In-Hospital Formula Feeding and Breastfeeding Duration

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abstract

BACKGROUND: In-hospital formula feeding (IHFF) of breastfed infants is associated with shorter duration of breastfeeding. Despite evidence-based guidelines on when IHFF is appropriate, many infants are given formula unnecessarily during the postpartum hospital stay. To account for selection bias inherent in observational data, in this study, we estimate liberal and conservative bounds for the association between hospital formula feeding and duration of breastfeeding.

METHODS: Infants enrolled in the Minnesota Special Supplemental Nutrition Program for Women, Infants, and Children were selected. Breastfed infants given formula were matched with infants exclusively breastfed (n = 5310) by using propensity scoring methods to adjust for potential confounders. Cox regression of the matched sample was stratified on feeding status. A second, more conservative analysis (n = 4836) was adjusted for medical indications for supplementation.

RESULTS: Hazard ratios (HR) for weaning increased across time. In the first analysis, the HR across the first year was 6.1 (95% confidence interval [CI] 4.9–7.5), with HRs increasing with age (first month: HR = 4.1 [95% CI 3.5–4.7]; 1–6 months: HR = 8.2 [95% CI 5.6–12.1]; >6 months: HR = 14.6 [95% CI 8.9–24.0]). The second, more conservative analysis revealed that infants exposed to IHFF had 2.5 times the hazard of weaning compared with infants who were exclusively breastfed (HR = 2.5; 95% CI 1.9–3.4).

CONCLUSIONS: IHFF was associated with earlier weaning, with infants exposed to IHFF at 2.5 to 6 times higher risk in the first year than infants exclusively breastfed. Strategies to reduce IHFF include prenatal education, peer counseling, hospital staff and physician education, and skin-to-skin contact.

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Ms McCoy conceptualized the study, gathered the data sources, conducted the initial analyses, and drafted the initial manuscript; Dr Heggie critically reviewed the manuscript for important intellectual content; and both authors reviewed and revised the manuscript, approved the final manuscript as submitted, and agree to be accountable for all aspects of the work.

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WHAT'S KNOWN ON THIS SUBJECT: In-hospital formula feeding (IHFF) of breastfed newborns is associated with shorter breastfeeding duration among diverse populations. Proven strategies to reduce unnecessary supplementation and increase rates of exclusive breastfeeding during the hospital stay have the potential to improve maternal and child health.

WHAT THIS STUDY ADDS: Although the association between IHFF and breastfeeding duration is well established, this study's methods allow for the estimation of the causal effect of IHFF on duration, increasing the strength of the evidence that IHFF negatively impacts duration.

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Breastfeeding is important for the health of the mother and child, with documented medical and neurodevelopmental advantages. Exclusive breastfeeding is associated with reduced infant morbidity and mortality compared with partial breastfeeding, including lower rates of respiratory and gastrointestinal tract infections and sudden infant death syndrome.[1–4] Even brief exposure to formula alters the infant microbiome long-term and increases the risk of allergy at 2 years of age.[5,6] Shorter breastfeeding duration is associated with in-hospital formula feeding (IHFF), impacting mothers' and infants' health long-term.[7–9]

In-hospital supplementation is influenced by a myriad of factors, from mothers' physical and cultural characteristics to hospital policies, staff training, availability of free formula, and even time of delivery (Fig 1).[10–14] Excessive neonatal weight loss is often cited as the reason for supplementation. Some weight loss is physiologically normal.[15] Flaherman et al[16] established nomograms for weight loss and found that among healthy infants delivered vaginally, 4.9% lost >10% of birth weight by 48 hours. Many hospitals commence formula feeds when an infant's weight loss exceeds a predefined percentage, typically 7% to 10% of birth weight. Excessive weight loss is not an automatic marker for supplementation but an indicator for infant evaluation.[17]

Other reasons given for IHFF include newborn hypoglycemia and hyperbilirubinemia. These conditions can be prevented or treated through proper lactation management and availability of expressed human milk.[18,19] Rare circumstances requiring IHFF include inborn errors of metabolism in neonates or maternal therapy that precludes lactation (eg, chemotherapy). In these cases, breastfeeding is usually not initiated.

In this analysis, we determined the propensity to receive IHFF on the basis of multiple preoccurring factors and measured the impact among those who received IHFF and those at equal risk for IHFF who were exclusively breastfed.

Breastfed infants cannot ethically be randomly assigned to receive formula. For estimation of the effect of formula feeding, we must use observational data, in which selection into the exposed group is biased. Observational studies measure associations that can only be causally interpreted when properly adjusted for bias and confounding.[20] Propensity score (PS) analysis allows for the comparison of treated and untreated subjects with similar distributions of measured baseline characteristics.[21]

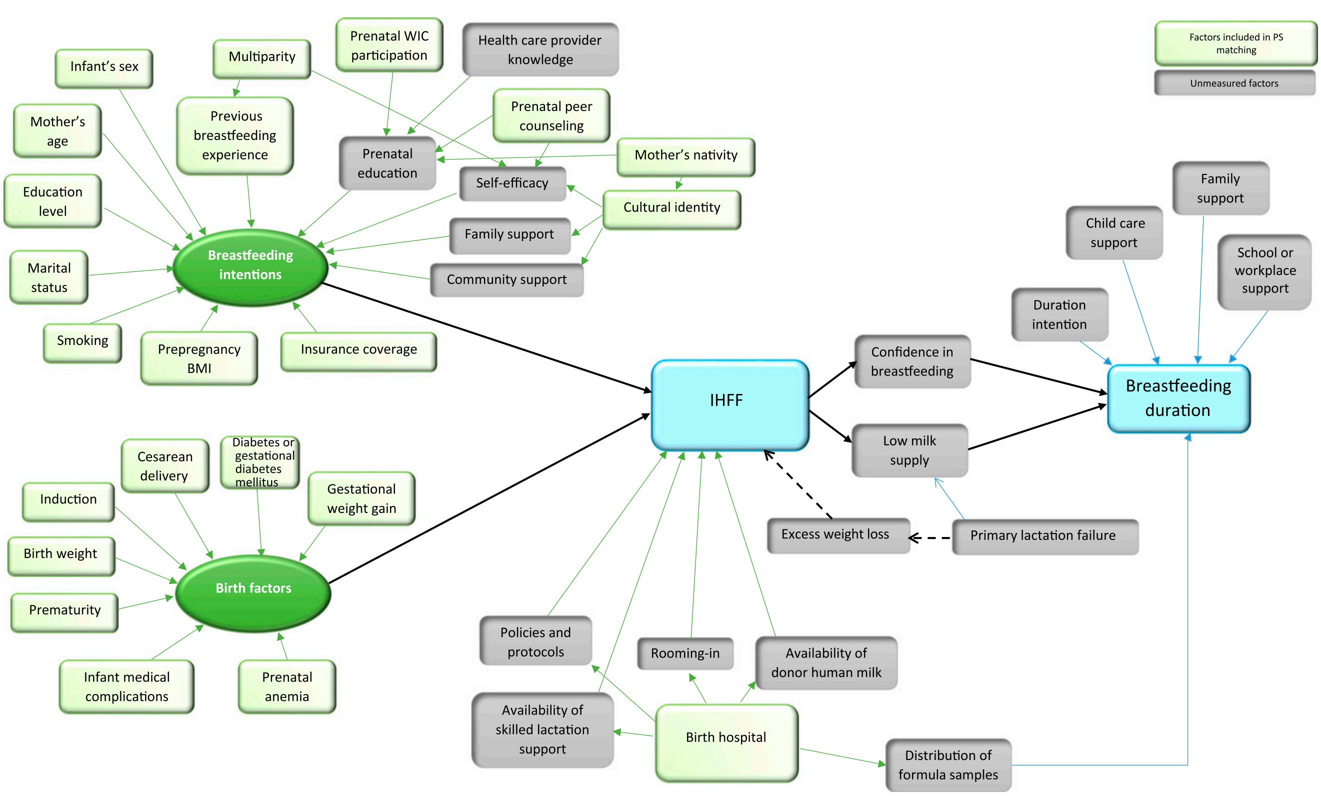

FIGURE 1
Factors associated with in-hospital supplementation of breastfed infants during the postpartum hospital stay and subsequent duration of breastfeeding.

PS methods are particularly suited to an analysis of the relationship between IHFF and breastfeeding duration because IHFF lies along the causal pathway between these demographic characteristics and breastfeeding duration. Traditional regression models, which include both prenatal factors and IHFF, are not appropriate when breastfeeding duration is the outcome of interest.[22] PS methods control for these numerous factors while segregating them from the duration outcome.

METHODS

Design

In an observational study of Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) participants, we used PS methods to match breastfed infants fed formula with infants exclusively breastfed during the postpartum hospital stay. We used survival analyses to compare duration of breastfeeding for infants exclusively breastfed in the hospital and breastfed infants fed formula during the hospital stay. Two analyses were conducted, the first assuming that all bias was controlled through matching and the second, more conservative analysis making additional correction for medically necessary supplementation (Fig 2).

The Minnesota Department of Health's Institutional Review Board determined that this study was not human subjects research, as defined by federal regulations, and was exempt from review.

Population

As a needs-based program, WIC serves low- to moderate-income infants and their mothers. WIC participants have higher rates of IHFF than Minnesota's general population, which, in 2016, varied from 32.6% for white infants to 82.4% for Hmong infants (Table 1). Minnesota had 8 hospitals with Baby-Friendly Hospital Initiative (BFHI) designation in 2016.[23] Twelve hospitals reported using donor milk, mostly in the NICU setting.[24] IHFF rates varied widely by birthing facility. Among Minnesota hospitals with at least 30 births in 2016, the lowest rate was 21.1% and the median rate was 51.0% (interquartile range [IQR] 42.3% to 58.4%).

Sample

Minnesota WIC collected in-hospital feeding data on 9860 infants in 2016. After exclusions for ineligibility and missing data, PS matching yielded a sample of 5310 infants for the first (liberal) and 4836 infants for the second (conservative) analysis (Fig 3).

Measurement and Data Collection

Demographic, pregnancy, and feeding information were entered into the Minnesota WIC information system by staff during WIC appointments. Previous research has revealed WIC administrative data to be sufficiently accurate for research purposes.[25,26] For this study, the WIC data were compared with birth certificate records. For most variables, agreement between the 2 data sources ranged from 91% (ever smoked) to 100%. Agreement on maternal weight and BMI was lower (59%–65%), whereas agreement on race and/or ethnicity (79%) was consistent with changes in self-reported race seen in census data.[27]

Birth facility, mother's country of origin, education level, and marital status were derived from birth certificate records. Cultural identity was self-reported at the WIC appointment or, when missing, taken from birth certificate self-report.

Breastfeeding difficulties were self-reported by mothers and included latch problems and breast or nipple soreness. Infant medical complications were reported by mothers and included jaundice, excess weight loss, central nervous system disorders, and genetic or congenital disorders (Table 2).

The main exposure of interest, IHFF, signified that a breastfed infant had been fed formula during the postpartum hospital stay. A question on "first time formula/other given to infant (meds ok)" was asked during the infant's initial certification appointment. Responses of "BF [breastfed] & formula given in the hospital" were coded as IHFF = 1, responses of "breast milk only since birth" and "BF & formula given after

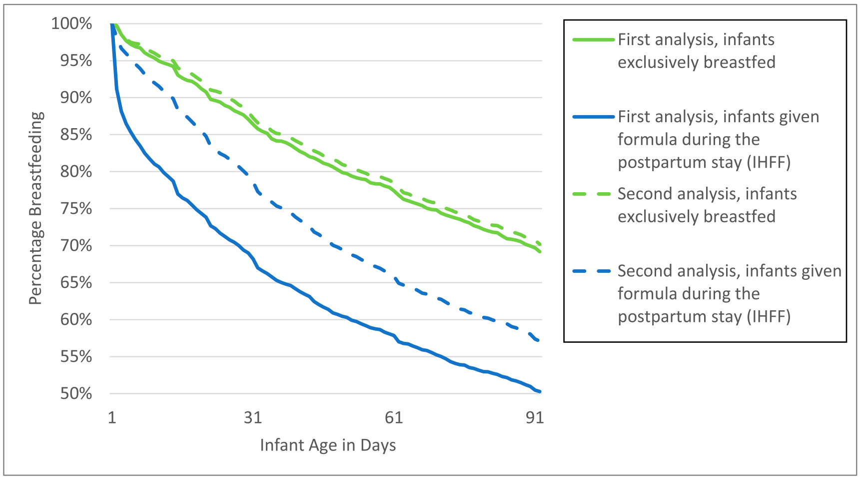

FIGURE 2
Continuation of breastfeeding across the first 3 months, comparing 2 PS-matched samples of infants exclusively breastfed during the postpartum hospital stay with breastfed infants exposed to IHFF.

TABLE 1 Rates of Supplementation (IHFF) and Median Days Breastfed for Breastfed Infants Born in 2016 Enrolled in the Minnesota WIC, by Mother's Cultural Identity

	Infants in Original Sample	Percentage IHFF, %	Median Days Breastfed	IQR
American Indian	273	41.8	73	19 to 254
Hmong	714	82.4	53	8 to 143
Non-Hmong Asian	600	58.3	174	52 to 381
US-born African American	1284	52.5	61	15 to 174
Foreign-born black	1899	72.6	271	147 to 382
White	2295	32.6	119	31 to 313
Hispanic (all races)	1658	44.3	191	51 to 381

discharge" were coded as IHFF = 0. Responses of "never breastfed" were excluded from the analysis.

Collection of IHFF data is optional for local WIC agencies. Data were collected on no one in some agencies and on >90% of infants in others. Most IHFF data (86%) were collected from urban and suburban WIC agencies. IHFF was collected on 37% of WIC participants born in 2016. PS methods are used to correct for the potential bias from this partial data collection.

The outcome variable for the analysis was number of days of any breastfeeding, calculated by subtracting the infant's date of birth from the date the mother reported that breastfeeding ended.

Data Analyses

By using logistic regression and controlling for numerous variables

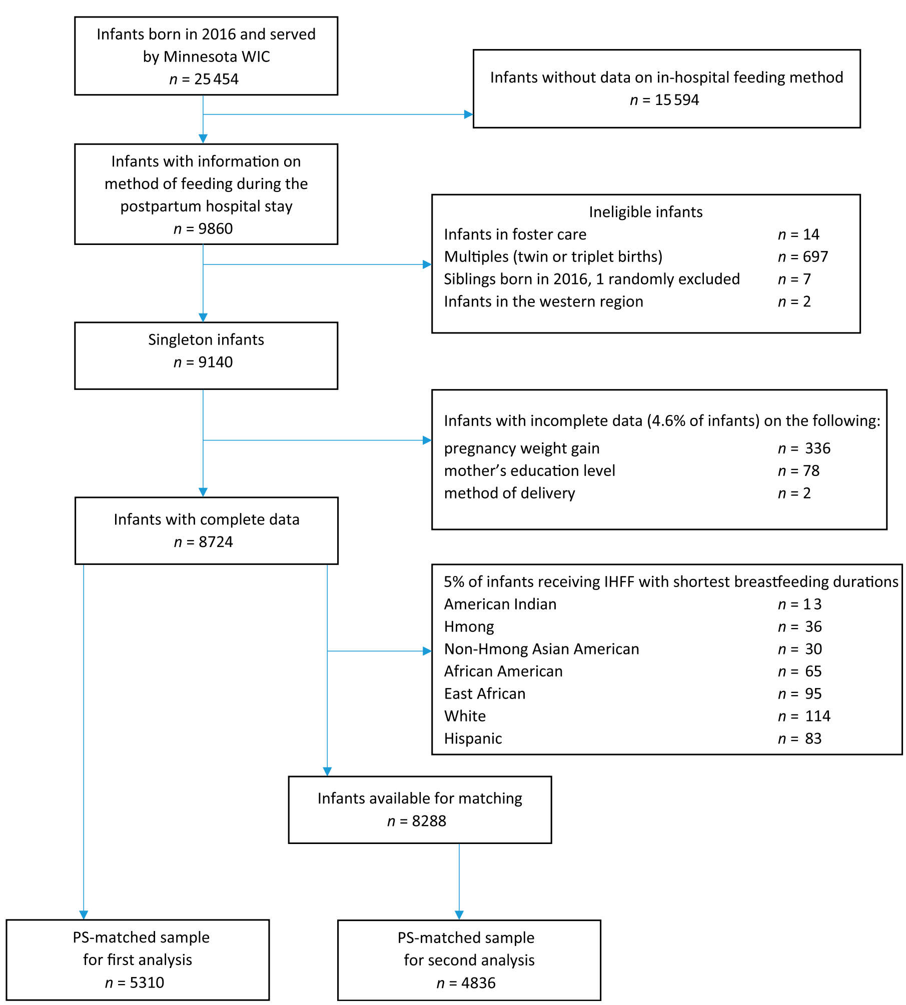

FIGURE 3
Derivation of samples used in the PS analyses (infants enrolled in the Minnesota WIC born in 2016).

TABLE 2 Timing of Collection of Measures Self-Reported by Mothers at WIC Appointments

Measure	Median	IQR
Age at report, d		
IHFF (*n* = 8720)	15	8 to 30
Infant medical complications (*n* = 199)	60	24 to 187
Breastfeeding difficulties (*n* = 261)	15	9 to 38
Days between weaning and report		
Duration of breastfeeding, excluding those lost to follow-up (*n* = 7068)	7	−20 to 38

(Fig 1), PSs were calculated for the predicted probability of IHFF for each infant. Matching used the gmatch macro supplied by HSR CodeXchange (Mayo Clinic College of Medicine, Rochester, MN). Nearest-neighbor caliper matching without replacement with a caliper width of 0.2 SD of the logit of the PS was used.[28] Exact matching on hospital precluded any analysis of hospital-level effects. Matching improved the balance of PSs across exposure (IHFF) and comparison (exclusively breastfed) groups (Fig 4). A Cox regression analysis of the matched sample was conducted, stratified on IHFF, and the hazard ratio (HR) for weaning was calculated with robust SEs.[21] SAS version 9.4 (SAS Institute Inc, Cary, NC) was used for all analyses.

A second, more conservative analysis was used to control for the maximum amount of bias that might be due to primary lactation failure. Although prevalence of primary lactation failure is unknown, causes include lack of breast tissue, hormonal abnormalities, and breast injury.[29] Inability to produce a full milk supply cannot be determined during the short hospital stay, but an early indicator could be excessive weight loss in the first days of life.

Erring on the side of underestimating the effect of IHFF on breastfeeding duration, 4 assumptions were made.

1. On the basis of early weight loss nomograms for exclusively breastfed newborns, a maximum of 5% of infants experienced weight loss ≥10% because of primary lactation failure.[16]
2. All cases of primary lactation failure were detected by excess weight loss.
3. All infants with excess weight loss were given formula rather than the mother's expressed milk or pasteurized donor human milk.
4. Those with excess weight loss had the shortest durations of breastfeeding of all infants exposed to IHFF.

In this analysis, we excluded the 5% of IHFF infants with the shortest breastfeeding durations before matching. Exclusions were conducted by cultural identity to prevent confounding due to cultural differences in IHFF and duration (Table 1). The same Cox regression model was used as in the first analysis.

RESULTS

Characteristics of the Matched Sample

PS matching yielded exposure (IHFF) and comparison (exclusively breastfed) groups with similar distributions of baseline

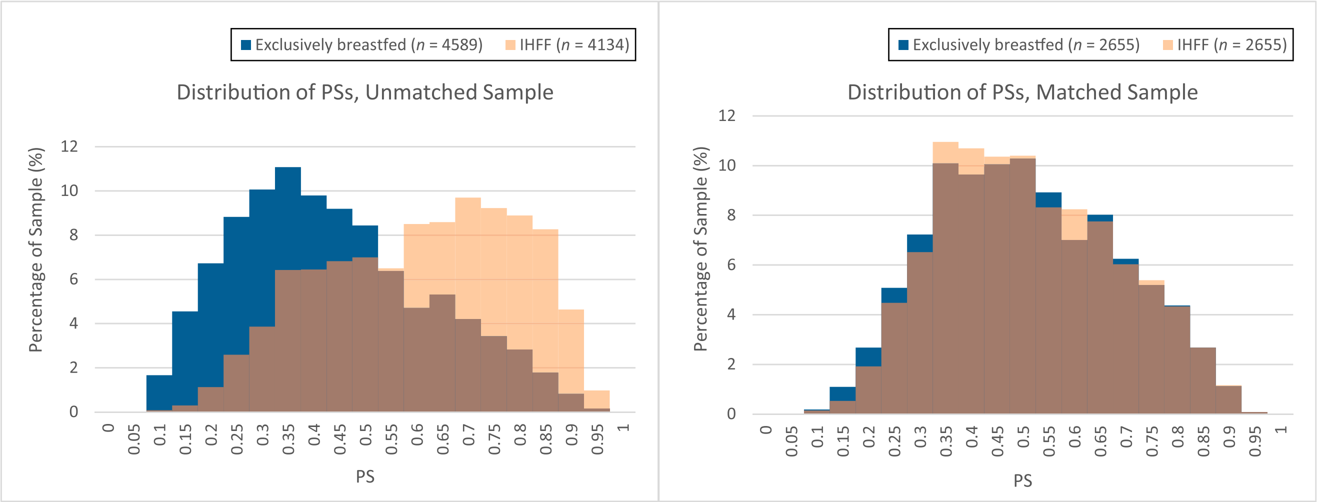

FIGURE 4
PSs for likelihood of exposure to IHFF during the postpartum hospital stay. PSs were derived by using maternal age, cultural identity (defined by race, ethnicity, nativity, and, for Hmong, self-reported cultural affiliation), type of insurance (a marker of socioeconomic status), marital status, education level, prenatal WIC participation, prenatal WIC peer counseling, smoking, prepregnancy BMI, pregnancy weight gain, prenatal anemia, diabetes mellitus, gestational diabetes mellitus, previous breastfeeding experience, region of residence, method of delivery, medications, infant sex, gestational age, and birth weight.

characteristics (Table 3). Largest weighted standardized differences in means were for pregnancy weight gain (0.087) and primiparity (0.084). Histograms reveal the distribution of PSs in the exposed and unexposed groups before and after matching (Fig 4).

HRs for Weaning

In this analysis, we found a clinically and statistically significant longer duration of breastfeeding among exclusively breastfed infants compared with infants exposed to IHFF. For the first analysis, the HR across the first year was 6.1 (95% confidence interval [CI] 4.9–7.5) and increased with age (first month: HR = 4.1 [95% CI 3.5–4.7]; 1–6 months: HR = 8.2 [95% CI 5.6–12.1]; >6 months: HR = 14.6 [95% CI 8.9–24.0]). The second, more conservative analysis revealed that infants exposed to IHFF had 2.5 times the hazard of weaning across the first year compared with exclusively breastfed infants (HR = 2.5; 95% CI 1.9–3.4) (Fig 5).

Sensitivity Analysis

To assess how sensitive the analysis results would be to residual bias after matching, a sensitivity analysis was conducted by using the Wilcoxon rank test.[30] γ, the odds of differential assignment to treatment due to unobserved factors, became nonsignificant between the values of 2.0 and 2.1. In other words, results of this analysis are statistically significant unless an unmeasured confounder exists, uncorrelated with the factors already controlled for by PS matching, which more than doubles the risk of IHFF.

DISCUSSION

Our study strengthens the evidence that formula supplementation of breastfed infants negatively affects breastfeeding duration. Infants exposed to IHFF are at 2.5 to 6 times higher risk of early weaning than infants exclusively breastfed. This finding has important clinical implications because breastfeeding duration has been shown to have a significant impact on numerous health outcomes, with a dose-response protective effect for sudden infant death syndrome, infection in infancy, and childhood obesity.[2,4,31] Exclusive breastfeeding rates can be improved through prenatal, hospital, and postdischarge improvements in care.

Researchers have proposed biological and psychosocial mechanisms for the negative impact of IHFF on breastfeeding duration. IHFF may directly impact milk supply. Infant formula is often fed in larger amounts than physiologically appropriate. An infant given supplements suckles less frequently, leading to reduced prolactin secretion in the mother.[32] Decreased breastfeeding due to supplementation, whether formula or human milk, reduces the volume of milk removed, increasing the risk of severe maternal engorgement and downregulation of supply.[17] Depending on the method and number of supplements, an infant may have difficulty returning to the breast ("flow confusion" or "nipple preference").

IHFF often leads to continued supplementation after discharge.[33] Women who are told their infant needs formula lose confidence in their ability to produce an adequate milk supply. Recommendation of formula by health care providers increases the perception of formula as a healthy alternative. Some women feel that once formula is introduced, breastfeeding is no longer pure and exclusivity no longer achievable. Although donor milk is considered a temporary measure, formula is seen as an ongoing plan.[34]

Interventions to improve exclusive breastfeeding rates begin prenatally. Physicians' explicit endorsement of breastfeeding is influential.[35] Comprehensive prenatal education includes information on early skin-to-skin care, normal infant behavior and feeding cues, and, when appropriate, hand expression. Education should extend beyond the mother to her support system. Culturally appropriate resources, such as peer counseling, doula support, and breastfeeding support groups, can augment prenatal education. Providing a breastfeeding-friendly office environment can improve overall and exclusive breastfeeding rates.[36,37] Ceasing provision of formula samples to pregnant women is a simple first step.[38]

During the postpartum hospital stay, IHFF is seldom medically necessary and, with rare exceptions, not medically indicated when the mother's own milk or pasteurized donor milk is available. Yet, as of 2014, nearly one-fourth of hospitals were still providing at least 50% of healthy, term breastfed newborns with non–breast milk supplements.[39] In 2014, hospital IHFF rates in New York hospitals varied from 2.3% to 98.3%.[40] Among a sample of low-income mothers in Washington, District of Columbia, there was no clear medical need for IHFF for 87% of the breastfed infants who received it.[41]

Birthing hospitals can reduce IHFF by changing hospital protocols and improving maternity care practices, such as those outlined in the BFHI Ten Steps.[17,42] Hospital routines for vaginal and surgical births, as well as protocols for blood glucose monitoring, excess infant weight loss, hyperbilirubinemia, and hypoglycemia, influence IHFF practices. Timing of daily weights, rooming-in, early skin-to-skin contact, provision of pacifiers, and location of routine newborn procedures also influence the likelihood of IHFF.[1,43,44] Early skin-to-skin contact between the mother and infant improves breastfeeding in the first hour after birth and can help reduce formula supplementation by increasing the

TABLE 3 Characteristics of Mothers and Their Breastfed Infants Born in 2016 Enrolled in the Minnesota WIC, Matched by Using PS Methods

Characteristics Included in the Calculation of the PS	Original (Unmatched) Sample			P[a]	Matched Sample			P[a]
	All Infants in Original Sample	Exclusively Breastfed	Breastfed and Given Formula (IHFF)		All Infants in Matched Sample	Exclusively Breastfed	Breastfed and Given Formula (IHFF)	
Sample, *n* (%)	8723	4589 (52.6)	4134 (47.4)	—	5310	2655 (50)	2655 (50)	—
US-born mother	4794 (55)	2736 (66.2)	2058 (44.8)	.00	3030 (57.1)	1525 (57.4)	1505 (56.7)	.58
Payment type, *n* (%)				.00				.12
Medicaid	5715 (65.5)	2506 (60.6)	3209 (69.9)		3497 (65.9)	1726 (65)	1771 (66.7)	
Private	2639 (30.2)	1435 (34.7)	1204 (26.2)		1586 (29.9)	811 (30.5)	775 (29.2)	
Other	313 (3.6)	194 (4.7)	176 (3.8)		227 (4.3)	118 (4.4)	109 (4.1)	
Married, *n* (%)	3636 (41.7)	1779 (43)	1857 (40.5)	.02	2085 (39.3)	1047 (39.4)	1038 (39.1)	.80
Education level, *n* (%)				.00				.25
Less than HS	2174 (24.9)	824 (19.9)	1350 (29.4)		1333 (25.1)	661 (24.9)	672 (25.3)	
HS graduate	2310 (26.5)	1042 (25.2)	1268 (27.6)		1449 (27.3)	729 (27.5)	720 (27.1)	
Some college	3089 (35.4)	1607 (38.9)	1482 (32.3)		1889 (35.6)	946 (35.6)	943 (35.5)	
College graduate	974 (11.2)	588 (14.2)	386 (8.4)		534 (10.1)	275 (10.4)	259 (9.8)	
Prenatal WIC participation, *n* (%)				.00				.38
≥3 mo	5404 (61.9)	2476 (59.9)	2928 (63.8)		3255 (61.3)	1617 (60.9)	1638 (61.7)	
<3 mo	1427 (16.4)	661 (16)	766 (16.7)		875 (16.5)	432 (16.3)	443 (16.7)	
Post partum or never	1893 (21.7)	998 (24.1)	895 (19.5)		1180 (22.2)	606 (22.8)	574 (21.6)	
Cultural identity, *n* (%)[b]				.00				.66
American Indian	273 (3.1)	159 (3.8)	114 (2.5)		189 (3.6)	88 (3.3)	101 (3.8)	
Hmong	714 (8.2)	126 (3)	588 (12.8)		237 (4.5)	121 (4.6)	116 (4.4)	
Non-Hmong Asian	600 (6.9)	250 (6)	350 (7.6)		396 (7.5)	202 (7.6)	194 (7.3)	
US-born African American	1284 (14.7)	610 (14.8)	674 (14.7)		979 (18.4)	500 (18.8)	479 (18)	
Foreign-born black	1899 (21.8)	520 (12.6)	1379 (30.1)		1004 (18.9)	500 (18.8)	504 (19)	
White	2295 (26.3)	1545 (37.4)	750 (16.3)		1334 (25.1)	676 (25.5)	658 (24.8)	
Hispanic (all races)	1659 (19)	925 (22.4)	734 (16)		1171 (22.1)	568 (21.4)	603 (22.7)	
Assigned a peer prenatally, *n* (%)	2183 (25)	1073 (25.9)	1110 (24.2)	.06	1383 (26)	730 (27.5)	653 (24.6)	.02
History of smoking, *n* (%)	1559 (17.9)	834 (20.2)	725 (15.8)	.00	1041 (19.6)	527 (19.8)	514 (19.4)	.65
Cesarean delivery, *n* (%)	1985 (22.8)	813 (19.7)	1172 (25.5)	.00	1228 (23.1)	595 (22.4)	633 (23.8)	.22
Labor induction, *n* (%)	1972 (22.6)	923 (22.3)	1049 (22.9)	.55	1236 (23.3)	606 (22.8)	630 (23.7)	.44
Male infant, *n* (%)	4480 (51.4)	2107 (51)	2373 (51.7)	.48	2704 (50.9)	1330 (50.1)	1374 (51.8)	.23
IOM wt gain category, *n* (%)				.00				.92
Under recommended	2457 (28.2)	1074 (26)	1383 (30.1)		1448 (27.3)	723 (27.2)	725 (27.3)	
Within recommended range	2935 (33.6)	1388 (33.6)	1547 (33.7)		1748 (32.9)	873 (32.9)	875 (33)	
Over recommended	3332 (38.2)	1673 (40.5)	1659 (36.2)		2114 (39.8)	1059 (39.9)	1055 (39.7)	
Prenatal anemia, *n* (%)	1847 (21.2)	736 (17.8)	1111 (24.2)	.00	1161 (21.9)	581 (21.9)	580 (21.8)	.97
Previous breastfeeding duration, *n* (%)				.24				.99
Did not initiate	1986 (22.8)	870 (21)	1116 (24.3)		1239 (23.3)	604 (22.7)	635 (23.9)	
≤2 wk	478 (5.5)	190 (4.6)	288 (6.3)		277 (5.2)	143 (5.4)	134 (5)	
≤3 mo	848 (9.7)	381 (9.2)	467 (10.2)		523 (9.8)	263 (9.9)	260 (9.8)	
≤6 mo	575 (6.6)	237 (5.7)	338 (7.4)		326 (6.1)	158 (6)	168 (6.3)	
>6 mo	2104 (24.1)	1089 (26.3)	1015 (22.1)		1179 (22.2)	594 (22.4)	585 (22)	
First child (primiparity)	2733 (31.3)	1368 (33.1)	1365 (29.7)		1766 (33.3)	893 (33.6)	873 (32.9)	
Diabetes mellitus, *n* (%)	144 (1.7)	44 (1.1)	100 (2.2)	.00	80 (1.5)	39 (1.5)	41 (1.5)	.82
Gestational diabetes mellitus, *n* (%)	838 (9.6)	316 (7.6)	522 (11.4)	.00	486 (9.2)	228 (8.6)	258 (9.7)	.15
Low birth wt, *n* (%)	534 (6.1)	162 (3.9)	372 (8.1)	.00	275 (5.2)	134 (5)	141 (5.3)	.66
Infant medical complications, *n* (%)	43 (0.5)	14 (0.3)	29 (0.6)	.05	24 (0.5)	11 (0.4)	13 (0.5)	.68
Breastfeeding difficulties reported, *n* (%)	110 (1.3)	46 (1.1)	64 (1.4)	.24	62 (1.2)	32 (1.2)	30 (1.1)	.80
Age at birth, *n* (%)				.73				.73
Premature	619 (7.1)	199 (4.8)	420 (9.2)		316 (6)	159 (6)	157 (5.9)	
Near term	1971 (22.6)	962 (23.3)	1009 (22)		1219 (23)	615 (23.2)	604 (22.7)	
Term	3775 (71.1)	1881 (70.9)	1894 (71.3)		3775 (71.1)	1881 (70.9)	1894 (71.3)	
	912 (10.5)	387 (9.4)	525 (11.4)	.00	547 (10.3)	271 (10.2)	276 (10.4)	.82

TABLE 3 Continued

Characteristics Included in the Calculation of the PS	Original (Unmatched) Sample			P[a]	Matched Sample			P[a]
	All Infants in Original Sample	Exclusively Breastfed	Breastfed and Given Formula (IHFF)		All Infants in Matched Sample	Exclusively Breastfed	Breastfed and Given Formula (IHFF)	
Small for gestational age, *n* (%)								
Large for gestational age, *n* (%)	877 (10.1)	392 (9.5)	485 (10.6)	.09	555 (10.5)	275 (10.4)	280 (10.5)	.82
Region, *n* (%)				.91				.91
Central	54 (10.2)	26 (1.0)	28 (1.1)		54 (10.2)	26 (1.0)	28 (1.1)	
Metropolitan area	4332 (82.6)	2164 (81.5)	2168 (81.7)		4332 (82.6)	2164 (81.5)	2168 (81.7)	
Northeast	135 (2.5)	69 (2.6)	66 (2.5)		135 (2.5)	69 (2.6)	66 (2.5)	
South central	89 (1.7)	46 (1.7)	43 (1.6)		89 (1.7)	46 (1.7)	43 (1.6)	
Southeast	606 (11.4)	304 (11.5)	302 (11.4)		606 (11.4)	304 (11.5)	302 (11.4)	
West	94 (1.8)	46 (1.7)	48 (1.8)		94 (1.8)	46 (1.7)	48 (1.8)	
Mother's age, median (IQR)	28 (24–33)	28 (24–32)	29 (24–33)	.41[c]	28 (24–32)	28 (24–32)	28 (24–33)	.41[c]
Prepregnancy BMI, median (IQR)	27 (23–32)	26 (23–31)	27 (23–32)	.22[c]	27 (23–32)	27 (23–32)	27 (23–32)	.22[c]
Outcome of interest								
Days breastfed, median (IQR)	146 (38–344)	199 (64–382)	98 (23–272)	<.001[c]	133 (34–334)	190 (62–378)	89 (18–263)	<.001[c]

HS, high school; IOM, Institute of Medicine; IQR, interquartile range; —, not applicable.

a P value for χ^2 test.

b Cultural identity was determined by race, ethnicity, mother's country of origin, and self-reported cultural affiliation.

c P value for nonparametric test.

frequency of feedings throughout the hospital stay. Skin-to-skin care has been shown to be safe and leads to improved breastfeeding outcomes, including duration.[45,46]

Careful assessment of the breastfeeding dyad determines when supplementation is medically necessary. The mother's own milk should be used for supplementation whenever possible. When the mother's milk is not available, pasteurized donor human milk can protect the infant's vulnerable digestive system while reinforcing the importance of breast milk and the temporary nature of supplementation. Prenatally expressed colostrum may be an option in some circumstances.[47,48] Infants given human milk are considered exclusively breastfed and are more likely to be breastfeeding or exclusively breastfeeding at discharge.[49,50]

Supplementation should be given in physiologically appropriate small volumes, combined with best practice breastfeeding management, including frequent milk removal by hand expression or pumping. Pediatric provider skill building and knowledge in breastfeeding management is important, as is team-based care including physicians, nurses and lactation specialists, to help mothers and families reach their infant feeding goals. When families request formula, care providers can explore the reasoning behind the request and address their concerns in a culturally appropriate way.

Continuity of care remains important through hospital discharge, especially for families of infants who have received supplementation. Families need a clear plan for increasing milk supply and decreasing supplementation so that the mother's milk supply is not reduced by ongoing supplementation. Discharge plans

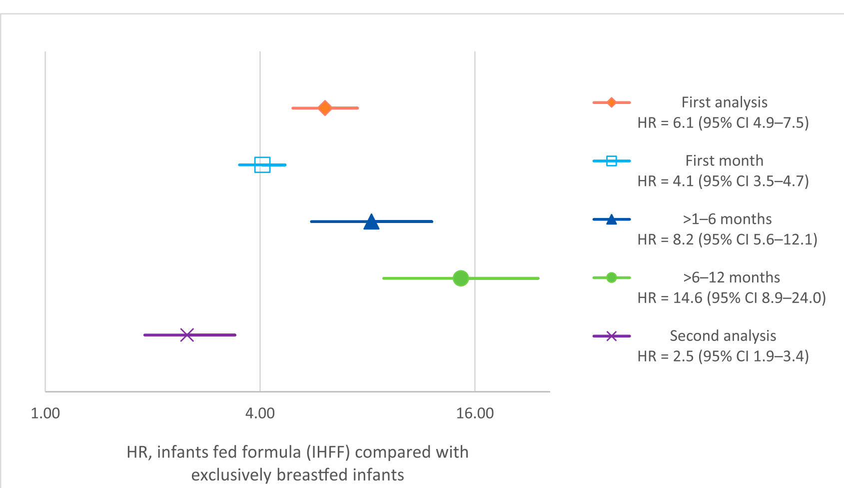

FIGURE 5
HRs for weaning across the first year, in PS-matched cohorts, comparing exclusively breastfed infants with infants exposed to IHFF.

should include early and ongoing follow-up with a provider experienced with lactation management until breastfeeding issues have been resolved. All families should be provided referrals to community resources for ongoing support.[42]

Non–medically necessary IHFF is often attributed to mother's preference, but this is disputed in studies. The Listening to Mothers II survey revealed that 81.4% of those intending to breastfeed intended to breastfeed exclusively.[14] Chantry et al[9] found that of mothers intending to exclusively breastfeed, only 53% achieved their goal. Declercq et al[14] found that when mothers who intended to exclusively breastfeed gave birth in hospitals practicing none or 1 of the BFHI Ten Steps, only 14% achieved their goal. Gagnon et al[10] found that supplementation was affected by time of birth, with births between 7 PM and 9 AM at increased risk. Perrine et al[8] found that overall, 60% of mothers do not reach their breastfeeding goals, and IHFF contributes to this outcome.

Mother's intention to exclusively breastfeed is heavily influenced by social, cultural, and economic factors but can be changed through prenatal education delivered in culturally appropriate ways, such as peer counseling. Some studies have revealed that prenatal participation in WIC may improve breastfeeding exclusivity and duration.[51,52]

In recent years, concerns have been raised about the safety of exclusive breastfeeding in the first days of life, with some advocating for routine use of small amounts of formula to prevent the rare circumstance in which failure to successfully establish breastfeeding, combined with a lack of proper follow-up, may lead to tragedy. Essential to human survival, breastfeeding is a robust process. In the medical model in which women in the United States give birth, however, multiple processes interfere with the establishment of breastfeeding. A breastfeeding-friendly hospital environment gets infants off to the best start. For the mother-infant dyad, we need to ensure care that recognizes when breastfeeding is not going well and provides early and ongoing skilled assistance in resolving breastfeeding issues.

In this analysis, we recognize IHFF not only as a predictor of breastfeeding duration but also as an intermediate outcome in which many factors contribute to the decision to formula feed a breastfed infant; addressing these factors could reduce IHFF and avoid the long-term consequences of early formula use, including shortened breastfeeding duration.

The population of infants in this study is of lower income and is more culturally diverse than the general population, which may limit generalizability of the results.

Much of WIC data rely on self-report. Because food benefits are tied to breastfeeding status, there may be an incentive to underreport breastfeeding to receive more formula or to overreport breastfeeding so that the mother remains eligible for benefits for the period 6 to 12 months post partum. Weaning information was collected near to the time of weaning, avoiding recall bias. For this study, it was assumed that reporting bias was unrelated to IHFF status and thus did not bias the results.

Mothers' breastfeeding intentions are not collected by WIC and were not available for this study. Although exclusivity intentions were unmeasured, many factors correlated with intention were included in calculation of the PSs. Nevertheless, residual bias may remain. Intention to use formula may influence duration, but this factor is modifiable and can be addressed prenatally.[53] Self-efficacy is known to influence breastfeeding behaviors but was not available for this study.

CONCLUSIONS

IHFF of breastfed infants is widespread among participants in Minnesota WIC, as is shorter-than-recommended and shorter-than-desired duration of breastfeeding. Addressing the societal, structural, and procedural factors that contribute to IHFF has the potential to improve breastfeeding duration and thus the lifelong health of both mothers and infants. Strategies to reduce IHFF include culturally appropriate prenatal education, peer counseling, and hospital implementation of BFHI steps such as staff and physician education, giving supplementation only when medically indicated, and early skin-to-skin contact.[1] Team-based care including lactation specialists integrated into routine patient care helps to reduce IHFF and supports the infant feeding goals of mothers and families, leading to increased breastfeeding duration.

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ABBREVIATIONS

BFHI: Baby-Friendly Hospital Initiative
CI: confidence interval
HR: hazard ratio
IHFF: In-hospital formula feeding
PS: propensity score
WIC: Special Supplemental Nutrition Program for Women, Infants, and Children

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In-Hospital Formula Feeding and Breastfeeding Duration

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