. Malaysia*, **47**, 134-138.

Cleves, M., Gould, W. & Marchenko, Y.V. (2016) *An Introduction to Survival Analysis Using Stata*, Revised 3rd ed., Stata Press, College Station, TX.

Coulibaly, R., Séguin, L., Zunzunegui, M.V. & Gauvin, L. (2006) Links between maternal breast-feeding duration and Québec infants' health: a population-based study. Are the effects different for poor children? *Matern. Child Health J.*, **10**, 537-543.

Dhandapany, G., Bethou, A., Arunagirinathan, A. & Ananthakrishnan, S. (2008) Antenatal counseling on breastfeeding: is it adequate? A descriptive study from Pondicherry, India. *Int. Breastfeed J.*, **3**, 5.

Feinstein, J.M., Berkelhamer, J.E., Gruszka, M.E., Wong, C.A. & Carey, A.E. (1986) Factors related to early termination of breast-feeding in an urban population. *Pediatrics*, **78**, 210-215.

Human Rights Watch (2015) Marry Before Your House is Swept Away: Child Marriage in Bangladesh, New York, NY. https://www.hrw.org/report/2015/06/09/marry-your-house-swept-away/child-marriage-bangladesh [*Accessed*: May 4, 2018].

Lin, S.S., Chien, L.Y., Tai, C.J. & Lee, C.F. (2008) Effectiveness of a prenatal education programme on breastfeeding outcomes in Taiwan. *J. Clin. Nurs.*, **17**, 296-303.

Lumbiganon, P., Martis, R., Laopaiboon, M., Festin, M.R., Ho, J.J. & Hakimi, M. (2016) Antenatal breastfeeding education for increasing breastfeeding duration. *Cochrane Database Syst. Rev.*, **12**, CD006425.

McKechnie, A.C., Tluczek, A. & Henriques, J.B. (2009) Maternal variables influencing duration of breastfeeding among low-income mothers. *Infant Child Adolesc. Nutr.*, **1**, 126-132.

National Institute of Population Research and Training (NIPORT); Mitra and Associates; ICF International (2013) Bangladesh Demographic and Health Survey 2011. https://dhsprogram.com/publications/publication-FR265-DHS-Final-Reports.cfm [*Accessed*: May 4, 2018].

Prado, E.L. & Dewey, K.G. (2014) Nutrition and brain development in early life. *Nutr. Rev.*, **72**, 267-284.

Rollins, N.C., Bhandari, N., Hajeebhoy, N., Horton, S., Lutter, C.K., Martines, J.C., Piwoz, E.G., Richter, L.M. & Victora, C.G. (2016) Why invest, and what it will take to improve breastfeeding practices? *Lancet*, **387**, 491-504.

Roy, S.K., de Groot, S., Shafique, S. & Afroz, A. (2002) Perceptions of mothers and use of breastmilk substitutes in

Dhaka, Bangladesh. *J. Health Popul. Nutr.*, **20**, 264-270.

Thu, H.N., Eriksson, B., Khanh, T.T., Petzold, M., Bondjers, G., Kim, C.N.T., Thanh, L.N. & Ascher, H. (2012) Breastfeeding practices in urban and rural Vietnam. *BMC Public Health*, **12**, 964.

Thulier, D. & Mercer, J. (2009) Variables associated with breast-feeding duration. *J. Obstet. Gynecol. Neonatal Nurs*., **38**, 259-268.

United Nations Children's Fund (UNICEF) (2018) Infant and Young Child Feeding.
https://data.unicef.org/topic/nutrition/infant-and-young-child-feeding/#
[*Accessed*: May 4, 2018].

Victora, C.G., Bahl, R., Barros, A.J.D., França, G.V.A., Horton, S., Krasevec, J., Murch, S., Sankar, M.J., Walker, N. & Rollins, N.C. (2016) Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. *Lancet*, **387**, 475-490.

World Bank (2016) Helping Bangladesh Reach Middle Income Country Status.
http://www.worldbank.org/en/news/feature/2016/04/07/World_Bank_Group_s_New_Country_Partnership_Framework_helps_Bangladesh_Reach_Middle_Income_Country_Status
[*Accessed*: June 4, 2018].

World Health Organization (WHO) (2018) Infant and young child feeding.
http://www.who.int/news-room/fact-sheets/detail/infant-and-young-child-feeding
[*Accessed*: May 24, 2018].

Zhao, J., Zhao, Y., Lee, A.H. & Binns, C.W. (2017) A time-varying covariate approach for survival analysis of paediatric outcomes. *Paediatr. Perinat. Epidemiol.*, **31**, 598-602.