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Hing Ting Connie Li
connie.li.ht@gmail.com

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**Association between engagement in a community-based home visitation
program and birth spacing between first and second children**

H. Connie Li

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Committee Chair: Dr. Joshua L. Warren
Committee Member: Dr. Margaret L. Holland

Abstract

OBJECTIVE: To identify patterns in engagement in the Connecticut-based home visitation program, Nurturing Families Network (NFN), and to determine whether associations exist between various engagement patterns and birth-to-pregnancy intervals between first and second children.

METHODS: Repeated measures latent class analysis was employed to identify patterns in program engagement among 5,248 families enrolled in NFN with available home visit information. Maternal socio-demographic characteristics were examined to identify potential predictors of engagement patterns. Propensity score matching was used to identify firstborn children of families in Connecticut with comparable eligibility and tendency to enroll in NFN. Survival analysis was conducted to assess the association between engagement patterns and birth-to-pregnancy intervals for 19,489 firstborn children both enrolled and not enrolled in NFN.

RESULTS: Five engagement patterns were identified. A large proportion of NFN participants is comprised of “High, late drop attenders” (22%), who maintain high levels of engagement for at least 9 months before gradually dropping out of the program, and “High, early drop attenders” (21%), who have near perfect home visit attendance in the first couple of months but begin to drop out at around 3 to 6 months. Engagement patterns are associated with interpregnancy intervals, but are not significantly associated with narrow interpregnancy intervals of <18 months. Engagement patterns are significantly associated with characteristics of the mother, such as age, race, and socioeconomic status.

CONCLUSIONS: Distinct patterns exist in program engagement by participants enrolled in home visitation programs. Maternal socio-demographic characteristics can influence how and when participants engage in home visitation relative to first child’s birth. Engagement patterns are shown to be associated with interpregnancy intervals; in particular, “Not enrolled” and “Low attendance” families were observed to have increased risk of more narrow interpregnancy intervals. Further investigation of home visit attendance records is necessary to confirm findings in engagement patterns.

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Table 1. Demographics of families who had a second pregnancy within 18 months of their first birth.

Characteristic	Second pregnancy occurred within 18 months of first birth, % or Mean (SD)	
	Yes	No
N	1,019	16,086
Year of Birth	2009.2	2009.4
Mother's Education Level		
Grade 1 to 11	48.0	38.0
Grade 12	31.6	35.7
College, <4 years	16.0	19.7
College, 4 years	2.7	3.6
College, 5+ years	1.8	3.0
Mother's Age at Birth*	20.8 (4.5)	21.6 (5.2)
Mother's Race**		
White	24.5	26.6
Black	17.8	22.4
Asian	1.6	1.8
Hispanic	53.7	47.4
Other	2.3	1.9
Mother's Country of Birth**		
U.S.	67.3	67.7
U.S. Other	11.4	8.8
Foreign	21.4	23.6
Had Connection w/ Partner at Birth	61.0	61.8
†Concentrated Poverty	0.81 (1.27)	1.13 (1.28)
‡Hispanic Enclave	0.69 (1.22)	0.95 (1.27)
#Housing Stability	-0.73 (0.89)	-0.95 (0.85)
Had Prenatal Enrollment	5.1	4.3
Insurance for Prenatal Care		
Public / Medicaid	73.2	70.8
Private	15.0	18.5
Self-pay	7.1	6.1
Other	4.7	4.7
Insurance for Delivery		
Public / Medicaid	69.8	71.4
Private	15.7	18.1
Self-pay	7.6	5.2
Other	6.7	5.3

†Aggregate of % households in poverty, % households on public assistance, and % single mothers at census-tract level.

‡Aggregate of % Spanish-speaking households, % linguistically isolated households, and % Puerto Rican residents at census-tract level.

#Aggregate of % living in same house as 1 year ago and median income at census-tract level.

Table 2. Model fit statistics for repeated measures latent class analysis.

No. of Classes	AIC	Adjusted BIC	Proportion of families in the smallest class
1	17,471	17,501	1.00
2	8,162	8,226	0.33
3	5,547	5,645	0.10
4	3,314	3,446	0.10
5	2,323	2,489	0.09
6	1,849	2,048	0.08

Note: AIC = Akaike information criterion; BIC = Bayesian information criterion.

Table 3. Multinomial logistic regression model examining socio-demographic variables in predicting membership in program engagement patterns.

Characteristic	Class 1: “High, constant”, % or Mean (SD)	Class 2: “High, late drop”, % or Mean (SD)	Class 3: “Late, inconsistent”, % or Mean (SD)	Class 4: “Low”, % or Mean (SD)	Class 5: “High, early drop”, % or Mean (SD)
N	647	1158	478	1858	1107
Average Home Visits Received in 36 months since birth	78.4	30.1	44.3	2.8	9.5
Year of Birth**	2008.8 (2.6)	2010.2 (2.9)	2010.0 (2.6)	2010.0 (2.9)	2010.5 (3.0)
Mother’s Education Level					
Grade 1 to 11	37.5	38.9	38.1	38.5	36.8
Grade 12	38.4	34.4	35.5	34.6	33.9
College, <4 years	16.7	19.7	18.5	20.1	20.4
College, 4 years	4.2	3.7	3.0	3.5	4.8
College, 5+ years	3.1	3.3	4.9	3.3	4.1
Mother’s Age at Birth*	22.4 (5.9)	21.7 (5.3)	22.6 (6.0)	21.7 (5.3)	21.9 (5.5)
Mother’s Race**					
White	24.7	25.7	29.9	23.6	24.8
Black	16.5	20.0	19.0	26.3	26.6
Asian	2.6	1.0	0.8	1.1	0.9
Hispanic	54.9	51.3	49.2	47.1	45.1
Other	1.2	2.1	1.1	1.9	2.7
Mother’s Country of Birth**					
U.S.	56.9	64.3	62.9	68.5	69.1
U.S. Other	10.6	9.9	8.8	9.3	8.5
Foreign	32.6	25.8	28.3	22.3	22.4
Had Connection w/ Partner at Birth*	68.0	61.3	65.9	60.9	62.7
Concentrated Poverty*	0.85 (1.34)	0.77 (1.30)	0.80 (1.24)	0.92 (1.30)	0.84 (1.32)
Hispanic Enclave	0.76 (1.35)	0.70 (1.29)	0.65 (1.25)	0.72 (1.31)	0.66 (1.28)
Housing Stability	-0.77 (0.90)	-0.72 (0.93)	-0.71 (0.91)	-0.78 (0.93)	-0.72 (0.94)
Had Prenatal Enrollment**	28.3	22.5	1.7	10.9	19.7
Insurance for Prenatal Care*					
Public / Medicaid	68.8	70.1	68.7	72.5	71.0
Private	16.2	18.2	19.5	18.2	19.4
Self-pay	8.4	6.5	5.7	5.6	4.9
Other	6.7	5.2	6.1	3.7	4.8
Insurance for Delivery*					
Public / Medicaid	69.8	71.4	70.3	73.7	72.6
Private	15.7	18.1	19.0	18.1	18.4
Self-pay	7.6	5.2	4.4	4.6	4.2
Other	6.7	5.3	6.3	3.7	4.9

*Significant at * p<0.05; **p<0.0001*

Table 4. Logistic regression model examining associations between class membership and narrow spacing (<18 months) between first birth and second pregnancy.

Characteristic	Odds Ratio (95% CI)
Engagement Pattern	
Class 0 “Not Enrolled”	1.05 (0.85, 1.30)
Class 1 “High, constant”	1.04 (0.77, 1.40)
Class 2 “High, late drop”	0.94 (0.71, 1.25)
Class 3 “Late, inconsistent”	1.01 (0.72, 1.43)
Class 4 “Low”	1.08 (0.84, 1.37)
Class 5 “High, early drop”	--
Year of Birth*	0.98 (0.96, 0.95)
Mother’s Age at Birth*	0.98 (0.97, 0.99)
Mother’s Race**	
White	--
Black	0.74 (0.64, 0.86)
Asian	1.00 (0.69, 1.46)
Hispanic	1.01 (0.89, 1.14)
Other	1.33 (0.98, 1.81)
Mother’s Country of Birth	
U.S.	--
U.S. Other	1.09 (0.93, 1.28)
Foreign	1.00 (0.88, 1.14)
Connection w/ Partner at Birth	
No	--
Yes	1.04 (0.95, 1.14)
Concentrated Poverty**	1.11 (1.07, 1.15)
Prenatal Enrollment	
No	--
Yes	1.11 (0.88, 1.40)
Insurance for Prenatal Care	
Public / Medicaid	--
Private	0.76 (0.39, 1.51)
Self-pay	1.08 (0.69, 1.71)
Other	0.81 (0.33, 1.96)
Insurance for Delivery	
Public / Medicaid	--
Private	1.37 (0.69, 2.72)
Self-pay	1.12 (0.70, 1.81)
Other	1.34 (0.56, 3.21)

*Significant at * $p < 0.05$; ** $p < 0.0001$*

Table 5. Cox regression model predicting average birth-to-pregnancy interval (in days) between first and second child.

Characteristics	β -estimate	Standard Error	<i>p</i> -value	Hazard Ratio
Engagement Pattern*				
Class 0 “Not Enrolled”	0.200	0.060	0.001	1.22
Class 1 “High, constant”	0.144	0.083	0.081	1.16
Class 2 “High, late drop”	0.067	0.077	0.386	1.07
Class 3 “Late, inconsistent”	0.140	0.097	0.150	1.15
Class 4 “Low”	0.155	0.069	0.024	1.17
Class 5 “High, early drop”	--	--	--	--
Year of Birth	0.005	0.006	0.399	1.01
Mother’s Age at Birth**	-0.044	0.003	<.0001	0.96
Mother’s Race**				
White	--	--	--	--
Black	-0.190	0.039	<.0001	0.83
Asian	-0.024	0.108	0.821	0.98
Hispanic	0.015	0.035	0.666	1.02
Other	-0.039	0.092	0.675	0.96
Mother’s Country of Birth				
U.S.	--	--	--	--
U.S. Other	0.069	0.043	0.111	1.07
Foreign	0.017	0.036	0.635	1.02
Connection w/ Partner at Birth				
No	--	--	--	--
Yes	0.030	0.025	0.238	1.03
Poverty**	0.082	0.010	<.0001	1.09
Prenatal Enrollment				
No	--	--	--	--
Yes	0.019	0.062	0.765	1.02
Insurance for Prenatal Care*				
Public / Medicaid	--	--	--	--
Private	0.259	0.170	0.128	1.30
Self-pay	0.386	0.118	0.001	1.47
Other	0.254	0.230	0.269	1.29
Insurance for Delivery				
Public / Medicaid	--	--	--	--
Private	-0.134	0.171	0.433	0.87
Self-pay	-0.246	0.124	0.047	0.78
Other	-0.198	0.228	0.386	0.82

*Significant at * $p < 0.05$; ** $p < 0.0001$*

Table 6. Cox regression model predicting average birth-to-pregnancy interval (in days) between first and second child, censoring at 18 months

Characteristics	β -estimate	Standard Error	<i>p</i> -value	Hazard Ratio
Engagement Pattern				
Class 0 “Not Enrolled”	0.061	0.099	0.534	1.06
Class 1 “High, constant”	-0.005	0.141	0.974	1.00
Class 2 “High, late drop”	-0.096	0.131	0.463	0.91
Class 3 “Late, inconsistent”	0.013	0.161	0.938	1.01
Class 4 “Low”	0.043	0.115	0.710	1.04
Class 5 “High, early drop”	--	--	--	--
Year of Birth**	-0.039	0.009	<.0001	0.96
Mother’s Age at Birth**	-0.020	0.005	<.0001	0.98
Mother’s Race**				
White	--	--	--	--
Black	-0.290	0.070	<.0001	0.75
Asian	0.012	0.177	0.945	1.01
Hispanic	-0.008	0.060	0.890	0.99
Other	0.256	0.139	0.065	1.29
Mother’s Country of Birth				
U.S.	--	--	--	--
U.S. Other	0.081	0.073	0.267	1.09
Foreign	0.012	0.062	0.851	1.01
Connection w/ Partner at Birth				
No	--	--	--	--
Yes	0.024	0.044	0.581	1.03
Poverty**	0.098	0.018	<.0001	1.10
Prenatal Enrollment				
No	--	--	--	--
Yes	0.088	0.106	0.405	1.09
Insurance for Prenatal Care				
Public / Medicaid	--	--	--	--
Private	-0.275	0.324	0.395	0.76
Self-pay	0.054	0.213	0.802	1.06
Other	-0.214	0.401	0.593	0.81
Insurance for Delivery				
Public / Medicaid	--	--	--	--
Private	0.310	0.325	0.341	1.36
Self-pay	0.144	0.223	0.519	1.15
Other	0.290	0.395	0.464	1.34

*Significant at * $p < 0.05$; ** $p < 0.0001$*

Time Period	1	2	3	4	5	6	7	8	9
Age of child (time since birth)	1 month	2-3 months	3-6 months	7-9 months	10-14 months	15-19 months	20-24 months	25-30 months	31-36 months

Figure 1. Time periods relative to child’s birth used in identification of engagement patterns. Families’ completion of 50% of recommended home visits within each time period act as an indicator for specific engagement patterns.

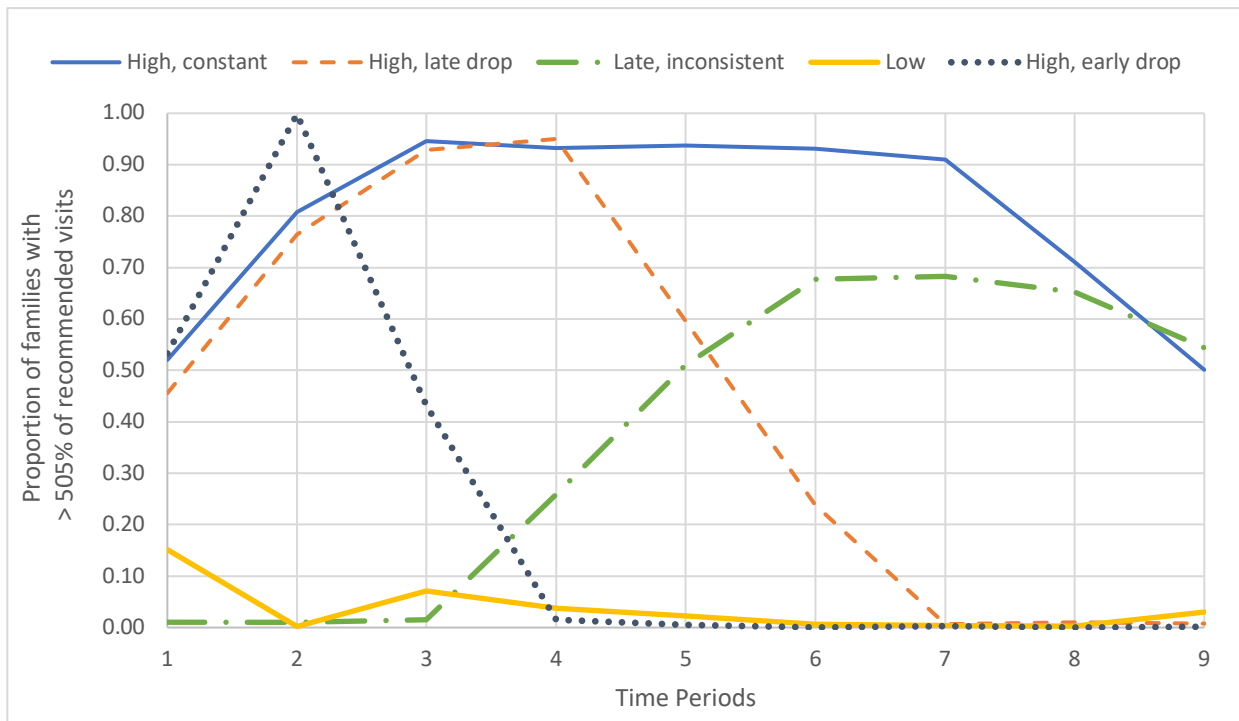


Figure 2. Patterns in home visit completion of each class by time periods following child’s birth.

Background

Adverse birth outcomes, including low birth weight, small-for-gestational age, and preterm birth, can have life-long impacts on the health of children. Studies have shown birth spacing, or the allotted time between births, to be associated with birth outcomes; in particular, narrow birth spacing is associated with an elevated risk in adverse perinatal outcomes as well as maternal outcomes¹. In multiple studies, interpregnancy interval—the time between birth of one child and conception of the next—of less than 18 months has been found to be significantly associated with increased risk of preterm delivery²⁻⁴. The World Health Organization recommends an interval of at least 24-months after a live birth and before attempting the next pregnancy⁵. In 2014, 28.9% of mothers who had a second or higher-order birth had a short interpregnancy interval of less than 18 months in the U.S¹. This high number of closely spaced births is a growing concern, and reduction of this number has been addressed as a Healthy People 2020 goal¹.

Home visiting is a prevention strategy which aims to improve health of children and families by encouraging better parenting practices and family planning and acts as a conduit to other health and social services⁶. Nurturing Families Network (NFN) is a statewide home visitation (HV) program in Connecticut (CT) that targets first-time mothers and recruits the majority of its participants in hospitals after birth. Families enrolled in NFN receive home visits from a paraprofessional with a focus on nurturing parenting, healthy families, parent life outcomes, and school readiness.⁷ The approach of supporting families and connecting them with the necessary resources should improve overall outcomes for subsequent children.

NFN has served over 9,000 families in CT since 1995.⁸ Traditionally, studies conducted on HV programs have employed small to mid-sized randomized controlled trials. The availability of visit data from NFN along with statewide birth certificate data allows for the opportunity to investigate in a large community-based program and look specifically at its effects on subsequent children of families receiving this service.

Methods

Identifying Study Sample via Propensity-Score-Matching

As part of the primary study investigating associations between home visitation and birth outcomes, data from NFN between 2005 and 2015 (n=7,870) were linked with birth certificate data from the same years (n=413,191) using probabilistic matching based on variables including mother and child's dates of birth, child sex, race, and town of residence.⁹ Propensity score matching was used to identify similar comparison families for each NFN family. Maternal demographics including age, education, birth place, and census block characteristics (aggregated into 3 factors: Hispanic enclave, housing stability, concentrated poverty) were variables used to estimate propensity of NFN enrollment.⁹ Given that NFN is a program targeting first-time mothers, the study sample was limited to all firstborns enrolled in NFN and all firstborns identified through propensity score matching (n=19,489) for the purposes of this investigation.

Identifying Patterns in Engagement

Patterns in program engagement were identified via repeated measures latent class analysis. *PROC LATENT CLASS ANALYSIS*¹⁰ in SAS version 9.4 was used to identify visit attendance

classes (families or dyads who follow similar engagement patterns). All participants of NFN with available home visit information whose data linked with the birth certificate dataset (n=5,248) were included to identify patterns that would be generalizable to the overall population of interest. The number of visits attended per month was used to cluster families who enrolled in NFN into common patterns of home visit attendance. Patterns were established based on when families attended or missed visits, and when they dropped out. Families were assessed for whether they completed at least 50% of recommended home visits within various time periods with respect to birth. Engagement in 9 time periods—following the scheme shown in Figure 1—act as indicators as to which engagement pattern families fell under. Time periods were determined in accordance to program design as well as key stages in child development. Families who were not affiliated with NFN were grouped into a separate class “Not Enrolled” and were excluded in the latent class analysis.

Identifying Predictors for Engagement Patterns

Multinomial logistic regression was used to examine socio-demographic variables to determine their role in explaining individual membership of engagement patterns. Variables that were significant in predicting membership were controlled for in subsequent survival analysis models.

Associations Between Engagement Patterns and Interpregnancy Interval

Following identification of engagement patterns, the association between patterns and interpregnancy interval was examined; interpregnancy interval was considered both as a binary and continuous variable. Logistic regression was used to assess whether patterns can predict if there was sufficient birth spacing based on a chosen threshold for interpregnancy interval. Cox

regression modeling was also conducted to examine whether engagement patterns resulted in a difference in average interpregnancy intervals.

Results

Patterns in Program Engagement

The 5-class model was selected, for the purposes of reporting results, based on the Akaike Information Criterion (AIC) and adjusted Bayesian Information Criterion (BIC), in addition to the proportion of families falling under each class (Table 2). The 5-class model was representative of distinct patterns of engagement among NFN participants, in consideration of engagement patterns identified in previous studies conducted on other home visitation programs.^{11,12} Figure 2 illustrates these classes, each representing a behavioral pattern in program engagement generalizable to a specific group of families.

“High, constant attenders” (13%) maintain high levels of engagement for at least 2 years. “High, late drop attenders” (22%) maintain high levels of engagement for at least 9 months before gradually dropping out of the program. “High, early drop attenders” (21%) have near perfect home visit attendance in the first couple of months but begin to drop out at around 3 to 6 months. “Low attenders” (36%) have low to no engagement throughout their enrollment in the NFN program. “Late, inconsistent attenders” (9%) do not begin program engagement until the 7-9 month period and maintain inconsistent attendance throughout their enrollment.

Predictors for Engagement Pattern

Socio-demographic variables—including those used to establish propensity of program enrollment,—were examined; of which, year of birth, mother’s age at birth, mother’s race, mother’s country of birth, connection with partner at birth, census block concentrated poverty, prenatal enrollment in NFN, type of insurance used for prenatal care, and type of insurance used for delivery were found to be statistically significant in predicting latent class membership (Table 3). These variables were adjusted for in the models that follow, describing associations between program engagement and birth spacing intervals.

Engagement patterns and Narrow Birth-to-Pregnancy Spacing

No evidence was observed for an association between engagement patterns and narrow birth spacing (defined here as a binary variable of less than 18 months between first birth and second pregnancy). Year of birth, mother’s age at birth, mother’s race, connection with partner at birth, and poverty were found to be significantly associated with narrow birth spacing. Lower risk for narrow birth spacing is associated with older mothers and for births in later years. Black mothers are associated with lower risks for narrow birth spacing compared to White mothers. Increase in neighborhood concentrated poverty is also observed be associated with increased odds in narrow birth spacing (Table 4).

Engagement Pattern and Average Birth-to-Pregnancy Interval

Average birth-to-pregnancy intervals were examined via Cox regression model. Among families whose first birth was in 2005-2015, 7310 (37.5%) mothers had a second pregnancy within this timeframe. The median birth-to-pregnancy interval is 808 days (IQR: 428 – 1377). Engagement

pattern, mother's age at birth, mother's race, poverty, and type of prenatal care insurance were significantly associated with birth-to-pregnancy intervals between first and second child (Table 5). A significant difference was noted between hazard rates of families "Not Enrolled" and "High, early drop attenders". Hazard rates between "Low attenders" and "High, early drop attenders" were also found to be significantly different.

Given previous studies have shown that birth-to-pregnancy intervals of less than 18 months are significantly associated with increased risk of preterm delivery, censoring at 18 months was conducted to examine associated hazard²⁴. 2483 (12.7%) mothers had a second pregnancy within 18 months of their first birth. The median birth-to-pregnancy interval for these families was 313 days (IQR: 193 – 436). Year of birth, mother's age at birth, mother's race, and poverty were significantly associated with birth-to-pregnancy intervals, given censoring at 18 months (Table 6). In both models, increase in mother's age at birth was associated with a decrease in birth spacing. Black mothers were observed to have a lower associated hazard rate in comparison to White mothers. Higher likelihood of poverty is also observed to be significantly associated to increase in hazard rate.

Discussion

Among NFN participants, a large proportion of families consists of "High, late drop attenders" (22%) and "High, early drop attenders" (21%). Based on the observed engagement patterns, most families drop out within the first 12 months of their child's birth, and only a small group of "High, constant attenders" receive over 50% of recommended home visits for prolonged periods of time. These families may be more vulnerable and may require more

assistance, which may have resulted in the home visitor allocating more time to them under the case-by-case adaptation practice of the NFN program.⁸ It should be noted that the group of “Late attenders”, enrolling at the 7-9 month period, is unusual, given that screening for NFN eligibility takes place early on in hospitals immediately following birth of the firstborn child and up to 3 months after birth.⁸ Late enrollment may potentially indicate circumstances or lead to other factors that may be associated with birth spacing and other birth outcomes. Aside from “Late attenders”, engagement patterns and drop out times observed in this investigation are similar to patterns found in previous studies conducted on another home visitation program.^{11,12}

Examination of birth-to-pregnancy intervals via Cox regression indicates that engagement patterns may be associated with spacing between first and second child. Families “Not Enrolled” and families with “Low” attendance both appear to be associated with increased hazard rates compared to families who have “High, early drop” attendance immediately following birth of first child. In the model subject to more stringent censoring of <18 months, “High, late drop” attenders were found to be associated with a lowered hazard rate of narrow birth spacing; however, these associations were not found to be statistically significant. The results observed in these models suggest that home visits following birth may potentially have an overall effect on birth spacing of the subsequent child through providing families with resources to help improve family planning. Although engagement patterns are associated with interpregnancy intervals in general, no significant association was observed between engagement patterns and narrow interpregnancy intervals of <18 months, specifically. Further investigation of these findings is necessary, by examining interactive relationships with other socio-

demographic variables to better understand association directionality between engagement patterns and interpregnancy intervals.

Various socio-demographic factors demonstrate significance in predicting patterns in program engagement. Investigation in these characteristics should be conducted to better target families and provide them with assistance that is needed. In alignment with existing literature, characteristics of the mother is shown to be associated with participation in the program, which can impact overall effectiveness of the program.¹²⁻¹⁴ Thus, it is important to take into consideration social and cultural factors when implementing strategies to encourage enrollment and engagement.

Furthermore, mother's age at birth, race, and neighborhood concentrated poverty have consistently shown significant associations with birth spacing outcomes in models employed in this study (Tables 2-4). Increase in mother's age is associated with lower hazard rate for narrow birth spacing. Mother's age is reflective of other factors that may potentially be associated with birth spacing, such as family and economic status as well as stability in other areas of life. Higher neighborhood concentrated poverty is associated with higher hazard rates of narrow birth spacing, which could potentially be explained by challenges in accessing health care and other resources.

Limitations

Engagement patterns observed in this study are based on administrative data obtained from NFN. Missing information and random errors in data entry is inevitable due to the substantial size of the program and number of participants. A closer examination of home visit information of "Low" and "Late attenders" may be necessary to confirm that engagement

patterns determined via latent class analysis is true and not an artifact of unavailable or unreliably documented information. Generalizability of findings may be limited to participants enrolled in home visiting as well as to those residing in the region. Moreover, birth certificate information used in this analysis is limited to 2005 to 2015. Given availability of data in later years from NFN, restricted access to birth certificate information limited analysis to only include NFN participants of earlier years.

Conclusions

Distinct patterns exist in program engagement by participants enrolled in home visitation programs. Maternal socio-demographic characteristics can influence how and when participants engage in home visitation. Engagement patterns are shown to be associated with interpregnancy intervals; in particular, being in the “Not enrolled” and “Low attendance” groups were associated with narrower interpregnancy intervals.

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