Expectant fathers' health behaviors, infant care intentions, and social-emotional wellbeing in the perinatal period: A latent class analysis and comparison to mothers

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ABSTRACT

While parental behaviors during the 'first thousand days' are critical for child health, little is known about fathers during this time. We examined prenatal patterns of health behaviors, social-emotional wellbeing, and infant care intentions among expectant fathers, both overall and compared to expectant mothers. Among 227 mother-father dyads enrolling in a randomized controlled trial of a perinatal obesity prevention program in Boston, Massachusetts (July 2020–July 2022), participants independently completed baseline surveys addressing (1) health behaviors, (2) social emotional wellbeing, and (3) infant care intentions. We compared paternal and maternal responses to survey items within each of these domains. Further, we conducted a latent class analysis of paternal responses and examined their associations with sociodemographic characteristics. Compared to expectant mothers, fathers were more likely to report increased body mass index, less fruit intake, decreased sleep, increased physical activity, and no recent primary care visit. Latent class analysis revealed four distinct groups of paternal health behaviors and infant care intentions: (1) more health behaviors with less infant care; (2) less health behaviors with less infant care; (3) less health behaviors with more infant care; and (4) more health behaviors with more infant care. Fathers with increased health behaviors were more likely to have higher education and income. Fathers with decreased health behaviors were more likely to endorse food insecurity, housing insecurity, and social isolation. Our findings identify potential areas for targeting expectant fathers in health promotion initiatives and suggest that social needs may impact the capacity to adopt healthy lifestyle behaviors.

1. Background/Introduction

The first 1000 days – from pregnancy through a child's second birthday – are a critical period for optimizing children's health and nutrition, with implications for future growth, development, and risk of chronic disease (Technical Guidance Brief, 2014). While maternal-child health has traditionally been at the center of initiatives targeting the first 1000 days, increasing evidence supports the importance of fathers' participation. Paternal involvement in the perinatal period is associated with reduced prevalence of adverse birth outcomes (Alio et al., 2011;

Alio et al., 2010; Surkan et al., 2019); reduced maternal depression (Giurgescu and Templin, 2015), and higher rates of breastfeeding (Redshaw and Henderson, 2013). The impact of fathers extends beyond the first 1,000 days, as fathers influence their children's lifestyle behaviors, dietary quality, obesity risk, and social-emotional wellbeing throughout childhood and beyond (Khandpur et al., 2014; Wong et al., 2017; Lloyd et al., 2014; Rosenberg and Wilcox, 2006). Despite this importance, a minority of health behavior interventions in the perinatal period include fathers (Lee et al., 2018; Morgan et al., 2017).

A substantial body of literature characterizes maternal health

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behaviors in the perinatal period. Several large studies suggest that many pregnant people do not meet dietary guidelines, with disparities between racial/ethnic and socioeconomic groups (Bodnar et al., 2017; Carmichael et al., 2019; Bailey et al., 2019; Rai et al., 2015). Many pregnant people do not meet physical activity guidelines (Hesketh and Evenson, 2016) and suffer from sleep-related disorders (Salari et al., 2021). Knowledge of dietary, physical activity, and sleep behaviors – as well as evidence that behaviors evolve throughout pregnancy and post-partum – has been critical in informing both interventions (Dalrymple et al., 2018) and broader policies from professional organizations invested in maternal-child health (Marshall et al., 2022; Dipietro et al., 2019; Report of the Commission on Ending Childhood Obesity, 2017).

Far less is known about paternal behaviors in the perinatal period. Several observational studies have found that fathers have increased risk of weight gain compared to men without children (Syrda, 2017; Garfield et al., 2016). Emerging literature suggests that fatherhood is associated with decreased physical activity (Pot and Keizer, 2016; Saxbe et al., 2018) and impaired sleep (Wynter et al., 2020), with a minority of fathers meeting dietary recommendations (Nasuti et al., 2014). The transition to fatherhood is associated with increased stress (Philpott et al., 2017) and increased risk for depression versus the general population (Cameron et al., 2016). Better understanding of paternal health behaviors in the perinatal period is critical to meet new fathers' needs in this profound transitional period, with implications for both paternal health and overall wellbeing of the mother-father-infant triad.

The current study aims to describe expectant fathers' health-related behaviors, social-emotional wellbeing, and parenting expectations during the second trimester of pregnancy, both overall and compared to expectant mothers. Additionally, we aim to use latent class analysis – an analytic approach that identifies subgroups within a population based on participant characteristics - to better understand the heterogeneity that may exist among fathers. We hypothesize that while fathers will differ from mothers across these domains, distinct patterns (latent classes) will emerge among fathers' responses. These findings may have implications for understanding fathers' unique needs when engaging them in health promotion interventions within the perinatal period.

2. Methods

2.1. Setting, participants, and procedures

This analysis includes baseline data from expectant mother-father dyads (n = 227 dyads) enrolled from July 2020–July 2022 in *First Heroes*, a randomized controlled trial of an intervention equally engaging fathers and mothers in pregnancy and parenthood while addressing social determinants of health and obesity-related health behaviors. We report detailed protocol and intervention design elsewhere (Whooten et al., 2021).

We identified potentially eligible dyads via electronic health records (EHR) of scheduled 2nd trimester fetal anatomy ultrasounds at Massachusetts General Hospital (MGH) and Brigham and Women's Hospital (BWH) in Boston, Massachusetts. Affiliated obstetrics practices included both hospital- and community health center-based clinics, serving a diverse population with over 40% of birthing people identifying as a racial/ethnic minority. Dyads were eligible to participate if (1) English- or Spanish-speaking, (2) >18 years old with a (3) singleton pregnancy without fetal anomalies, and (4) care within the MassGeneral Brigham (MGB) healthcare system. For purposes of this study, we will subsequently refer to birthing people as "mothers." Only mothers with partners identifying as fathers and intending to co-parent were eligible for this study. We determined sample size based on the primary outcome of the randomized controlled trial (Whooten et al., 2021).

Due to COVID19 restrictions, all recruitment was remote (July 2020–July 2022). Potentially eligible mothers (n = 2741) received a study introduction letter. Study staff called mothers to assess interest and obtain father's contact information and permission to contact. We reached a total of 1066 mothers to introduce the study; of these, 324 mothers (30%) and 261 fathers (24%) consented. Each parent provided verbal consent over the phone; consent of both parents was required for enrollment. Participants independently completed a questionnaire addressing health behaviors, parenting expectations, social-emotional wellbeing, and social needs. Following survey completion, each parent received a $15 gift-card and the dyad was randomized. A total of 227 dyads (21% of those introduced to study) completed the baseline survey and are included in this analysis. The MassGeneral Brigham Institutional Review Board approved all study procedures. The trial is recorded in clinicaltrials.gov (NCT04477577).

2.2. Measures

2.2.1. Anthropometrics and health behaviors

2.2.1.1. Anthropometrics. Due to COVID-19, in-person anthropometric measurements were not possible. Each dyad received a study kit containing a Tanita HD-366 digital weight scale along with detailed instructions for at-home measurement of weight and height. Each parent self-reported weight and height via the baseline survey.

2.2.1.2. Dietary intake. Mothers and fathers responded to six questions regarding average consumption of fruits, vegetables, fast food, juice, soda, and other sugar-sweetened beverages within the last 7 days. We derived items from the National Health and Nutrition Examination Survey (NHANES) Dietary Screener Questionnaire (DSQ) (NHANES Questionnaire, 2019). We dichotomized responses for items assessing fruit and vegetable intake into frequent (nearly daily or more) versus less frequent (2–4 times per week or less). We chose this dichotomization cut-point after examining sample distributions, as only a small minority of respondents met World Health Organization guidelines of >4–5 servings of fruits and vegetables daily. Given overall lower reports of fast food and sugar sweetened beverage intake in our sample, we dichotomized responses for items assessing fast food and beverage consumption into frequent (2–4 times per week or more) versus less frequent (once per week or less).

2.2.1.3. Sleep. Mothers and fathers responded to two questions regarding average weekday and weekend sleep duration, with response options ranging in 0.5-hour intervals from <3 h/night to >11 h/night. We dichotomized responses into <7 h versus ≥7 h, based on guidelines for sufficient sleep (Watson et al., 2015).

2.2.1.4. Physical activity. Participants responded to two questions about participation in weekly physical activity, indicating 'yes' or 'no' as to whether they participated in moderate and/or vigorous intensity activity.

2.2.1.5. Healthcare access/routine healthcare maintenance. Participants responded to two questions adapted from the Center for Disease Control (CDC) Pregnancy Risk Assessment Monitory System (PRAMS) (Phase 8 Core Questionnaire: Center for Disease Control (CDC), 2016), including (1) whether they have a primary care provider and (2) healthcare maintenance visit in the past 12 months.

2.2.2. Parenting involvement intention

Participants completed 5 items addressing intended involvement in routine infant care tasks (ECLS-B 9-Month Measure). Parents scored each item on a 5-item Likert scale with response options ranging from rarely to always. Infant care tasks included attending to night awakenings, soothing when upset, taking the child to the doctor, staying home with the child when ill, and taking the child to/from childcare.

2.2.3. Social-emotional wellbeing

Participants completed the Perceived Stress Scale – Short Form (PSS-4), a validated 4-item scale assessing experience of stress over the past month (Cohen et al., 1983). Response options are on a 4-item Likert scale, ranging from never (0) to fairly often (4) with two items reverse-scored (never = 4; fairly often = 0). The PSS-4 item responses are added together for a total score (maximum 16), with higher score indicating higher stress. Participants also completed the Patient Health Questionnaire-2 (PHQ-2), a validated screening measure for depression (Kroenke et al., 2003). Score range is 0 to 6, with a score ≥3 indicating risk for depression and need for further screening.

2.2.4. Social needs

A total of six items addressed four social needs, including food insecurity, housing insecurity, transportation needs, and social connectedness.

We assessed food insecurity through a validated 2-item screen [(1)] "Within the past 12 months we worried whether our food would run out before we got money to buy more" and [(2)] "Within the past 12 months the food we bought just didn't last and we didn't have money to get more", with response options including "often true," "sometimes true," or "never true" (Hager et al., 2010). We classified a "often true" or "sometimes true" to either item as food insecure.

We evaluated housing insecurity via 2-items from the National Survey of American Families. Each respondent reported if, in the last 12 months, [(1)] there was a time when they were not able to pay the mortgage, bills, or rent and whether/if, [(2)] there was a time when they or their children moved in with others because they could not pay mortgage, bills, or rent, with response options "yes" or "no" (Kushel et al., 2006). We classified a yes to either item as housing insecure.

We assessed unmet transportation needs via one item adapted from a Medicare/Medicaid social need screening tool, asking "During the last 12 months, has lack of transportation kept you from medical appointments or from doing things needed for daily living?" with response options including "Yes, this is a problem for me" or "No, this is not a problem for me." (Billioux et al., 2017).

We evaluated social isolation using a single item from the Berkman-Syme Social Network Index (Berkman and Syme, 1979): "In a typical week, how many times do you talk on the telephone with or text your family, friends, or neighbors?", with a 5-item Likert-like response with options ranging from less than "once per week" to "2 or more times per day". We classified participants with less than three per week as socially isolated (Pantell et al., 2013).

2.2.5. Demographics and additional characteristics

Each participant self-reported race, ethnicity, highest level of education completed, annual household income, date of birth, parity, and relationship status. We calculated approximate gestational age at time of survey completion based on maternal estimated due date within the EHR.

2.3. Analyses

We performed chi square, T-tests, and Wilcoxon tests to compare paternal and maternal responses to survey items within the domains of health behaviors, social emotional wellbeing, and infant care expectations.

To examine patterns of paternal responses, we performed latent class analysis for dichotomized indicator variables across these domains (see Supplemental Table 1 for indicator variables, original response categories, and dichotomized response categories). We evaluated models of 2–5 classes, and examined parameters for each model including G2 fit, Akaike's information criterion (AIC), Bayesian Information Criterion (BIC), and entropy R2 (see Supplemental Table 2). We chose the solution with the best fit using statistical criteria as well as theoretical interpretability (Weller et al., 2020). We named each class by paternal health

behavior and infant care intentions represented within the class. We describe the socio-demographic characteristics of each latent class subgroup. To assess the distribution of demographic characteristics between classes, we performed chi-square and fisher's exact tests for categorical variables and ANOVA for continuous variables.

3. Results

3.1. Participant characteristics

We report sample characteristics in Table 1, with 454 individuals (227 mother-father dyads) completing the baseline survey at mean (SD) 21.5 (2.3) weeks gestation. Overall, the sample was racially and ethnically diverse and highly educated, with over 50% of both mothers and fathers identifying as a racial/ethnic minority and approximately 75% of mothers and 66% of fathers reporting a bachelor's degree or higher. A minority of respondents were low income, with approximately 24% of

Table 1

Baseline characteristics of mothers and fathers participating in the *First Heroes* Program, Boston, Massachusetts, July 2020-July 2022.

	Mothers (N = 227)	Fathers (N = 227)	P-value
Age, years, mean (SD)	32.4 (4.9)	33.6 (5.1)	**0.01**
Parity, n (%)			
0	184 (81.1)	176 (77.5)	0.35
1 or more	43 (18.9)	51 (22.5)	
Education, n (%)			
High school/GED	31 (13.7)	48 (21.1)	0.10
Some college or an associate degree	26 (11.5)	27 (11.9)	
Bachelor's degree or higher	170 (74.9)	152 (67.0)	
Household income, n (%)			
Less than $50,000 yearly	53 (23.8)	46 (20.5)	0.70
$50,001 to $100,000 yearly	35 (15.7)	38 (17.0)	
Greater than $100,000 yearly	135 (60.5)	140 (62.5)	
Relationship Status, n (%)			
Married	174 (76.7)	175 (77.1)	0.91
Not married, living together	41 (18.1)	40 (17.6)	
Involved, not living together	10 (4.4)	10 (4.4)	
Other	2 (0.9)	2 (0.9)	
Race/Ethnicity, n (%)			
Hispanic	78 (34.4)	54 (24.0)	0.15
Non-Hispanic White	91 (40.1)	110 (48.9)	
Non-Hispanic Black	31 (13.7)	34 (15.1)	
Non-Hispanic Asian	22 (9.7)	20 (8.9)	
Non-Hispanic Other	5 (2.2)	7 (3.1)	
BMI category, n (%)*			
BMI < 25 kg/m²	126 (55.5)	77 (33.9)	**<0.001**
BMI 25–30 kg/m²	60 (26.4)	97 (42.7)	
BMI > 30 kg/m²	41 (18.1)	53 (23.3)	
Social needs positive screen, n (%)			
Food Insecurity (Yes)	28 (12.3)	23 (10.1)	0.46
Housing Insecurity (Yes)	16 (7.1)	19 (8.4)	0.60
Lack of Transportation (Yes)	11 (4.8)	6 (2.7)	0.22
Social Isolation (Yes)	22 (9.7)	55 (24.2)	**<0.001**
Total Unmet social needs, n (%)			
0	169 (75.1)	146 (65.2)	0.06
1	41 (18.2)	63 (28.1)	
≥2	15 (6.7)	15 (6.7)	

*BMI = Body Mass Index; mothers provided report of pre-pregnancy weight for use in calculation of body mass index.

mothers and 21% of fathers reporting annual household income <$50,000. Approximately 25% of mother and 35% of fathers endorsed ≥1 unmet social need, including food insecurity (12.3% of mothers; 10.1% of fathers), housing insecurity (7.1% mothers, 8.4% fathers), transportation barriers (4.8% mothers, 2.7% fathers), or social isolation (9.7% mothers, 24.2% fathers). Fathers had increased prevalence of body mass index >25 kg/m^2 (65.7%) versus mothers (44.5%), consistent with CDC criteria for overweight (25–30 kg/m^2) and obesity (>30 kg/m^2) (CDC Defining Overweight and Obesity, 2022).

3.2. Health behaviors and social-emotional wellbeing

Table 2 summarizes maternal and paternal health behaviors and social-emotional wellbeing. Mothers were more likely to report frequent fruit intake versus fathers (76.2% versus 53.3%, p < 0.001). A minority of respondents reported fruit and vegetable intake in accordance with WHO guidelines of >4–5 servings daily (Diet, nutrition and the prevention of chronic diseases, 2003) (Mothers: 6.2% fruit, 5.3% vegetable; Fathers: 4.0% fruit, 3.6% vegetable). Fathers were more likely to report frequent fast food and soda intake (17.2% versus 8.8%, p = 0.009; 26.5% versus 9.7%, p < 0.001). Mothers were more likely to report adequate weeknight sleep (75.7% versus 63.3%, p = 0.004). Few fathers within our sample exhibited excessive sleep (n < 10 reporting weekday or weekend sleep >9 h). Fathers were more likely to report participation in weekly vigorous activity (54.0% versus 17.3%; <0.001). Mothers were more likely to report having a primary care physician (93.4% versus 83.7%, p = 0.002) and a visit within the past 12 months (80.2% versus 59.0%, p < 0.001).

Overall, there were low rates of positive depression screening, with no difference noted between mothers (6.2%) and fathers (4.0%). There was no difference in perceived stress total score between mothers and fathers, although mothers were more likely to endorse lack of control (54.2% endorsing "sometimes," "often," or "very often" versus 41.4% of fathers, p = 0.007).

3.3. Infant care involvement intentions

Table 3 summarizes mothers' and fathers' intended involvement in infant care after birth. Overall, both parents intended a high level of involvement with their child. Mothers were more likely to anticipate waking with child overnight (94.3% versus 72.2%, p < 0.001), soothing child when upset (91.6% versus 78.3%, p < 0.001), taking child to the doctor (92.9% versus 68.3%, p < 0.001), and staying home with child when ill (78.7% versus 62.8%, p < 0.001). Fathers were more likely to report intention to take their child to and from childcare (61.3% versus 51.6%, p < 0.04).

3.4. Latent class analysis

The final solution yielded a 4-class model, which was chosen given its lower BIC (2497) compared to the 3- and 5-class models (2780 and 2882, respectively; see Supplemental Table 2). Overall and class-specific response probabilities for each of the 21 possible indicators are provided in Table 4. Class 1 (more health behaviors/less infant care (MHLC); 25% of the sample) was characterized by increased report of healthy nutrition, sleep and physical activity behaviors, high levels of primary care engagement, and lower intended infant care involvement. While Class 2 (less health behaviors with less infant care (LHLC); 13% of the sample) was also characterized by lower levels of intended infant care involvement, this group reported lower adoption of health lifestyle behaviors. Class 3 (less health behaviors with more infant care (LHMC); 28% of the sample) was characterized by lower adoption of health behaviors and higher intended infant care involvement. Class 4 (more health behaviors with more infant care (MHMC); 34% of the sample) was characterized by higher endorsement of health behaviors, along with higher levels of intended infant care.

Table 2

Self-report of health behaviors and social emotional wellbeing in the 2nd trimester of pregnancy among mothers and fathers participating in the *First Heroes* Program, Boston, Massachusetts, July 2020-July 2022.

	Mothers (N = 227) n (%)	Fathers (N = 227) n (%)	p-value
Nutrition			
Frequent fruit intake *(nearly daily or more)*	173 (76.2%)	121 (53.3%)	**<0.001**
Frequent vegetable intake *(nearly daily or more)*	157 (69.2%)	140 (62.2%)	0.12
Less frequent fast-food intake *(once per week or less)*	207 (91.2%)	188 (82.8%)	**0.009**
Less frequent juice intake *(once per week or less)*	140 (61.7%)	156 (68.7%)	0.12
Less frequent soda intake *(once per week or less)*	205 (90.3%)	166 (73.5%)	**<0.001**
Less frequent other SSB intake *(once per week or less)*	193 (85.4%)	176 (77.9%)	**0.04**
Sleep			
Adequate weekday sleep (≥7 h)	171 (75.7%)	143 (63.3%)	**0.004**
Adequate weekend sleep (≥7 h)	201 (88.5%)	194 (86.2%)	0.46
Physical Activity (PA)			
Participation in weekly moderate PA *(Small increase in breathing or heart rate such as brisk walking, bicycling, swimming, or volleyball for at least 10 min continuously)*	144 (63.4%)	154 (67.8%)	0.32
Participation in weekly vigorous PA *(Large increases in breathing or heart rate like running or basketball for at least 10 min continuously)*	39 (17.3%)	122 (54.0%)	**<0.001**
Routine Healthcare Maintenance			
Have a Primary Care Physician (PCP) *(A doctor, nurse, or nurse practitioner you would see for a regular check-up or go to if you have a medical problem)*	212 (93.4%)	190 (83.7%)	**0.002**
Visit with PCP within past 12 months	182 (80.2%)	134 (59.0%)	**<0.001**
Social-emotional wellbeing			
Depression Screening (PHQ-2)' score category, n (%)			
Increased depression risk (Total score 3–6)	14 (6.2%)	9 (4.0%)	0.30
Perceived Stress Scale (PSS-SF) total score, median (IQR)	5 (3, 7)	5 (3, 7)	0.32
PSS-SF Items, n (%): *In the last month, how often have you felt*:			
(1) That you were unable to control the important things in your life?			
Never/Almost never	104 (45.8%)	133 (58.6%)	**0.007**
(2) Confident about your ability to handle your personal problems?			
Sometimes, Often, or Very often	217 (95.6%)	212 (93.8%)	0.4
(3) That things were going your way?			
Sometimes, Often, or Very often	211 (93.4%)	212 (94.2%)	0.71
(4) Felt difficulties were piling up so high that you could not overcome them?			
Never/Almost never	149 (65.6%)	160 (80.8%)	0.24

SSB = Sugar-sweetened beverage (such as punch, sweetened fruit drinks, sports drinks, Kool-Aid, lemonade, etc.).

Table 5 shows the proportion of paternal characteristics in the overall sample and within each of the four latent classes. There was no significant difference between classes with respect to age, parity, or BMI classification. Fathers within Class 1 (MHLC) and Class 4 (MHMC) were more likely to be highly educated with a bachelor's or higher (87.5% and 83.1%, respectively) and reported higher income (63.6% and 53.9%

Table 3
Self-report in the 2nd trimester of pregnancy of intended infant care following birth among mothers and fathers participating in the *First Heroes* Program, Boston, Massachusetts, July 2020-July 2022.

	Mothers (N = 227) n (%)	Fathers (N = 227) n (%)	p-value
Infant Care *When the following things happen or need to be done after your child is born, how often do you think you will be the one who does them?*			
Get up with your child when he/she wakes up during the night?			
Always/often	214 (94.3)	164 (72.2)	**<0.001**
Soothe your child when he/she is upset?			
Always/often	208 (91.6)	177 (78.3)	**<0.001**
Take your child to the doctor?			
Always/often	210 (92.9)	155 (68.3)	**<0.001**
Stay home to care for your child when he/she is ill?			
Always/often	177 (78.7)	142 (62.8)	**<0.001**
Take your child to or from the sitter or day care center?			
Always/often	116 (51.6)	138 (61.3)	**0.04**

earning >$150,000 yearly, respectively). Class 2 (LHLC) and Class 3 (LHMC) represented a wider range of education and income levels, with a higher proportion of group members with a high school degree/GED or lower (43.3% and 42.4%, respectively) and earning <$50,000 yearly (36.7% and 31.7%, respectively). Class 1 (MHLC) had the highest proportion of fathers who identified as non-Hispanic White and were married, with the lowest rate of unmet social needs. Classes 2 (LHLC)

and 3 (LHMC) had a higher numbers of unmet social needs.

4. Discussion

In this cross-sectional analysis of mother-father dyads participating in a perinatal obesity prevention intervention, we identified key similarities and differences between mothers and fathers, as well as heterogeneity among fathers as a group. While both parents intend for a high level of involvement with their child and had similar report of social-emotional wellbeing, fathers reported increased rates of overweight/obesity with increased report of some obesogenic behaviors. Additionally, fathers were more likely to report social isolation and less engagement in routine healthcare maintenance. Among fathers, both sociodemographic variables and social determinants of health were associated with self-reported lifestyle behaviors. These findings have implications for programs that engage fathers to promote health in early childhood period through more positive interactions with their infants.

Our findings suggest that many expectant fathers may enter fatherhood with lower dietary quality and risk for increased BMI. This is in line with United States national data, in which men report lower rates of meeting federal fruit and vegetable intake recommendations compared to women (Lee et al., 2022). This has important implications for child health, as paternal dietary patterns and obesity influence children's eating behaviors and weight status (Freeman et al., 2012; Litchford et al., 2020). Additionally, the transition to fatherhood is associated with less capacity to engage in healthy sleep and physical activity behaviors (Saxbe et al., 2018; Bellows-Riecken and Rhodes, 2008) and an increased risk of weight gain (Garfield et al., 2016). This may compound on the pre-existing increased BMI and suboptimal nutrition identified

Table 4
Sample proportions in each class, with overall and class-specific probabilities among 227 fathers completing the "First Heroes" baseline questionnaire, July 2020-July 2022.

Indicators	Overall Sample Proportion (N = 227)	Class 1: MHLC (25%) "More health behaviors, less infant care" (N = 56)	Class 2: LHLC (13%) "Less health behaviors, less infant care" (N = 30)	Class 3: LHMC (28%) "Less health behaviors, more infant care" (N = 64)	Class 4: MHMC (34%) "More health behaviors, more infant care" (N = 77)
Health behaviors					
Frequent Fruit Intake	53.3	**66.1**	*36.7*	*25.0*	**74.0**
Frequent Vegetable Intake	62.2	**76.8**	*41.4*	*28.6*	**87.0**
Less Frequent Fast-Food Intake	82.8	**94.6**	*70.0*	*57.8*	**100**
Less Frequent Sugar Sweetened Beverage Intake	40.9	**78.6**	*3.4*	*20.6*	44.2
Adequate Sleep (Weekday)	63.3	**76.8**	*33.3*	*39.7*	**84.4**
Adequate Sleep (Weekend)	86.2	92.9	83.3	*67.7*	**97.4**
Weekly Moderate Physical Activity	67.8	75.0	*43.3*	*37.5*	**97.4**
Weekly Vigorous Physical Activity	54.0	63.6	*16.7*	37.5	**75.3**
Have a Primary Care Physician (PCP)	83.7	**100.0**	*50.0*	81.2	87.0
Visit with PCP in past 12 months	59.0	66.1	*20.0*	64.1	64.9
Social-emotional wellness					
PHQ-2 Items					
Feeling down, depressed, hopeless *(Not at all/several)*	98.2	100.0	100.0	93.5	100.0
Little interest/pleasure *(Not at all/several)*	96.9	100.0	93.1	92.1	100.0
Perceived Stress Index-Short Form Items					
Unable to control important things *(Never/almost never)*	58.6	67.9	46.7	53.1	61.0
Ability to handle stress *(Sometimes-Very Often)*	93.8	100.0	86.7	85.7	98.7
Felt things are going your way *(Sometimes - very often)*	94.2	100.0	96.7	87.1	94.8
Difficulties piling too high to overcome *(Never/almost never)*	70.8	**89.3**	*60.0*	66.7	64.9
Infant care intentions					
Get up with child overnight *(Always/often)*	72.2	*50.0*	*36.7*	**95.3**	**83.1**
Soothe child when upset *(Always/often)*	78.3	*57.1*	*20.0*	**100**	**98.7**
Take child to the doctors *(Always/often)*	68.3	*16.1*	43.3	**87.5**	**100.0**
Stay home to care for child when ill *(Always/often)*	62.8	*17.9*	*26.7*	**84.1**	**92.2**
Take to/from childcare *(Always/often)*	61.3	46.4	*13.3*	**79.4**	**76.3**

Note: Latent Class Models were performed using dichotomized indicator variables in STATA.
Bold indicates class-specific probabilities > 10% **over** the overall sample proportion, *italics* indicates class-specific probabilities > 10% *under* the overall sample proportion.

Table 5

Sociodemographic characteristics by latent class grouping of 227 fathers completing the "First Heroes" baseline questionnaire, July 2020-July 2022.

	(N = 227)	Class 1: MHLC (25%) "More health behaviors, less infant care" (N = 56)	Class 2: LHLC (13%) "Less health behaviors, less infant care" (N = 30)	Class 3: LHMC (28%) "Less health behaviors, more infant care" (N = 64)	Class 4: MHMC (34%) "More health behaviors, more infant care" (N = 77)	p-value
Age	33.6 (5.1)	34.9 (4.1)	32.1 (6.2)	33.0 (6.6)	33.8 (3.7)	0.36
Married	175 (77.1)	**53 (94.6)**	*16 (53.3)*	*39 (60.9)*	67 (87.0)	**<0.001**
First-time father	176 (77.5)	48 (85.7)	*19 (63.3)*	45 (70.3)	64 (83.1)	**0.03**
Education						
Less than High school/GED	48 (21.1)	*2 (3.6)*	**13 (43.3)**	**27 (42.2)**	6 (7.8)	**<0.001**
Some college/associate degree	27 (11.9)	5 (8.9)	6 (20.0)	9 (14.1)	7 (9.1)	
Bachelor's or higher	152 (67.0)	**49 (87.5)**	*11 (36.7)*	*28 (43.8)*	**64 (83.1)**	
Household income						
<$50,000 yearly	46 (20.5)	1 (1.8)	**11 (36.7)**	**20 (31.7)**	14 (18.4)	**<0.001**
$50,001 to $100,000 yearly	38 (17.0)	6 (10.9)	**9 (30.0)**	14 (22.2)	9 (11.8)	
>$100,000 yearly	140 (62.5)	**48 (87.3)**	10 (33.3)	29 (46.0)	53 (69.7)	
Race/Ethnicity						
Hispanic	54 (24.0)	4 (7.1)	**12 (40.0)**	**22 (34.9)**	16 (21.1)	**<0.001**
Non-Hispanic White	110 (48.9)	**40 (71.4)**	8 (26.7)	21 (33.3)	41 (53.9)	
Non-Hispanic Black	34 (15.1)	*5 (8.9)*	6 (20.0)	**16 (25.4)**	7 (9.2)	
Non-Hispanic Asian	20 (8.9)	*5 (8.9)*	1 (3.3)	4 (6.3)	10 (13.2)	
Non-Hispanic Other	7 (3.1)	*2 (3.6)*	3 (10.0)	0 (0.0)	2 (2.6)	
BMI category						
<25.0 kg/m^2	77 (33.9)	18 (32.1)	10 (33.3)	16 (25.0)	33 (42.9)	0.28
25.0–29.9 kg/m^2	97 (42.7)	26 (46.4)	10 (33.3)	31 (48.4)	30 (39.0)	
≥30.0 kg/m^2	53 (23.3)	12 (21.4)	10 (33.3)	17 (26.6)	14 (18.2)	
Social needs identified, n (%)						
Food Insecurity	23 (10.1)	*0 (0.0)*	4 (13.3)	**14 (21.9)**	5 (6.5)	**<0.001**
Housing Insecurity	19 (8.4)	0 (0.0)	**7 (24.1)**	10 (15.6)	2 (2.6)	**<0.001**
Lack of Transportation	6 (2.7)	0 (0.0)	2 (6.7)	1 (1.6)	3 (3.9)	0.23
Social Isolation	55 (24.2)	11 (19.6)	**11 (36.7)**	19 (29.7)	14 (18.2)	0.12

Note: Latent Class Models were performed using dichotomized indicator variables in STATA.
Bold indicates class-specific probabilities > 10% **over** the overall sample proportion, *italics* indicates class-specific probabilities > 10% *under* the overall sample proportion.

within our analysis. These findings support a life course approach to men's health to optimize health and wellbeing before men enter fatherhood (Kotelchuck and Lu, 2017).

This echoes existing literature, which has described men as less engaged with preventive care (Mursa et al., 2022; Baker et al., 2014) with lower health literacy (Oliffe et al., 2020 Oct 1) and fathers as more socially isolated (Skreden et al., 2012; Kotelchuck et al., 2022), when compared with women and mothers. This is critical to consider, as primary healthcare services, and peer engagement, and improving health literacy could be potential intervention strategies for improving paternal health. Within the preconception health literature, some argue for a transition from maternal-focused to couple-focused strategy for health promotion in this period (Hieronimus and Ensenauer, 2021). This may support the strategy used within 'First Heroes', the study for which this baseline data was collected, to equally engage both parents in health promotion. The 6- and 12-month postpartum results from this study may provide additional information on longitudinal changes in paternal behaviors and the impact of the intervention on health behaviors and parenting.

The findings of our latent class analysis highlight the limitations of referring to "fathers" as a homogenous group. Our analyses revealed four distinct groups of fathers that varied by report of health behaviors and intended involvement in infant care, each then further characterized by racial/ethnic and sociodemographic differences. The two groups of fathers with fewer health-promoting behaviors (Classes 2 [LHLC] & 3 [LHMC]) were more likely to identify as a racial/ethnic minority, report lower income, lower education levels, and unmet social needs. These

findings support a high prevalence of unmet social needs among new fathers (Neri Mini et al., 2020) and food/housing insecurity as potential barriers to healthy lifestyle behaviors (Egan et al., 2023). Social needs within our sample may have increased secondary to COVID-19 (Paremoer et al., 2021), as we enrolled our sample from July 2020 through June 2022. Lastly, our findings echo racial/ethnic and socioeconomic disparities in maternal dietary behaviors (Rai et al., 2015). These disparities have implications for population health, as barriers to healthy lifestyle behaviors among underserved populations translates into excess cardiovascular disease burden among these groups (Kris-Etherton et al., 2020).

It is important to acknowledge that our study examined parent behaviors in the prenatal period through the lens of heterosexual mother-father coparenting dyads. While we chose this enrollment criteria for purposes of study design within the larger randomized controlled trial, we recognize the heterogeneity and diversity of families. Our findings of the variation among fathers within the prenatal period supports the importance of engaging, involving, and understanding the diverse needs of the non-birthing parent from the earliest phases of parenthood.

Taken as a whole, our findings argue against a 'one-size-fits-all' approach to engaging expectant and new fathers. Each latent class may have unique needs to address through intervention participation. These findings support the need to design interventions targeted to the non-birthing parent that are adaptable and can be tailored to meet individual needs. Additionally, it will be important to consider our findings when interpreting results of the larger 'First Heroes' randomized controlled trial, as latent class membership may influence intervention

participation and effectiveness (Lanza and Rhoades, 2013).

5. Strengths and limitations

Our study is unique in this paired approach to understanding mothers' and fathers' health behaviors, parenting intentions, and social-emotional wellness in this period. As there is limited data regarding paternal perspectives and behaviors during this period, we used latent class analysis as an innovative exploratory analytic strategy to identify patterns among fathers that will be useful in both analysis of results and intervention efforts, as well as hypothesis generating for future work.

Although latent class analysis is a powerful tool to detect unobserved heterogeneity within a group, a limitation of this analytic method is that the naming of each class may not fully capture complexity within each class and is limited to the variables assessed. For example, there were small differences in perceived stress levels, with some evidence of lower stress reported in Class 1 and higher stress reported in Class 2. However, as these findings were subtle and we observed no notable differences Classes 3 and 4, we distinguished groups primarily by health behaviors and parenting intentions.

We assessed health behaviors, parenting intention, and social-emotional measures via self-report. While measures were overall brief to limit participant burden, we drew from measures previously used in large scale studies or validated screening measures. While there were many other domains we would have liked to explore, we prioritized the domains presented in this manuscript to gain a broad view of mothers and fathers in prenatal period. It is possible that more comprehensive measures beyond depression and stress, such as anxiety, irritability, and substance use, may have provided additional information on expectant fathers' mental health, especially given evidence to suggest that the paternal experience of perinatal depression is distinct from that of mothers (Philpott et al., 2020).

Lastly, mother-father respondents in our analysis were participants in a perinatal health promotion intervention and may not represent the general population, as they may have greater interest in this subject area. Additionally, as this study reports baseline data from a longitudinal intervention requiring ongoing participation over ~16 months, study consent rates and sample composition may differ from a cross-sectional study that required one-time survey completion. Even with potential selection bias, we still identified social needs and opportunities to improve health. We recruited respondents from academic and community-based locations that represent a single geographic area, which may also limit generalizability.

6. Conclusions

While the first 1000 days is a critical period for obesity prevention and health, fathers are currently not included in most health promotion initiatives. Our findings highlight opportunities for paternal health promotion in the prenatal period, with the findings of increased rates of obesity/overweight and less healthy lifestyle behaviors among some fathers during this time. Additionally, there may be a role for addressing unmet social needs in relation to the capacity to adopt healthy lifestyle behaviors. These findings are important to consider in health promotion interventions targeting expectant fathers.

Ethical considerations

All research activities were approved by the MassGeneral Brigham Institutional Review Board. All participants provided verbal consent for participation in this study.

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Trial registration: Clinicaltrials.gov Registration Number NCT04477577.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2023.102375.

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