



Prevalence and predictors of exclusive breastfeeding among immigrant and Canadian-born Chinese women

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Abstract

Breastfeeding is the optimal method for infant feeding, yet migrant women may be at risk for suboptimal exclusivity rates. In a cohort of immigrant and Canadian-born Chinese women, our objectives were to (a) describe patterns and prevalence of exclusive breastfeeding at 1, 3, and 6 months postpartum; (b) identify risk and protective factors associated with exclusivity; and (c) examine potentially differential importance of these factors across this 6-month period. This was a prospective study of 565 immigrants and Canadian-born Chinese women (Toronto, Canada). Exclusive breastfeeding was measured at 1, 3, and 6 months postpartum. Predictors comprised fixed (demographics, history of depression, immigrant status, prenatal breastfeeding classes, in-hospital formula supplementation, baseline social support, and baseline acculturative stress) and time-dependent (depression, anxiety, fatigue, and breastfeeding problems) variables. Descriptive statistics, logistic regression, and generalized linear mixed models, respectively, were undertaken to address the objectives. Patterns of breastfeeding practices included exclusive breastfeeding in all time points (26.8%) or none (32.9%) and moving from exclusive to nonexclusive (20.3%) or nonexclusive to exclusive breastfeeding (15.2%). Women less likely to breastfeed exclusively at 1, 3, or 6 months were those whose infants received in-hospital formula supplementation. Exclusivity attrition was higher between 3 and 6 months than 1–3 months. Immigrant status and in-hospital formula supplementation had a significant impact on exclusivity earlier in the postpartum period while breastfeeding problems were associated with decreased exclusivity across time. Proactive preventive efforts are needed to maintain breastfeeding exclusivity especially between 3 and 6 months if women are to meet international breastfeeding recommendations.

KEYWORDS

breast feeding, emigrants and immigrants, postpartum period

1 | INTRODUCTION

Exclusive breastfeeding is the internationally endorsed infant feeding method for the first 6 months postpartum, but despite well-documented benefits (Bar, Milanaik, & Adesman, 2016; Binns, Lee, & Low, 2016; Moss & Yeaton, 2014; Ross-Cowdery, Lewis, Papić, Corbelli, & Schwarz, 2017) and significant health care costs savings

(Eidelman & Schanler, 2012), very few women worldwide meet this recommendation (World Health Organization, 2011). In the United States, following a breastfeeding initiation rate of 81%, only 44% of women exclusively breastfeed to 3 months, decreasing to 22% at 6 months (Centers for Disease Control and Prevention, 2016). In Canada, 89% of women initiate breastfeeding, but only 55% exclusively breastfeed to 3 months, falling to 26% at 6 months (Gionet,

2013). Similar low rates of exclusive breastfeeding are seen in other high-income countries (Organization for Economic Cooperation and Development, 2011). These rates are concerning given a possible dose–response effect, with health benefits being proportional to the extent of exclusive breastfeeding and duration of breastfeeding (Kramer et al., 2003; Kramer & Kakuma, 2002; Victora et al., 2015), suggesting most women and infants do not experience the full benefits of breastfeeding.

In most cases, exclusive breastfeeding discontinuation occurs early in the postpartum period. In the United States, infant formula supplementation is used by 17% of women before 2 days postpartum, increasing to 37% before 3 months (Centers for Disease Control and Prevention, 2016); similar rates are found in Canada (Gionet, 2013). Complete discontinuation of breastfeeding often occurs early in the postpartum period as well. By 1 month postpartum, 18.5% of Canadian women switch to infant formula and most do so within 1 week of delivery (Sheehan, Krueger, Watt, Sword, & Bridle, 2001; Sheehan, Watt, Krueger, & Sword, 2006). Common reasons for discontinuation include breastfeeding difficulties, perceived insufficient milk supply, and sore nipples (Mangrio, Persson, & Bramhagen, 2017; Rozga, Kerver, & Olson, 2015).

Breastfeeding initiation and duration are predicted by demographic factors (i.e., maternal age, marital status, education, employment, income, and smoking), reproductive factors (e.g., parity), professional and lay support, and hospital policies (Dennis, 2002; Kehler, Chaput, & Tough, 2009; Mathews, Leerkes, Lovelady, & Labban, 2014; Meedya, Fahy, & Kable, 2010; Thuiler & Mercer, 2009). However, predictors of exclusive breastfeeding have less frequently been examined (Kristiansen, Lande, Overby, & Andersen, 2010), particularly among potentially high-risk groups such as immigrant women. Given the rapidly growing immigrant population in North America and other high-income countries over the last three decades, this is a significant limitation. Immigrants account for 13% of the U.S. population (Brown & Patten, 2014) and 20.6% of the Canadian population (Statistics Canada, 2015), and there is growing evidence to suggest that migrant women may have higher fertility rates (Statistics Canada, 2017). These data reflect the need to understand patterns of breastfeeding in immigrant populations.

There is some evidence that immigrant women have higher breastfeeding initiation rates and longer duration than nonimmigrants (Millar & Maclean, 2005; Nolan & Layte, 2014; Singh, Kogan, & Dee, 2007; Tavoulari, Benetou, Vlastarakos, Kreatsas, & Linos, 2015; Vanderlinden, Levecque, & Rossem, 2015; Zuppa et al., 2010). In a study of 33,121 children in the United States, breastfeeding initiation rates were 76% in children of foreign-born parents and 70% in those of U.S.-born parents (Singh et al., 2007). Likewise, a study of 7,266 Canadian mothers showed that breastfeeding initiation rates were 92% in immigrant women and 83% in nonimmigrant women (Millar & Maclean, 2005). Other studies have found lower breastfeeding rates in immigrants (Busck-Rasmussen, Villadsen, Norsker, Mortensen, & Andersen, 2014; Groleau, Souliere, & Kirmayer, 2006; Sussner, Lindsay, & Peterson, 2008). A study of 42,420 infants born in Denmark found that non-Western immigrant women were less likely to breastfeed until 3 months (42.7% to 57.8%) than nonimmigrants (61.8%; Busck-Rasmussen et al., 2014). Discrepancies in the literature

Key messages

- The patterns and predictors of breastfeeding exclusivity among immigrant and Canadian-born Chinese women at 1, 3, and 6 months postpartum suggest that high-risk groups may need support to initiate and maintain exclusive breastfeeding to 6 months, as recommended.
- Formula supplementation and breastfeeding problems should be identified early in the postpartum period to guide breastfeeding advice and resources given to women.
- Future research should examine the specific cultural approaches that can be used to effectively address and support exclusive breastfeeding in immigrant women.

may be explained by factors such as acculturation, which is the process of adjusting to a new culture (Ahluwalia, D'Angelo, Morrow, & McDonald, 2012). Greater acculturation in immigrants has been associated with lower breastfeeding initiation and exclusivity rates (Ahluwalia et al., 2012). Other predictors may include challenges related to migration status, ethnicity, socio-economic status, and cultural differences.

In Canada, individuals who identify as Chinese are the second largest visible minority group, comprising 1.3 million residents (Statistics Canada, 2015). Although a previous study has found that Chinese-Canadian women's cultural beliefs about breastfeeding influence their decision to breastfeed (Chen, 2002), little is known about their breastfeeding rates and the role of migration on their infant feeding practices. Thus, in a cohort of Chinese-Canadian women, our objectives were to (a) describe patterns of exclusive breastfeeding across the first 6 months postpartum, including the prevalence of exclusive breastfeeding at 1, 3, and 6 months; (b) identify risk and protective factors that can be assessed early in the postpartum period that are associated with exclusive breastfeeding at 1, 3, and 6 months; and (c) examine whether factors are associated with exclusive breastfeeding across this 6-month period and determine factors associated with discontinuation in the early (1–3 months) versus later (3–6 months) periods.

2 | METHODS

2.1 | Sample and procedures

The data for the current study were derived from a larger cohort of 571 Chinese immigrant and Canadian-born women who were followed across the first year postpartum. Women were recruited in Toronto, Canada, via public health home visitors, community-based health organizations, advertisements in Chinese newspapers, and study flyers. After referral to or contact with the study coordinator, a research assistant matched on maternal language preference telephoned potentially eligible women to provide them with a detailed study explanation and to determine eligibility. Women who then

agreed to participate in the study and provided informed consent completed a baseline interview within 1 month postpartum and were telephoned again at 3, 6, and 12 months to complete follow-up interviews. Ethics approval for the study was obtained from the university.

Women were eligible if they (a) had a live birth; (b) were discharged home from hospital; (c) were <4 weeks postpartum; (d) were fluent in spoken English, Cantonese, or Mandarin; and (e) identified as a Chinese immigrant (i.e., born in Mainland China, Hong Kong, Taiwan, Vietnam, or Macau) or a Canadian-born Chinese woman. Women were excluded if (a) their infant was not discharged home with them at recruitment; (b) they had active thoughts of suicide or self-harm; or (c) they currently used antidepressant or antipsychotic medications. For this analysis, we focus on women who practiced exclusive breastfeeding at one of the data collection time points ($n = 565$). Overall, 558 women provided data at 1 month postpartum, 471 at 3 months, and 429 at 6 months.

2.2 | Measurement

The primary outcome was exclusive breastfeeding at 1, 3, and 6 months postpartum. Exclusivity was defined as providing breast milk only (which could include infrequent addition of vitamin supplements or medicines) without the provision of formula, cereals, juice, or other supplements. Women were dichotomously categorized as either exclusive breastfeeding or not (Labbok & Krasovec, 1990).

Predictors were composed of both fixed and time-dependent variables. At 1 month postpartum, fixed variables were background demographics: age (in years), parity (primiparous or multiparous), education level (\leq high school or $>$ high school), income adequacy ("How do you find you manage on your present family income?"; 4-point Likert-type scale), history of depression ("Have you previously suffered from depression or feeling prolonged sadness?"; yes/no), and immigrant status (immigrated <5 years ago; immigrated \geq 5 years ago; or born in Canada or immigrated before commencement of formal education at 6 years). Other fixed variables were breastfeeding measures assessed at 1 month postpartum as follows: breastfeeding class attendance prior to birth (yes/no), infant provided fluids other than breastmilk in hospital (yes/no), infant provided a pacifier in hospital (yes/no), and the provision of breastfeeding support following hospital discharge (yes/no). Finally, we included measures of social support and acculturative stress as fixed variables. Social support was measured using the 24-item Social Provisions Scale. Items are rated using a 4-point Likert-type scale, producing a total score ranging from 24 to 96, with higher scores indicating increased perception of support. The measure has good psychometric properties in diverse samples (Cutrona & Russell, 1987) and in postpartum women (Cutrona, 1984) and had a Cronbach's α of 0.91 at baseline. Acculturative stress was measured using the 36-item Acculturative Stress Index. Items are rated using a 4-point Likert-type scale, producing a total score ranging from 0 to 144, with higher scores indicating increased stress. The measure has good psychometric properties in Canadian Asian immigrants (Noh & Kaspar, 2003) and had a Cronbach's α of 0.93 at baseline.

The time-varying variables measured at each time point were depressive symptomatology, anxiety, fatigue, and breastfeeding

problems. Depressive symptomatology was assessed using the 10-item Edinburgh Postnatal Depression Scale (Cox, Holden, & Sagovsky, 1987), an internationally used measure that has good psychometric properties and is acceptable among those of Chinese origin (Lee et al., 1998). Items are rated on a 4-point Likert-type scale, producing a total score ranging from 0 to 30, with higher scores indicating increased depressive symptomatology. Cronbach's α s were between 0.78 and 0.79 across time points. Anxiety was assessed using the 20-item State subscale of the State-Trait Anxiety Inventory (Spielberger, 1983). Items are rated on a 4-point Likert-type scale, producing a total score ranging from 20 to 80, with higher scores indicating increased anxiety symptomatology. This scale has been widely used in Chinese populations (Zheng, Shu, Zhang, & Huang, 1993). Cronbach's α s were between 0.93 and 0.94 across time points. Fatigue was assessed using the 16-item Multidimensional Assessment of Fatigue Scale (Fairbrother, Hutton, Stoll, Hall, & Kluka, 2008), which measures fatigue according to dimensions of severity, distress, and interference with daily living activities; higher scores indicate increased fatigue. Cronbach's α s were between 0.81 and 0.87 across time points. Finally, at each time point, women were asked if they had experienced any breastfeeding problems (yes/no) since the last questionnaire.

2.3 | Statistical methods

Sample characteristics were summarized using means and standard deviations and frequencies and percentages, as appropriate. Missing data analysis was undertaken to identify patterns of missingness over time. To address Objective 1, patterns of exclusive breastfeeding were identified and prevalence of exclusive breastfeeding was assessed at 1, 3, and 6 months postpartum. To calculate prevalence, the total number of those reporting exclusivity at each time was divided by the total number of nonmissing cases at the corresponding time point. Ninety-five per cent confidence intervals (CIs) were calculated for each estimate of prevalence.

To address Objective 2, separate logistic regression models of exclusive breastfeeding were specified at 1, 3, and 6 months postpartum, using predictors measured at 1 month to determine if early risk and protective factors could be identified. All factors were selected a priori based on existing empirical evidence. For the outcome of exclusive breastfeeding at 3 and 6 months, we ran two models: one including all the predictors *excluding* exclusivity at 1 month and a second model including all predictors from Model 1 *plus* exclusivity at 1 month. Missing data on predictors accounted for less than 10% of the sample at each time point (1 month = 9.6%; 3 months = 9.5%; 6 months = 9.5%).

To address Objective 3, a generalized linear mixed model (GLMM) was run using the SAS GLIMMIX program to identify (a) time-dependent predictors of exclusivity across the 6-month period and (b) interactions between risk/protective factors measured at baseline and time. Predictors were selected a priori based on empirical evidence. Time-varying variables were depressive symptomatology, anxiety, fatigue, and breastfeeding problems. Fixed factors were age, parity, education level, immigration status, attendance of a prenatal breastfeeding class, infant receipt of fluids other than breastmilk in

hospital, and infant use of a bottle or pacifier in hospital. All interactions between time and each of the predictors were also included, as well as a linear and non-linear specification of time. Missing data were dealt with in GLMMIX (similar to other likelihood-based methods), by integrating all available information.

Prior to modelling, diagnostics were undertaken to improve model specification, including testing for multicollinearity and non-linearity in the relationships between the predictors and the outcome. For all models, full fit was desired and all variables were left in the model regardless of *P* value, with the exception of interactions, which were removed if nonsignificant. Statistical significance was established at $P < 0.05$. Analyses were run using SAS (version 9.4).

3 | RESULTS

The overall cohort has been described elsewhere (Dennis et al., 2018); in this study, we focus on women who were exclusively breastfeeding ($n = 565$) at one time point. Their mean age was 31.7 years ($SD = 4.4$), and the majority were primiparous (70.6%) and had postsecondary education (91.0%). Most women were nonrecent immigrants who resided in Canada ≥ 5 years (43.4%), followed by recent immigrant who lived in Canada < 5 years (38.9%) and Canadian-born women (17.7%). One third of women had a history of depression, postpartum, or otherwise (34.2%). Half had taken a prenatal breastfeeding class (51.5%). Over one third reported that their infant used a pacifier or bottle in hospital (35.9%), whereas more than half said their infant had fluids other than breastmilk in hospital (54.0%). Missing data analyses revealed that those who breastfed exclusively at baseline and those with higher education were less likely to drop out of the study.

3.1 | Patterns and prevalence of exclusive breastfeeding

Examination of exclusive breastfeeding patterns across the first 6 months postpartum found the most common infant feeding method was nonexclusive breastfeeding at 1, 3, and 6 months (32.9%) followed by exclusive breastfeeding to 6 months (26.8%). Twenty percent (20.3%) of women moved from exclusive to nonexclusive breastfeeding by 6 months postpartum, with 5.6% only exclusively breastfeeding to 1 month and 14.7% only exclusively breastfeeding to 3 months. Finally, 15.2% of women moved from nonexclusive to exclusive breastfeeding within the 6-month time period. This included 1.6% of women who only exclusively breastfed at 6 months, 4.7% of women who only exclusively breastfed at 3 and 6 months, 1.4% who only exclusively breastfed at 1 and 6 months, and 7.5% of women who only exclusively breastfed at 3 months. Data were missing for 4.7% of women.

The prevalence of exclusive breastfeeding was calculated at each time point. At 1 month postpartum, the prevalence was 50.9% (284/558; 95% CI [46.7, 55.0]). At 3 months, the prevalence was higher at 59.2% (279/471; 95% CI [54.7, 63.4]). At 6 months, the prevalence was 37.1% (159/429; 95% CI [32.6, 41.7]). The higher prevalence of exclusive breastfeeding at 3 months compared with 1 month postpartum can be accounted for by the one in 10 women who moved from

nonexclusive breastfeeding at 1 month to exclusive breastfeeding at 3 months.

3.2 | Predictors of exclusive breastfeeding at 1, 3, and 6 months

Table 1 presents the results of the separate logistic regression models of exclusive breastfeeding at 1, 3, and 6 months postpartum. At 1 month postpartum, there were only three statistically significant risk factors associated with exclusivity once all others were accounted for: immigrant status (recent: OR 0.28, 95% CI [0.15, 0.55]; nonrecent, OR 0.32, 95% CI [0.15, 0.68]), those with infant formula supplementation in-hospital (OR 0.44, 95% CI [0.28, 0.68]), and those who used a bottle or pacifier in hospital (OR 0.51, 95% CI [0.32, 0.82]) had lower odds of exclusivity.

At 3 months postpartum, two models are presented (also Table 1). Model 1 does not include breastfeeding exclusivity at 1 month postpartum. In this model, three factors were statistically significant: multiparity (OR 1.69, 95% CI [1.01, 2.82]) and prenatal breastfeeding class attendance (OR 1.54, 95% CI [1.02, 2.33]) were associated with higher odds of exclusivity, whereas those whose infants received formula supplementation in hospital had lower odds (OR 0.45, 95% CI [0.28, 0.74]). Model 2 added exclusivity at 1 month to Model 1. In Model 2, parity and breastfeeding class attendance were no longer statistically significant, but infant receipt of in-hospital formula supplementation continued to be associated with lower odds of exclusivity (OR 0.53, 95% CI [0.30, 0.93]). Exclusivity at 1 month was associated with higher odds of exclusivity at 3 month postpartum (OR 10.82, 95% CI [6.53, 17.94]).

At 6 months postpartum, two models are also presented (also Table 1). In Model 1, which does not include exclusivity at 1 month postpartum, having experienced breastfeeding problems at 1 month was the only statistically significant predictor of exclusivity (OR 0.61, 95% CI [0.38, 0.97]). In Model 2, which included exclusivity at 1 month, this relationship became nonsignificant. Exclusivity at 1 month was associated with higher odds of exclusivity at 6 months (OR 4.04, 95% CI [2.46, 6.63]).

3.3 | Variability in exclusive breastfeeding predictors across time

Table 2 presents the results of the final GLMM model of exclusivity over time. In this model, only the statistically significant interactions terms were included; the model effects should be interpreted as subject specific. First, looking at the relationship between time and exclusivity, the non-linear specification of time was statistically significant ($b -0.70$; SE 0.14; $P < 0.0001$), suggesting that there was an acceleration in the negative log odds of exclusivity over time. In other words, for any given woman, the drop off in the odds of exclusivity was larger from 3 to 6 months than from 1 to 3 months. Among the time-dependent factors, only breastfeeding problems were associated with exclusivity; for any given individual across time, the log odds of exclusivity decreased in the presence of a breastfeeding problem ($b -0.59$; SE 0.17; $P < 0.0001$). There was no evidence of a relationship between depression, anxiety, or fatigue and exclusivity across time. Next,

TABLE 1 Early risk and protective factors associated with exclusive breastfeeding among Chinese-Canadian women at 1, 3, and 6 months postpartum

Variable	1 month (N = 534)			3 months (N = 447)						6 months (N = 406)					
	Model 1			Model 1		Model 2				Model 1		Model 2			
	OR	95% CI		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Age (in years)	1.03	0.98	1.09	0.99	0.94	1.05	0.97	0.92	1.03	1.05	0.99	1.11	1.06	1.00	1.12
Multiparous	1.35	0.84	2.16	1.69	1.01	2.82	1.59	0.89	2.85	1.18	0.70	1.99	1.11	0.64	1.92
Postsecondary education	1.33	0.63	2.81	1.95	0.80	4.78	2.32	0.84	6.41	1.95	0.59	6.39	2.07	0.60	7.12
Mean income adequacy	0.84	0.63	1.14	1.24	0.90	1.69	1.41	0.98	2.02	1.12	0.80	1.56	1.19	0.84	1.69
History of depression	1.09	0.70	1.70	0.89	0.56	1.43	0.81	0.47	1.38	0.94	0.58	1.53	0.89	0.53	1.48
Immigrant status															
Recent immigrant (<6 years)	0.28	0.15	0.55	0.65	0.32	1.28	1.33	0.60	2.95	1.08	0.55	2.14	1.58	0.77	3.23
Nonrecent immigrant (≥5 years)	0.32	0.15	0.68	1.08	0.48	2.41	2.24	0.89	5.66	1.43	0.62	3.27	2.09	0.88	4.99
Attended breastfeeding class	1.35	0.91	1.99	1.54	1.02	2.33	1.46	0.91	2.35	1.14	0.74	1.77	1.01	0.64	1.59
Supplementation in hospital	0.44	0.28	0.68	0.45	0.28	0.74	0.53	0.30	0.93	0.90	0.54	1.49	1.07	0.63	1.83
Bottle/pacifier use in hospital	0.51	0.32	0.82	0.98	0.60	1.62	1.59	0.89	2.84	0.62	0.36	1.07	0.75	0.42	1.34
Received breastfeeding support after leaving hospital	1.43	0.91	2.24	1.51	0.92	2.48	1.51	0.85	2.68	0.95	0.58	1.57	0.82	0.49	1.39
Social support	1.00	0.97	1.02	1.00	0.98	1.03	1.01	0.98	1.04	1.00	0.97	1.03	1.00	0.97	1.03
Acculturation stress	0.99	0.97	1.01	0.99	0.97	1.01	0.99	0.97	1.02	0.99	0.97	1.01	0.99	0.97	1.01
Depression (EPDS)	1.06	0.99	1.13	0.99	0.93	1.06	0.97	0.90	1.05	0.99	0.92	1.07	0.98	0.91	1.06
Anxiety (STAI)	0.98	0.96	1.01	1.00	0.97	1.02	1.00	0.97	1.03	1.02	0.99	1.05	1.03	0.99	1.06
Fatigue	1.00	0.96	1.03	1.01	0.97	1.05	1.02	0.97	1.07	0.98	0.94	1.02	0.98	0.94	1.02
Had breastfeeding problems	0.68	0.45	1.04	0.83	0.53	1.31	1.00	0.60	1.68	0.61	0.38	0.97	0.65	0.40	1.07
Baseline exclusive breastfeeding							10.82	6.53	17.94				4.04	2.46	6.63

Note. CI: confidence interval; EPDS: Edinburgh Postnatal Depression Scale; OR: odds ratio; STAI = State-Trait Anxiety Inventory. Values in bold are statistically significant at $P < 0.05$.

looking at the interactions between time and the baseline risk and protective factors, the log odds of exclusivity associated with immigrant status (recent: $b = -0.52$, SE 0.22, $P = 0.22$; nonrecent: $b = 0.61$, SE 0.23, $P = 0.008$) and infant in-hospital formula supplementation ($b = 0.47$, SE 0.16, $P = 0.003$) were dependent on time. Within any individual, the negative effect of providing nonbreastmilk fluid in hospital became smaller across the postpartum period. Similarly, the negative effect of immigrant status became smaller across the postpartum period. In other words, these risk factors were stronger earlier in the postpartum period. The other interactions were not statistically significant, suggesting the effects did not depend on time. When comparing women who were otherwise similar, those who were multiparous ($b = 0.41$; SE 0.20; $P = 0.043$), had higher education ($b = 0.74$; SE 0.34; $P = 0.029$), and attended a prenatal breastfeeding class ($b = 0.37$; SE 0.17; $P = 0.03$) had higher log odds of exclusivity.

4 | DISCUSSION

This is the first study to examine patterns and predictors of breastfeeding exclusivity among immigrant and Canadian-born Chinese women. One in four women exclusively breastfed to 6 months postpartum a rate comparable with current 6-month exclusive breastfeeding rate in China (Yang et al., 2016). However, the most common pattern of breastfeeding, representing one in three women, was nonexclusivity at any time point, and one in five women moved

from exclusive to nonexclusive breastfeeding by 6 months postpartum. This pattern is also comparable with China, where there is a traditional practice to introduce complementary food before 4 months postpartum (Xu, Qiu, Binns, & Liu, 2009). Women less likely to breastfeed exclusively at 1, 3, or 6 months were those who had infants provided with in-hospital formula supplementation. Immigrant women were also less likely than nonimmigrants to breastfeed exclusively at 1 month. The highest rate of attrition in exclusive breastfeeding occurred between 3 and 6 months versus 1 and 3 months. The effect of immigrant status and in-hospital infant formula supplementation decreased across time whereas breastfeeding problems continued to be associated with exclusivity across time. These results have implications for the development of supports to optimize breastfeeding practices.

Our results present some important comparisons to previous research. Earlier studies have consistently demonstrated the significance of maternal age, education, and support from the partner, family, peers, and professionals in predicting breastfeeding initiation and duration (Dennis, 2002; Kehler et al., 2009; Mathews et al., 2014; Meedy et al., 2010; Thuiler & Mercer, 2009). Qualitative studies have also highlighted the roles of breastfeeding problems, cultural beliefs, and conflicting views regarding breastfeeding on the initiation and duration of exclusive breastfeeding (Chen, 2002; Kuswara, Laws, Kremer, Hesketh, & Campbell, 2016). Although predictors of exclusive breastfeeding have rarely been examined (Kristiansen et al., 2010), our finding that higher education and support from professionals, in the

TABLE 2 Generalized linear mixed model of exclusive breastfeeding up to 6 months postpartum among Chinese-Canadian women

Variable	Log odds	Standard error	P value
Intercept	-0.29	0.93	0.756
Time	0.12	0.35	0.724
Age (in years)	0.01	0.02	0.600
Multiparous	0.41	0.20	0.043
Postsecondary education	0.74	0.34	0.029
Immigrant status (ref = Canadian born)			
Recent immigrant (<5 years)	-1.39	0.33	<0.0001
Nonrecent immigrant (≥ 5 years)	-1.19	0.34	0.001
Took a prenatal breastfeeding class	0.37	0.17	0.030
Supplementation in hospital	-1.12	0.24	<0.0001
Bottle or pacifier use in hospital	-0.31	0.21	0.141
Depression (EPDS, time varying)	0.00	0.02	0.841
Anxiety (STAI, time-varying)	-0.01	0.01	0.628
Breastfeeding problems (time varying)	-0.59	0.17	<0.0001
Fatigue (time varying)	0.01	0.01	0.406
Time*time	-0.70	0.14	<0.0001
Time*recent immigrant status	0.52	0.22	0.021
Time*nonrecent immigrant status	0.61	0.23	0.008
Time*received supplement	0.47	0.16	0.003

Note. EPDS: Edinburgh Postnatal Depression Scale; STAI: State-Trait Anxiety Inventory. Values in bold are statistically significant at $P < 0.05$.

form of prenatal breastfeeding class attendance, were important predictors of exclusive breastfeeding is consistent with this prior literature. However, a novel finding was that maternal age and social support were less important in the multivariable models than immigration status, indicators of formula supplementation in hospital, and breastfeeding problems.

We found that immigrant women were less likely than nonimmigrants to breastfeed exclusively at 1 month postpartum. This finding is consistent with research showing a negative association between immigration and breastfeeding outcomes (Busck-Rasmussen et al., 2014; Groleau et al., 2006; Sussner et al., 2008). For example, in the Danish study (Busck-Rasmussen et al., 2014), non-Western immigrant women were less likely to breastfeed to 3 months than nonimmigrants. Immigrant women may experience specific barriers to breastfeeding, such as poorer access to professional breastfeeding support (e.g., lactation clinics) to address breastfeeding problems (Groleau et al., 2006). Socio-economic factors may also play a role; immigrant women may be forced for financial reasons to return to work earlier than nonimmigrants, interfering with breastfeeding practices (Meftuh, Tapsoba, & Lamounier, 1991). There may also be issues related to acculturation such as conflict between traditional values of breastfeeding in private domestic spaces and increasing need, upon immigration, to exist in public spaces (Busck-Rasmussen et al., 2014). Women from particular cultural groups, including Southeast Asians, perceive the quality of their breastmilk to be correlated with their diet; if immigration interferes with their ability to conform to culturally prescribed diets in the postpartum period, they may prefer infant formula

(Tuttle & Dewey, 1994). Decision making of immigrant women's infant feeding practices may also be related to how they deal with the contradictions between their cultural beliefs and the Western practices (Chen, 2002). It is important to note that other studies have found immigrant women are more likely to initiate breastfeeding and do so longer than nonimmigrants (Chen et al., 2011; Lee, Elo, McCollum, & Culhane, 2009; Nolan & Layte, 2014; Tavoulari et al., 2015; Vanderlinden et al., 2015; Zuppa et al., 2010); this heterogeneity in findings may be explained by use of different study populations or methods. Overall, our findings suggest that it may be important to provide targeted breastfeeding support to immigrant women in the postpartum period. Because we found that the effect of immigration status on exclusive breastfeeding practices decreased across time, interventions early in the postpartum period may be particularly important.

Early formula supplementation with fluids other than breastmilk was shown in our study to be consistently associated with lower odds of exclusive breastfeeding at all time point. This is consistent with numerous studies showing that formula supplementation is associated with poorer breastfeeding outcomes (Blomquist, Jonsbo, Serenius, & Persson, 1994; Michaelsen, Larsen, Thomsen, & Samuelson, 1994). Early formula supplementation may conflict with messages supporting exclusivity or interfere with the development of breastfeeding skills and habits. Because formula supplementation may be provided in cases where establishing breastfeeding is problematic, it is possible that these difficulties, and not infant formula supplementation per se, explain poorer exclusive breastfeeding rates (Michaelsen et al., 1994). Our findings suggest that in cases where early formula supplementation is necessary, additional support should be provided to encourage the development of exclusive breastfeeding.

Similarly, we showed that breastfeeding problems were important predictors of exclusive breastfeeding across the postpartum period. Difficulties such as problems with latching as well as sore or cracked nipples are cited as being among the most common reasons for stopping breastfeeding in the postpartum period (Khan & Ramirez, 2017; Mangrio et al., 2017; Rozga et al., 2015). However, previous authors have found the impact of breastfeeding problems to be greater earlier in the postpartum period and suggest intensive breastfeeding support early in the postpartum period as a potential solution (Rozga et al., 2015). In contrast, we found that the effect of breastfeeding problems on exclusivity did not decrease across the postpartum period but maintained importance. In fact, the highest rates of attrition in exclusive breastfeeding occurred between 3 and 6 months, not 1 and 3 months postpartum. Both these findings suggest women require access to ongoing community support to address ever-evolving breastfeeding problems in order to increase rates of exclusivity to 6 months postpartum.

4.1 | Limitations

Our study has several limitations, which should be taken into consideration when interpreting our findings. First, because our cohort was restricted to immigrant and Canadian-born Chinese women, findings may not be generalizable to women of other ethnicities. This study should be replicated in other populations to determine whether

patterns and predictors of breastfeeding exclusivity are similar or different. Second, our study sample was a convenience sample, with a high percentage of women who had postsecondary education. Results may not be generalizable to women who are more marginalized and have poorer health literacy. Analysis of missing data revealed that those who breastfed exclusively at baseline and those with higher education were less likely to drop out of the study, again suggesting potential bias in the sample. Although our list of predictors was comprehensive, we were not able to measure some factors associated with exclusive breastfeeding, such as hospital policies. Previous research has shown that breastfeeding rates are higher in “Baby-Friendly” hospitals that actively promote breastfeeding (Merewood, Mehta, Chamberlain, Philipp, & Bauchner, 2005). Future studies could assess the roles of systemic factors, in addition to the individual-level factors that we examined, on breastfeeding exclusivity. Finally, although our sample was reasonably large, we were not able to conduct additional analyses, such as stratification of models by immigration status to compare patterns and predictors in immigrant and nonimmigrant women.

5 | CONCLUSION

Our study examined patterns and predictors of breastfeeding exclusivity among immigrant and Canadian-born Chinese women at 1, 3, and 6 months postpartum and across time. Our results suggest that immigrant women as well as those who had an infant that received formula supplementation in hospital or who had breastfeeding problems are at increased risk for discontinuation of exclusive breastfeeding. These findings have important implications for health care providers in the identification of women who may be at risk to discontinue exclusive breastfeeding before the recommended minimum target of 6 months postpartum (World Health Organization, 2011). Because each of the risk factors identified in this study can be identified early in the postpartum period, they can be used to guide advice and resources given to women during the early postpartum period while in hospital and upon discharge home. Future research should examine the specific cultural approaches that may be used to effectively address and support exclusive breastfeeding duration among immigrant women specifically.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

CONTRIBUTIONS

Dr. C-LD led the study design, analysis, and interpretation of the data, drafting of the manuscript, and manuscript revision; Dr. HKB contributed to the interpretation of the data, drafting of the manuscript, and manuscript revision; Drs. C-LD, JA-D, SS, and FM contributed to the interpretation of the data and manuscript revision; and Dr. SB contributed to the analysis and interpretation of the data, drafting of the manuscript, and manuscript revision. All authors approved the final manuscript and agree to be accountable for all aspects of the work.

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