

Original Paper

Completion Rates for Ecological Momentary Assessments of Food Intake During Pregnancy and Post Partum: Descriptive Study

Sarah Annalise Sanders¹, MPH, PhD; Serwaa Omowale², LMSW, MPH, PhD; Andrea Casas¹, MPH, PhD; Alexis Kiyanda³, MS; Abigail Smith Kosbie⁴, MPH; Yu-Hsuan Lai¹, MSPH, PhD; Meredith Wallace⁵, PhD; Stephen Rathbun⁶, MSc, PhD; Tiffany Gary-Webb¹, MHS, PhD; Esa Davis⁷, MPH, MD; Lora Burke⁸, MPH, PhD; Dara Méndez¹, MPH, PhD

¹Department of Epidemiology, University of Pittsburgh, Pittsburgh, PA, United States

²Department of Management, Policy, and Community Health, University of Texas Health Science Center at Houston, Houston, TX, United States

³Department of Environmental and Occupational Health, University of Pittsburgh, Pittsburgh, PA, United States

⁴Department of Behavioral & Community Health Sciences, University of Pittsburgh, Pittsburgh, PA, United States

⁵Department of Psychiatry, University of Pittsburgh, Pittsburgh, PA, United States

⁶Department of Epidemiology & Biostatistics, University of Georgia, Athens, GA, United States

⁷Family and Community Medicine, School of Medicine, University of Maryland, Baltimore, MD, United States

⁸School of Nursing, University of Pittsburgh, Pittsburgh, PA, United States

Corresponding Author:

Dara Méndez, MPH, PhD
Department of Epidemiology
University of Pittsburgh
130 De Soto Street
Pittsburgh, PA 15261
United States
Phone: 1 412-648-5664
Email: ddm11@pitt.edu

Abstract

Background: The collection of dietary behavior data is crucial in childbearing populations. In addition to observed inequities in perinatal dietary intake and quality, burdensome assessment methods (eg, 24-h dietary recall) may limit research participation for some groups. Ecological momentary assessment (EMA) is associated with reduced recall bias and participant convenience, but there is a dearth of studies with diverse cohorts.

Objective: Our aim is to describe participant completion of food intake items in EMA surveys, overall and across individual characteristics (eg, prepregnancy BMI).

Methods: Using secondary EMA data from participants in a longitudinal study, we report average completion rates of survey items regarding dietary behavior (eg, number of meals eaten in a day) across individual demographic variables (eg, age) and combined strata (eg, race+age) during late pregnancy and throughout 12 months post partum.

Results: In our analytic sample (N=310), the average completion rate was 52.4% (SD 27.8%) during pregnancy, rising to 59.1% (SD 22.0%) after giving birth. Participants who were older (>30 y), overweight before pregnancy, self-identified as White, working, or earning higher annual income (>US \$50,000) had higher average completion rates than their counterparts. Examining combined strata, we found some variation in survey completion within racial groups. Black participants using a study phone had higher average completion rates during pregnancy and post partum, but this relationship was reversed for White participants.

Conclusions: Our secondary analysis showed relatively stable engagement with EMA surveys in a childbearing cohort across 15 months. Increased completion rates among privileged groups (eg, White, higher income) may demonstrate the impact of socioeconomic advantages on individual health behaviors. Investigators should consider how intersections between race and other factors (eg, employment) may impact participation and data collection.

Keywords: dietary behavior; ecological momentary assessment; pregnancy; post partum; dietary; diet; dietary intake; survey; longitudinal study

Introduction

The collection of dietary behavior data is integral to understanding how diet and eating patterns shape health for individuals and communities [1,2]. In childbearing populations, studies show that dietary intake patterns during pregnancy are critical to the health of both the mother and infant [3]. Inadequate nutrition during pregnancy can increase the risk of cardiometabolic comorbidities (eg, hypertension disorders of pregnancy and gestational diabetes) during pregnancy and of low birthweight from fetal growth restriction and neurodevelopmental delays [4,5]. Additionally, research shows significant disparities in perinatal diet quality across social determinants of health (education, food security, income) [6-9], obliging studies to examine dietary behaviors across these strata. Racial inequities also exist, where Black birthing populations report higher food insecurity [6] and lower-quality diets [7-9] and increased prevalence of perinatal and postnatal comorbidities compared to White populations [10].

Commonly used dietary assessment methods include 24-hour dietary recalls, food frequency questionnaires, and food diaries, each presenting advantages and disadvantages in their administration and the quality of data collected [11]. The 24-hour dietary recall provides detailed information on dietary intake and has proven to be acceptable across diverse populations including pregnant individuals [12-15]. The major disadvantages of the 24-hour dietary recall measure are that it is prone to recall bias, it is limited by its reliance on an individual's episodic memory, there is potential for intentional misreporting, and it requires the greatest amount of time to complete [11,13]. Food frequency questionnaires also rely on participants' memory and lack detailed collection of specific food intake. Food diaries and the 24-hour dietary recall are similar in recording detailed food intake, increasing the burden on study participants and potentially influencing their eating behavior on the days being recorded [16].

Ecological momentary assessment (EMA) is a sampling method used to repeatedly collect information in "real time" [17] and in one's natural setting; it has been used to understand eating behaviors and food intake, typically via digital devices (eg, smartphones) [18]. EMA reduces retrospective bias and promotes reliability and ecological validity. Compared to more time-intensive methods, EMA reduces the burden of reporting and often the time lapse between a behavior and its recording. Furthermore, the repeated sampling design facilitates a broader behavioral assessment over time [17-22]. Recent research using EMA to assess dietary behaviors has been conducted in different populations, including children [23,24], adolescents [25,26], mother-child dyads [27-29], individuals with eating disorders [30], and postbariatric surgery patients [31]. The few EMA studies

examining dietary behavior in perinatal populations report homogenous samples and poor adherence to EMA completion, making a strong case for more demographically diverse cohorts in evaluating the usability of these assessment tools [32,33].

Since EMA is a novel approach to collecting dietary data, particularly over long periods of time (eg, >3 mo), it is critical to assess participant adherence to the EMA protocol for reporting food intake. It is important to note that EMA surveys are designed to be briefer, making them ideal for studying the context of eating behaviors, rather than nutritional content, which may be measured more precisely in recalls and diaries. Leveraging EMA data from a diverse childbearing cohort within a longitudinal, observational investigation (approximately 15 mo), this secondary analysis aimed to describe participant completion of dietary intake items in EMA surveys, overall and across individual characteristics (eg, prepregnancy BMI).

Methods

Study Design

This secondary analysis uses participant-reported data regarding dietary intake from the Postpartum Mothers Mobile Study (PMOMS), a longitudinal, observational investigation [34] designed to examine factors associated with racial disparities in postpartum weight retention and cardiometabolic health. Pregnant people were recruited between 18 and 32 weeks' gestation and followed through 12 months post partum. Participants completed daily EMA surveys via smartphones, weighed themselves weekly using Bluetooth-enabled scales, and attended follow-up visits for anthropometric measurements and biospecimen collection. The study applied EMA methods to better understand participants' experiences and exposures in their natural environment via real-time measurements of psychosocial (eg, stress, discrimination), behavioral (eg, eating behavior, consumption of foods with added sugars, physical activity), and contextual (eg, geographic location) factors.

Brief EMA surveys were administered at the beginning of day (BOD) and end of day (EOD), representing time-contingent responses, and at random times throughout the day (signal-contingent responses). Participants selected times for receiving BOD and EOD surveys, with at least 9 hours between the 2 surveys. Links for BOD and EOD surveys were active for 30 minutes (60 min for random surveys) to ensure that participant-reported data reflected real-time information. Each participant contributed approximately 15 months of EMA data during the pregnancy and postpartum periods. The protocol for PMOMS is described in more detail in a previous publication [34].

Ethical Considerations

The study was approved by the institutional review board within the University of Pittsburgh Human Research Protection Office (#PRO16100117).

Participants and Recruitment

PMOMS was an ancillary study to a randomized clinical trial, the Comparison of Two Screening Strategies for Gestational Diabetes (GDM²) [35,36], conducted at a women's hospital in southwestern Pennsylvania. The clinical trial visits provided 2 in-person opportunities for our staff to approach and recruit potential participants and determine eligibility between 18 and 32 weeks' gestation. Participants were recruited this way between December 2017 and March 2019. After the GDM² study ended recruitment, PMOMS staff directly recruited participants from December 2019 to March 2020, when study activities were interrupted by the COVID-19 pandemic.

After providing their written, informed consent at a baseline visit (between 18 and 32 weeks' gestation), participants completed demographic questionnaires and anthropometric measures. At this same visit, a research assistant facilitated setting up participants' smartphones for receiving daily EMA surveys, which were scheduled to begin the following day [34]. Individuals using their own phone for study participation were compensated US \$35 each month for using their data (up to US \$525 throughout the study). For those without a suitable device for participating in the study, PMOMS offered a smartphone with a paid, unlimited data plan for the duration of the study. Upon completing the study, these participants had the option of keeping the smartphone provided by the study as an additional incentive.

All participants were compensated monthly if their EMA completion rate reached 60% or more during that month. Those who reached a completion rate of 80% or higher were entered into a monthly drawing for additional compensation. In addition, PMOMS staff conducted routine check-ins (via phone or text) with all participants falling below the 60% threshold to identify and address any barriers to increasing their completion rate.

Pregnant individuals were excluded from participating in PMOMS if they indicated any of the following: plan to deliver at a different hospital from the study recruitment site, multiple pregnancy, plan to move from the area before 12 months post partum, history of type 1 or type 2 diabetes diagnosis, gestational diabetes diagnosis before 20 weeks' gestation in current pregnancy, consumption of oral glucocorticoids in last 30 days, history of "dumping syndrome" following gastric bypass surgery, hypertension diagnosis or medication for high blood pressure, and diagnosis of severe liver disease (eg, cirrhosis). Further details about the PMOMS protocol can be found elsewhere [34].

Measures

Although EOD surveys were delivered to participants every day, eating habits and intake of added-sugar foods were only assessed in these surveys on 10 randomly selected weekdays and 4 randomly selected weekend days for every 28-day

block of time after EMA prompts began [34]. Participants were asked to report the number of meals and snacks they ate during the day. They were also asked to report whether they had any food or drinks with added sugar. If they answered yes to either, they were asked to report the number of foods with added sugar in 4 categories (cookies, cake, pie, and donuts; candy; ice cream and frozen treats; and other sugary foods), as well as the number of drinks with added sugar in 4 categories (regular soda pop, juice drinks, coffee shop drink and frozen treats, and other sugary drinks). These EMA survey items, along with dozens of others, were developed for the purposes of our study and were tested in a pilot study [37]. All EMA surveys were designed to be brief (1-2 min in duration), and those including dietary intake items did not ask participants to specify sizes or types of added sugar items consumed.

Upon enrollment, we collected data on maternal age, education, race, ethnicity, employment status, marital status, and annual household income. We dichotomized some demographic variables for descriptive statistics: age as ≤ 30 years and > 30 years (based on the sample median), employment status as working (part-time or full-time) versus not working (unemployed or on disability), and annual household income as $\leq$ US \$50,000 per year versus $>$ US \$50,000 per year (based on the sample median). In this study, we also examined EMA completion between participants using their own phone and those using a smartphone provided by PMOMS. Study staff measured participant height at the first clinical trial visit, and participants self-reported their prepregnancy weight at the second clinical trial visit. We calculated prepregnancy BMI by dividing participants' weight in kilograms by their height in meters squared and categorized participants as normal/healthy (BMI 18.0-24.9) and overweight (BMI ≥ 25.0) [38].

Data Analysis

We determined our final sample for this secondary analysis (N=310) after excluding participants only if they were determined to be ineligible for PMOMS (n=3) at the study enrollment phase because they withdrew from either PMOMS or GDM² (parent study). We report frequencies and percentages for all demographic and anthropometric variables.

Completion rates were calculated for all participants included in the analytic sample by dividing the number of responses to dietary intake questions by the number of EOD surveys delivered during both pregnancy and postpartum periods. Given the sampling design described above, we only considered EOD surveys with the dietary intake questions in these completion calculations. We then stratified the study sample across demographic and clinical measures, describing average completion rates for each pair. In addition to the subgroups described above (by age, employment status upon study enrollment, household income), we examined average completion rates for participants by prepregnancy BMI (healthy: 18.0-24.9 vs overweight: ≥ 25.0), study phone usage, and race (Black vs White). Lastly, we looked at average completion rates across combined sample strata (eg, by race and age). We focused specifically on Black/African

American and White participants in describing completion rates in subgroups due to sample size limitations in other racial groups.

Results

Table 1 provides an overall description of the analytic sample (N=310), which attempted a total of 36,687 EOD surveys that

included dietary intake items, with a mean of 121.5 (SD 70.7) EOD surveys attempted per person (median 2128.0, IQR 60.3-185.8) and a range of 1.0-243.0 EOD surveys attempted per participant over the study period. Only 3 participants were excluded from these analyses due to being deemed ineligible to participate in PMOMS after enrolling in the study (eg, withdrew from parent study).

Table 1. Descriptive statistics of participant demographics and average end of day completion rates in the analytic sample (N=310).

	Sample, n (%)
Using study phone	87 (28.1)
≤30 y old	172 (55.5)
Healthy prepregnancy BMI (18.5-24.9)	81 (26.1)
Employment	
Full-time	172 (55.5)
Part-time	46 (14.8)
Disability	5 (1.6)
Unemployed/not working	87 (28.1)
Annual household income (US \$)	
<20,000	77 (24.8)
21,000-30,000	41 (13.2)
31,000-40,000	17 (5.5)
41,000-50,000	19 (6.1)
51,000-60,000	22 (7.1)
61,000-70,000	12 (3.9)
71,000-80,000	19 (6.1)
>81,000	103 (33.2)
Education	
<High school	16 (5.2)
High school (or equivalent)	57 (18.4)
Some college	65 (21.0)
College degree	82 (26.5)
Master's degree	55 (17.7)
Doctoral degree or higher	35 (11.3)
Marital status	
Single (never married)	122 (39.4)
Separated/divorced	11 (3.6)
Married	175 (56.5)
Other	2 (1.0)
Hispanic/Latina	18 (5.8)
Race	
Asian	12 (3.9)
NHOP ^a	1 (0.3)
Black/African American	87 (28.1)
White	187 (60.3)
More than one race	11 (3.6)
Other	10 (3.2)

^aNHOP: Native Hawaiian or other Pacific Islander.

Compared to the overall demographics of the county where this research was conducted, participants in the present

analytic sample are more likely to be Black, Hispanic, or multiracial; be in the labor force; have higher educational attainment; and earn less income annually [39].

Table 2 shows the average completion rates of dietary intake items during the pregnancy (third trimester) and postpartum periods (up to 12 mo after giving birth), as well as across sample strata (eg, study phone vs own phone). We

note that values are missing for 6 (1.9%) participants during pregnancy and 11 (3.5%) participants post partum, due to no EOD surveys being delivered to these participants during that time. Rate calculations for the 4 dietary intake items in EOD surveys did not vary between the items, so the completion rates for just 1 item (meals) are presented as proxy rates for overall completion of these items.

Table 2. Average completion rates for dietary items during pregnancy and post partum in the overall cohort (N=310), as well as by subgroups and combined strata.

	Average completion rate during pregnancy		Average completion rate post partum	
	Percent, mean (SD)	Sample, n	Percent, mean (SD)	Sample, n
Overall	52.4 (27.8)	299	59.1 (22.0)	304
Study phone	46.7 (29.2)	86	59.2 (20.7)	85
Own phone	54.7 (26.9)	213	59.0 (22.5)	219
BMI<25.0	49.2 (27.5)	77	56.7 (23.6)	80
BMI≥25.0	53.5 (27.8)	222	59.9 (21.4)	224
≤30 y	44.0 (28.6)	163	54.5 (24.2)	169
>30 y	62.5 (23.2)	136	64.9 (17.3)	135
Black/AA ^a	37.3 (27.6)	85	51.3 (24.7)	85
White	58.5 (25.6)	179	62.8 (19.8)	183
Working	43.2 (27.9)	88	59.4 (22.0)	214
Not working	56.3 (26.8)	211	58.4 (22.2)	90
≤US \$50,000/y	41.9 (28.4)	148	55.1 (23.5)	150
>US \$50,000/y	62.7 (23.0)	151	63.0 (19.7)	154
Black/AA+another variable				
Study phone	40.9 (28.2)	46	57.3 (22.2)	44
Own phone	33.1 (26.7)	39	44.9 (25.9)	41
BMI<25.0	31.1 (24.8)	24	45.9 (25.2)	24
BMI≥25.0	39.8 (28.5)	61	53.4 (24.4)	61
≤30 y	34.3 (27.7)	65	50.5 (25.7)	65
>30 y	47.2 (25.6)	20	53.9 (21.8)	20
Working	39.3 (29.9)	45	46.9 (25.1)	47
Not working	35.2 (25.1)	40	56.8 (23.5)	38
≤US \$50,000/y	37.1 (27.7)	79	51.0 (25.3)	79
>US \$50,000/y	41.0 (28.9)	6	55.2 (15.6)	6
White+another variable				
Study phone	52.3 (29.3)	28	58.5 (20.0)	29
Own phone	59.6 (24.7)	151	63.6 (19.8)	154
BMI<25.0	56.6 (24.2)	42	60.3 (23.0)	45
BMI≥25.0	59.0 (26.0)	137	63.6 (18.7)	138
≤30 y	51.3 (27.6)	80	57.6 (23.4)	85
>30 y	64.3 (22.3)	99	67.2 (14.8)	98
Working	60.5 (24.6)	142	63.3 (19.8)	143
Not working	50.5 (28.0)	37	60.8 (20.3)	40
≤US \$50,000/y	46.1 (28.5)	53	60.4 (20.8)	54
>US \$50,000/y	63.7 (22.3)	126	63.7 (19.4)	129

^aAA: African American.

Overall, participants had higher average completion rates for dietary intake items during the postpartum period (59.1%, SD 22.0%) compared to the pregnancy period (52.4%, SD

27.8%). Looking at subgroup strata, participants using a study phone had lower completion rates on average (46.7%, SD 29.2%) compared to those using their own phone (54.7%,

SD 26.9%) during pregnancy, but this difference was nearly eliminated after giving birth (59.2%, SD 20.7% vs 59.0%, SD 22.5%, respectively). Across both pregnancy and postpartum periods, participants who had an overweight BMI before pregnancy (>24.9), were older (>30 years), self-identified as White, were working, or earned a higher income ($>US \$50,000$ annually) had higher average completion rates of dietary intake items.

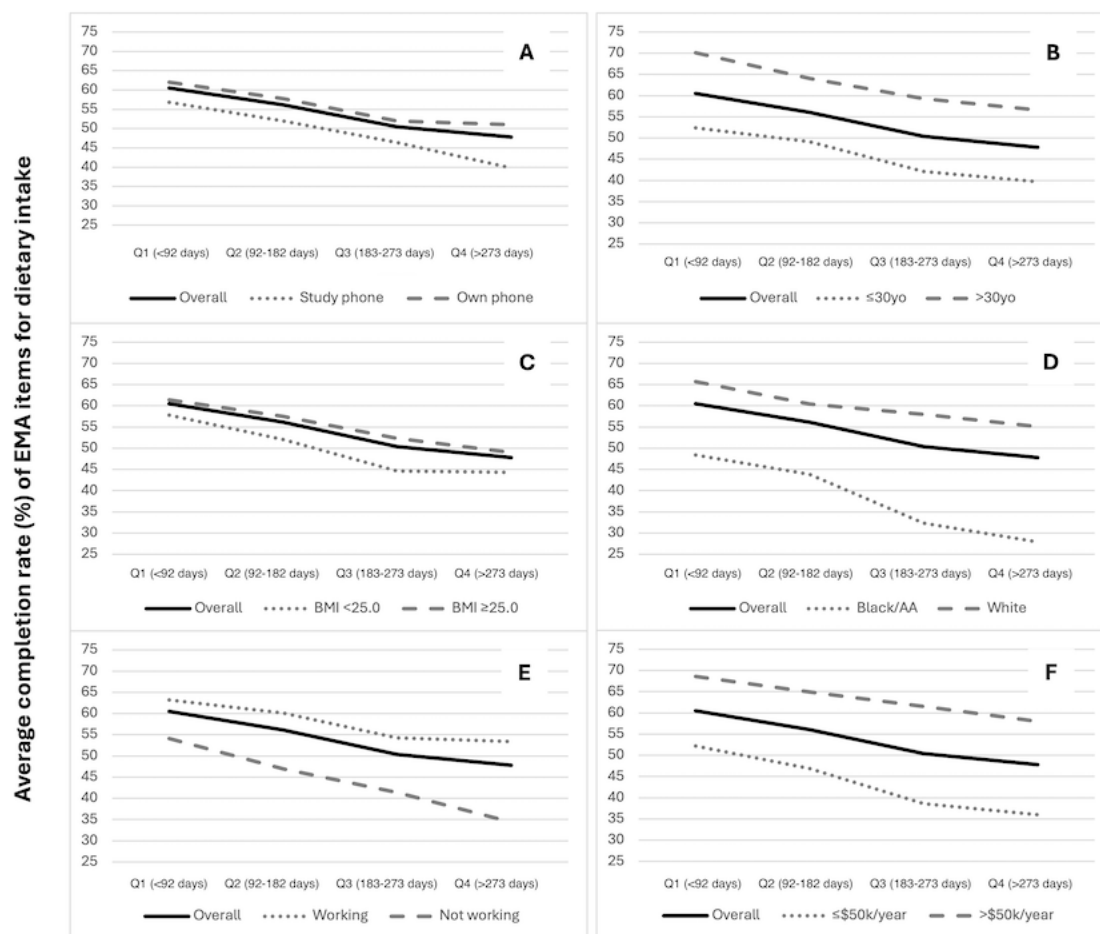
We also examined completion rates within combined strata, which consisted of race (Black or White) and another variable (eg, phone use), to have a better understanding of variation in responding to EMA surveys within racial groups (Table 2). We observed increased average completion rates from pregnancy to post partum across all strata of Black participants, with the largest increases found for those not working at the time of study enrollment (61%), those with a healthy prepregnancy BMI (48%), and those 30 years old or younger (47%). Black participants using the study phone had considerably higher completion rates on average compared to those using their own phone in both the pregnancy and postpartum periods. During pregnancy, Black participants who were not working at the time of study enrollment (eg,

unemployed, on disability) had lower average completion rates (35.2%) compared to those who were working (39.3%), but this was reversed in the postpartum period (56.8% vs 46.9%, respectively).

Similarly, we observed increased average completion rates from pregnancy to post partum across all strata of White participants, although with considerably less variation between time periods. The largest increases were found for White participants earning more than US \$50,000 annually (31%) and those who were not working at the time of study enrollment (20%).

Lastly, given the length of the postpartum period (12 mo), we reported completion rates for each postpartum quarter (approximately 3 mo or 91 d) in the overall sample and across subgroup strata (Figure 1). With very few exceptions, completion rates generally decreased over time during the postpartum period, with the lowest rates for all subgroups in the fourth quarter (>273 d after giving birth). We saw similar declining trends in average completion rates for the same combined strata across postpartum quarters (Table S1, Multimedia Appendix 1).

Figure 1. Line graphs depicting average completion rates (%) of EMA items for dietary intake across four postpartum quarters (~91 d) for overall sample, compared against individual characteristics: study phone usage (A); age at study enrollment (B); prepregnancy BMI (C); self-reported race (D); employment status at study enrollment (E); and annual household income (F). AA: African American; EMA: ecological momentary assessment.



Discussion

Principal Findings

Our secondary study is innovative in its examination of overall completion rates for EMA surveys of dietary behavior in a longitudinal, childbearing cohort (~15 mo, from late pregnancy to 1 y post partum), as well as across individual characteristics. Overall, the analytic sample (N=310) had average completion rates of 52.4% during pregnancy (approximately 3 mo) and 59.1% during the first postpartum year (12 mo). This relationship generally held true across subgroups, with average completion rates increasing during the postpartum period, compared to the pregnancy period.

The average completion rates examined here are lower than ideal for EMA research, where at least 80% is often cited as the minimum threshold for “adequate” levels of compliance [40]. Most dietary behavior studies using EMA report adherence rates close to this level or higher [19]. Even so, very few of these studies employed EMA for more than a month, with many of them having study durations

of just 1 week [19,41,42]. In our secondary analysis, we observed average completion rates over periods of about 3 months, potentially obscuring higher adherence during shorter intervals. Furthermore, the compensation structure for PMOMS participants was based on monthly rates of EMA adherence, rather than individual survey completion, which may have influenced participant responses.

Our findings partially contradict previous research that demonstrates reduced adherence to EMA protocols over time [19,20,43]. We observed an increase in average completion rates from pregnancy to post partum for all strata examined, potentially attributable to added availability for responding to EMA prompts (ie, maternity leave), reduced stress related to pregnancy symptoms, or increased interest in the study’s objectives regarding postpartum health.

Even so, during the postpartum period, we observed a gradual decline in survey completion across the cohort (Table S1, [Multimedia Appendix 1](#)), in agreement with previous literature. We interpret these reductions to survey burden, as well as changing parental obligations, which may impact

some populations more than others. In the last postpartum quarter (>273 d after giving birth), our overall cohort had an average completion rate of 47.8%. It is also important to highlight previous evidence demonstrating increased EMA adherence in the morning [20,43,44], whereas the dietary intake items being examined here appeared on the EOD survey.

We observed considerable disparities between subgroups in average completion rates, some of which provide insights into how racial and socioeconomic privilege may impact participation in research applying EMA. Participants who were >30 years old, self-identified as White, and earned >US \$50,000 annually had higher completion rates than their counterparts across both prenatal and postpartum periods. Although research examining demographic differences in EMA adherence is limited, a 9-week smoking cessation study found greater declines in adherence for participants who were younger, working full-time, and not White [44]. These differences in EMA completion rates may be attributable to the socioeconomic advantages associated with privileged groups, such as increased access to resources (eg, employment, childcare) and reduced exposure to stressors (eg, food insecurity, housing instability). Chronic exposure to stressors, particularly related to caregiving, may exacerbate EMA burden for participants, even from one day to the next [42].

During the first postpartum year, average completion rates increased by 38%, 35%, 32%, and 24% for participants who self-identified as Black, reported not working (upon study enrollment), had lower income (≤US \$50,000 annually), and were 30 years old or younger, respectively. These increases were more considerable than those observed among the privileged subgroups, which ranged from 0.5% to 7%. Beyond the experience of survey burden for participants, these findings suggest that the prenatal period carries additional burdens for childbearing people from racially and socioeconomically oppressed groups, potentially inhibiting their participation in research.

Examining combined strata here provided additional insights that would not have been afforded to us if we had ceased the analysis at single-identity categories. Black participants using the study phone had average completion rates approximately 20% higher than those using their own phone, across the study period, contrasting with results from both the overall study cohort and strata of White participants. We consider this a novel finding in EMA research, where study designs typically leverage the use of the participant's current mobile device, potentially excluding those who lack compatible devices or access to quality phone or internet service [41].

Strengths and Limitations

While this study offers novel, scientific insights into demographic and socioeconomic factors associated with completion of EMA surveys regarding food intake in a longitudinal, childbearing cohort, it is not without its

limitations. First, PMOMS is an ancillary study to a randomized clinical trial, which had specific exclusionary criteria (eg, history of diabetes diagnosis) that may have ultimately biased EMA survey responses within the cohort. Second, examining combined strata (eg, race and income) resulted in some small samples, making our study underpowered to conduct comparative analyses or report statistical significance. For this reason, we decided to provide descriptive results only. Future investigations of variation in EMA participation across sociodemographic factors would benefit from a larger, representative sample to apply comparative methods (ie, linear regression). Next, we conducted our assessment of employment status upon study enrollment (during late pregnancy). We asked about employment status in an exit survey within an administrative supplement of the study, meaning only a subset of the population had employment information at the conclusion of the study. Lastly, we would also like to qualify that our study findings do not include information about any technical issues (eg, device malfunction, survey delivery failure), which would likely impact participants' EMA completion. Although the PMOMS team documented these issues throughout the study period to assist participants and troubleshoot, these data were not prepared to be included in these analyses.

Public Health Implications

The findings presented here are novel and valuable to perinatal health research, particularly that which applies EMA or telehealth technologies to collect data in diverse, representative cohorts for longer periods (eg, several weeks, months). Although PMOMS is considerably longer than most EMA studies, here we demonstrated relatively stable engagement (average completion rate of 59%) in a childbearing population over the course of 15 months. Given evidence linking contextual factors (eg, stress) to parental behavior, including dietary behaviors [41], EMA may serve as a better methodological tool in maternal health research compared to more burdensome dietary recalls.

Our descriptive analysis of EMA completion rates in a childbearing cohort has important implications for future research and intervention designs. PMOMS remains unique in its application of EMA over more than 12 months, though there is room for improving completion rates in longer EMA studies. Immediately actionable strategies include reducing the number of EMA surveys per day or week and increasing opportunities for compensation among participants. Another approach would be increasing participant engagement through an online dashboard where they can see their own response data, as well as aggregate data for the entire cohort.

We recommend that investigators consider the intersections between race and other factors (eg, employment) in relation to study participation and develop strategies to improve EMA completion (eg, study-provided smartphone) among participants who are likely to face more socioeconomic burdens.

Acknowledgments

The authors thank the study participants who generously gave their time and effort. The authors would also like to thank Terri Washington, study coordinator; Maura Dugan, Marquita Smalls, and Gabriella Mendez for study recruitment and follow-up; Er Wang, Pedram Gharani, Meirman Syzdykbayev, and Bradley Wheeler, and Dr Hassan Karimi for technology and app development and support; and John Gianakas for database development and management. Finally, the authors thank all the staff and investigators of the Comparison of Two Screening Strategies for Gestational Diabetes trial.

Conflicts of Interest

ED is a member of the United States Preventive Services Task Force. This article does not necessarily represent the views and policies of the United States Preventive Services Task Force. MW is a consultant for Noctem, but the author's work is not related to this project.

Multimedia Appendix 1

Average completion rates (%) for dietary intake items by postpartum quarter (~91 d) across combined strata (race+another variable).

[\[DOCX File \(Microsoft Word File\), 16 KB-Multimedia Appendix 1\]](#)

References

1. Bailey RL. Overview of dietary assessment methods for measuring intakes of foods, beverages, and dietary supplements in research studies. *Curr Opin Biotechnol*. Aug 2021;70:91-96. [doi: [10.1016/j.copbio.2021.02.007](https://doi.org/10.1016/j.copbio.2021.02.007)] [Medline: [33714006](https://pubmed.ncbi.nlm.nih.gov/33714006/)]
2. Mousa A, Naqash A, Lim S. Macronutrient and micronutrient intake during pregnancy: an overview of recent evidence. *Nutrients*. Feb 20, 2019;11(2):443. [doi: [10.3390/nu11020443](https://doi.org/10.3390/nu11020443)] [Medline: [30791647](https://pubmed.ncbi.nlm.nih.gov/30791647/)]
3. Mitran AM, Gherasim A, Niță O, et al. Exploring lifestyle and dietary patterns in pregnancy and their impact on health: a comparative analysis of two distinct groups 10 years apart. *Nutrients*. Jan 27, 2024;16(3):377. [doi: [10.3390/nu16030377](https://doi.org/10.3390/nu16030377)] [Medline: [38337662](https://pubmed.ncbi.nlm.nih.gov/38337662/)]
4. Marshall NE, Abrams B, Barbour LA, et al. The importance of nutrition in pregnancy and lactation: lifelong consequences. *Am J Obstet Gynecol*. May 2022;226(5):607-632. [doi: [10.1016/j.ajog.2021.12.035](https://doi.org/10.1016/j.ajog.2021.12.035)] [Medline: [34968458](https://pubmed.ncbi.nlm.nih.gov/34968458/)]
5. Cortés-Albornoz MC, García-Guáqueta DP, Velez-van-Meerbeke A, Talero-Gutiérrez C. Maternal nutrition and neurodevelopment: a scoping review. *Nutrients*. Oct 8, 2021;13(10):3530. [doi: [10.3390/nu13103530](https://doi.org/10.3390/nu13103530)] [Medline: [34684531](https://pubmed.ncbi.nlm.nih.gov/34684531/)]
6. Shriver LH, Eagleton SG, Hosseinzadeh M, Buehler C, Wideman L, Leerkes EM. Associations among eating behaviors, food security status, and dietary intake during pregnancy. *Appetite*. Dec 1, 2023;191:107062. [doi: [10.1016/j.appet.2023.107062](https://doi.org/10.1016/j.appet.2023.107062)] [Medline: [37742786](https://pubmed.ncbi.nlm.nih.gov/37742786/)]
7. Yee LM, Silver RM, Haas DM, et al. Quality of periconceptional dietary intake and maternal and neonatal outcomes. *Am J Obstet Gynecol*. Jul 2020;223(1):121. [doi: [10.1016/j.ajog.2020.01.042](https://doi.org/10.1016/j.ajog.2020.01.042)] [Medline: [31981510](https://pubmed.ncbi.nlm.nih.gov/31981510/)]
8. Harris A, Chilukuri N, West M, et al. Obesity-related dietary behaviors among racially and ethnically diverse pregnant and postpartum women. *J Pregnancy*. 2016;2016:9832167. [doi: [10.1155/2016/9832167](https://doi.org/10.1155/2016/9832167)] [Medline: [27298738](https://pubmed.ncbi.nlm.nih.gov/27298738/)]
9. Bodnar LM, Simhan HN, Parker CB, et al. Racial or ethnic and socioeconomic inequalities in adherence to national dietary guidance in a large cohort of US pregnant women. *J Acad Nutr Diet*. Jun 2017;117(6):867-877. [doi: [10.1016/j.jand.2017.01.016](https://doi.org/10.1016/j.jand.2017.01.016)] [Medline: [28320597](https://pubmed.ncbi.nlm.nih.gov/28320597/)]
10. Howell EA. Reducing disparities in severe maternal morbidity and mortality. *Clin Obstet Gynecol*. Jun 2018;61(2):387-399. [doi: [10.1097/GRF.0000000000000349](https://doi.org/10.1097/GRF.0000000000000349)] [Medline: [29346121](https://pubmed.ncbi.nlm.nih.gov/29346121/)]
11. Naska A, Lagiou A, Lagiou P. Dietary assessment methods in epidemiological research: current state of the art and future prospects. *F1000Res*. 2017;6:926. [doi: [10.12688/f1000research.10703.1](https://doi.org/10.12688/f1000research.10703.1)] [Medline: [28690835](https://pubmed.ncbi.nlm.nih.gov/28690835/)]
12. Arab L, Wesseling-Perry K, Jardack P, Henry J, Winter A. Eight self-administered 24-hour dietary recalls using the internet are feasible in African Americans and Whites: the energetics study. *J Am Diet Assoc*. Jun 2010;110(6):857-864. [doi: [10.1016/j.jada.2010.03.024](https://doi.org/10.1016/j.jada.2010.03.024)] [Medline: [20497774](https://pubmed.ncbi.nlm.nih.gov/20497774/)]
13. DeBiasse MA, Bowen DJ, Quatromoni PA, Quinn E, Quintiliani LM. Feasibility and acceptability of dietary intake assessment via 24-hour recall and food frequency questionnaire among women with low socioeconomic status. *J Acad Nutr Diet*. Feb 2018;118(2):301-307. [doi: [10.1016/j.jand.2017.08.011](https://doi.org/10.1016/j.jand.2017.08.011)] [Medline: [29102422](https://pubmed.ncbi.nlm.nih.gov/29102422/)]
14. Savard C, Lemieux S, Lafrenière J, Laramée C, Robitaille J, Morisset AS. Validation of a self-administered web-based 24-hour dietary recall among pregnant women. *BMC Pregnancy Childbirth*. Apr 23, 2018;18(1):112. [doi: [10.1186/s12884-018-1741-1](https://doi.org/10.1186/s12884-018-1741-1)] [Medline: [29685127](https://pubmed.ncbi.nlm.nih.gov/29685127/)]
15. Karvetti RL, Knuts LR. Validity of the 24-hour dietary recall. *J Am Diet Assoc*. Nov 1985;85(11):1437-1442. [doi: [10.1016/S0002-8223\(21\)03818-9](https://doi.org/10.1016/S0002-8223(21)03818-9)] [Medline: [4056262](https://pubmed.ncbi.nlm.nih.gov/4056262/)]
16. Thompson FE, Subar AF. Ecological momentary assessment. *Annu Rev Clin Psychol*. 2017;1-32. [doi: [10.1146/annurev.clinpsy.3.022806.091415](https://doi.org/10.1146/annurev.clinpsy.3.022806.091415)]

17. Shiffman S, Stone AA, Hufford MR. Ecological momentary assessment. *Annu Rev Clin Psychol*. 2008;4:1-32. [doi: [10.1146/annurev.clinpsy.3.022806.091415](https://doi.org/10.1146/annurev.clinpsy.3.022806.091415)] [Medline: [18509902](https://pubmed.ncbi.nlm.nih.gov/18509902/)]
18. Maugeri A, Barchitta M. A systematic review of ecological momentary assessment of diet: implications and perspectives for nutritional epidemiology. *Nutrients*. Nov 7, 2019;11(11):2696. [doi: [10.3390/nu11112696](https://doi.org/10.3390/nu11112696)] [Medline: [31703374](https://pubmed.ncbi.nlm.nih.gov/31703374/)]
19. Battaglia B, Lee L, Jia SS, Partridge SR, Allman-Farinelli M. The use of Mobile-Based Ecological Momentary Assessment (mEMA) methodology to assess dietary intake, food consumption behaviours and context in young people: a systematic review. *Healthcare (Basel)*. Jul 18, 2022;10(7):1329. [doi: [10.3390/healthcare10071329](https://doi.org/10.3390/healthcare10071329)] [Medline: [35885855](https://pubmed.ncbi.nlm.nih.gov/35885855/)]
20. Spook JE, Paulussen T, Kok G, Van Empelen P. Monitoring dietary intake and physical activity electronically: feasibility, usability, and ecological validity of a mobile-based Ecological Momentary Assessment tool. *J Med Internet Res*. Sep 24, 2013;15(9):e214. [doi: [10.2196/jmir.2617](https://doi.org/10.2196/jmir.2617)] [Medline: [24067298](https://pubmed.ncbi.nlm.nih.gov/24067298/)]
21. Schembre SM, Liao Y, O'Connor SG, et al. Mobile ecological momentary diet assessment methods for behavioral research: systematic review. *JMIR Mhealth Uhealth*. Nov 20, 2018;6(11):e11170. [doi: [10.2196/11170](https://doi.org/10.2196/11170)] [Medline: [30459148](https://pubmed.ncbi.nlm.nih.gov/30459148/)]
22. Tanweer A, Khan S, Mustafa FN, Imran S, Humayun A, Hussain ZUN. Improving dietary data collection tools for better nutritional assessment—a systematic review. *Computer Methods Programs Biomedicine Update*. 2022;2:100067. [doi: [10.1016/j.cmpbup.2022.100067](https://doi.org/10.1016/j.cmpbup.2022.100067)]
23. Campbell KL, Babiary A, Wang Y, Tilton NA, Black MM, Hager ER. Factors in the home environment associated with toddler diet: an ecological momentary assessment study. *Public Health Nutr*. Jul 2018;21(10):1855-1864. [doi: [10.1017/S1368980018000186](https://doi.org/10.1017/S1368980018000186)] [Medline: [29526170](https://pubmed.ncbi.nlm.nih.gov/29526170/)]
24. O'Reilly GA, Huh J, Schembre SM, Tate EB, Pentz MA, Dunton G. Association of usual self-reported dietary intake with ecological momentary measures of affective and physical feeling states in children. *Appetite*. Sep 2015;92:314-321. [doi: [10.1016/j.appet.2015.05.032](https://doi.org/10.1016/j.appet.2015.05.032)] [Medline: [26032196](https://pubmed.ncbi.nlm.nih.gov/26032196/)]
25. Borgogna N, Lockhart G, Grenard JL, Barrett T, Shiffman S, Reynolds KD. Ecological momentary assessment of urban adolescents' technology use and cravings for unhealthy snacks and drinks: differences by ethnicity and sex. *J Acad Nutr Diet*. May 2015;115(5):759-766. [doi: [10.1016/j.jand.2014.10.015](https://doi.org/10.1016/j.jand.2014.10.015)] [Medline: [25482855](https://pubmed.ncbi.nlm.nih.gov/25482855/)]
26. Grenard JL, Stacy AW, Shiffman S, et al. Sweetened drink and snacking cues in adolescents: a study using ecological momentary assessment. *Appetite*. Aug 2013;67:61-73. [doi: [10.1016/j.appet.2013.03.016](https://doi.org/10.1016/j.appet.2013.03.016)] [Medline: [23583312](https://pubmed.ncbi.nlm.nih.gov/23583312/)]
27. Dunton GF, Dzibur E, Huh J, et al. Daily associations of stress and eating in mother-child dyads. *Health Educ Behav*. Jun 2017;44(3):365-369. [doi: [10.1177/1090198116663132](https://doi.org/10.1177/1090198116663132)] [Medline: [27531169](https://pubmed.ncbi.nlm.nih.gov/27531169/)]
28. O'Connor SG, Koprowski C, Dzibur E, Leventhal AM, Huh J, Dunton GF. Differences in mothers' and children's dietary intake during physical and sedentary activities: an Ecological Momentary Assessment Study. *J Acad Nutr Diet*. Aug 2017;117(8):1265-1271. [doi: [10.1016/j.jand.2017.02.012](https://doi.org/10.1016/j.jand.2017.02.012)] [Medline: [28392348](https://pubmed.ncbi.nlm.nih.gov/28392348/)]
29. Mason TB, O'Connor SG, Schembre SM, Huh J, Chu D, Dunton GF. Momentary affect, stress coping, and food intake in mother-child dyads. *Health Psychol*. Mar 2019;38(3):238-247. [doi: [10.1037/hea0000714](https://doi.org/10.1037/hea0000714)] [Medline: [30762403](https://pubmed.ncbi.nlm.nih.gov/30762403/)]
30. Levinson CA, Sala M, Fewell L, Brosos LC, Fournier L, Lenze EJ. Meal and snack-time eating disorder cognitions predict eating disorder behaviors and vice versa in a treatment seeking sample: a mobile technology based ecological momentary assessment study. *Behav Res Ther*. Jun 2018;105:36-42. [doi: [10.1016/j.brat.2018.03.008](https://doi.org/10.1016/j.brat.2018.03.008)] [Medline: [29614379](https://pubmed.ncbi.nlm.nih.gov/29614379/)]
31. Thomas JG, Bond DS, Ryder BA, et al. Ecological momentary assessment of recommended postoperative eating and activity behaviors. *Surg Obes Relat Dis*. 2011;7(2):206-212. [doi: [10.1016/j.soard.2010.10.007](https://doi.org/10.1016/j.soard.2010.10.007)] [Medline: [21130703](https://pubmed.ncbi.nlm.nih.gov/21130703/)]
32. Most J, Vallo PM, Altazan AD, et al. Food photography is not an accurate measure of energy intake in obese, pregnant women. *J Nutr*. Apr 1, 2018;148(4):658-663. [doi: [10.1093/jn/nxy009](https://doi.org/10.1093/jn/nxy009)] [Medline: [29659958](https://pubmed.ncbi.nlm.nih.gov/29659958/)]
33. Mason TB, Wang WL, Bastain T, et al. Bi-directional associations of affective states and diet among low-income Hispanic pregnant women using ecological momentary assessment. *Psychiatry Int*. 2022;3(4):273-285. [doi: [10.3390/psychiatryint3040022](https://doi.org/10.3390/psychiatryint3040022)]
34. Mendez DD, Sanders SA, Karimi HA, et al. Understanding pregnancy and postpartum health using ecological momentary assessment and mobile technology: protocol for the postpartum mothers mobile study. *JMIR Res Protoc*. Jun 26, 2019;8(6):e13569. [doi: [10.2196/13569](https://doi.org/10.2196/13569)] [Medline: [31244478](https://pubmed.ncbi.nlm.nih.gov/31244478/)]
35. Davis EM, Abebe KZ, Simhan HN, et al. Perinatal outcomes of two screening strategies for gestational diabetes mellitus: a randomized controlled trial. *Obstet Gynecol*. Jul 1, 2021;138(1):6-15. [doi: [10.1097/AOG.0000000000004431](https://doi.org/10.1097/AOG.0000000000004431)] [Medline: [34259458](https://pubmed.ncbi.nlm.nih.gov/34259458/)]
36. Abebe KZ, Scifres C, Simhan HN, et al. Comparison of Two Screening Strategies for Gestational Diabetes (GDM 2) trial: design and rationale. *Contemp Clin Trials*. Nov 2017;62:43-49. [doi: [10.1016/j.cct.2017.08.012](https://doi.org/10.1016/j.cct.2017.08.012)] [Medline: [28823926](https://pubmed.ncbi.nlm.nih.gov/28823926/)]

37. Mendez D, DeVaughn S, Duell J. The pregnancy ecological momentary assessment pilot study: applications of mobile technology. *Integr Gyn Obstet J*. Feb 26, 2019;2(1):1-6. [doi: [10.31038/IGOJ.2019215](https://doi.org/10.31038/IGOJ.2019215)]
38. Adult BMI calculator. Centers for Disease Control and Prevention. Jun 3, 2022. URL: <https://www.cdc.gov/bmi/adult-calculator/index.html> [Accessed 2025-09-29]
39. Quick facts. US Census Bureau. 2024. URL: <https://www.census.gov/quickfacts/fact/table/allegHENYcountypennsylvania/BZA115223> [Accessed 2025-09-29]
40. Stone AA, Shiffman S. Capturing momentary, self-report data: a proposal for reporting guidelines. *Ann Behav Med*. 2002;24(3):236-243. [doi: [10.1207/S15324796ABM2403_09](https://doi.org/10.1207/S15324796ABM2403_09)] [Medline: [12173681](https://pubmed.ncbi.nlm.nih.gov/12173681/)]
41. Trofholz A, Tate A, Janowiec M, et al. Ecological momentary assessment of weight-related behaviors in the home environment of children from low-income and racially and ethnically diverse households: development and usability study. *JMIR Res Protoc*. Dec 1, 2021;10(12):e30525. [doi: [10.2196/30525](https://doi.org/10.2196/30525)] [Medline: [34855612](https://pubmed.ncbi.nlm.nih.gov/34855612/)]
42. Tate AD, Fertig AR, de Brito JN, et al. Momentary factors and study characteristics associated with participant burden and protocol adherence: ecological momentary assessment. *JMIR Form Res*. Apr 24, 2024;8:e49512. [doi: [10.2196/49512](https://doi.org/10.2196/49512)] [Medline: [38656787](https://pubmed.ncbi.nlm.nih.gov/38656787/)]
43. Comulada WS, Swendeman D, Koussa MK, et al. Adherence to self-monitoring healthy lifestyle behaviours through mobile phone-based ecological momentary assessments and photographic food records over 6 months in mostly ethnic minority mothers. *Public Health Nutr*. Mar 2018;21(4):679-688. [doi: [10.1017/S1368980017003044](https://doi.org/10.1017/S1368980017003044)] [Medline: [29199630](https://pubmed.ncbi.nlm.nih.gov/29199630/)]
44. Tonkin S, Gass J, Wray J, et al. Evaluating declines in compliance with ecological momentary assessment in longitudinal health behavior research: analyses from a clinical trial. *J Med Internet Res*. Jun 22, 2023;25:e43826. [doi: [10.2196/43826](https://doi.org/10.2196/43826)] [Medline: [37347538](https://pubmed.ncbi.nlm.nih.gov/37347538/)]

Abbreviations

BOD: beginning of day

EMA: ecological momentary assessment

EOD: end of day

GDM²: Comparison of Two Screening Strategies for Gestational Diabetes

PMOMS: Postpartum Mothers Mobile Study

Edited by Andre Kushniruk; peer-reviewed by Tom Baranowski, Traci M Kennedy; submitted 01.10.2024; final revised version received 19.06.2025; accepted 10.07.2025; published 08.10.2025

Please cite as:

Sanders SA, Omowale S, Casas A, Kiyanda A, Kosbie AS, Lai YH, Wallace M, Rathbun S, Gary-Webb T, Davis E, Burke L, Méndez D

Completion Rates for Ecological Momentary Assessments of Food Intake During Pregnancy and Post Partum: Descriptive Study

JMIR Hum Factors 2025;12:e67081

URL: <https://humanfactors.jmir.org/2025/1/e67081>

doi: [10.2196/67081](https://doi.org/10.2196/67081)

© Sarah Annalise Sanders, Serwaa Omowale, Andrea Casas, Alexis Kiyanda, Abigail Smith Kosbie, Yu-Hsuan Lai, Meredith Wallace, Stephen Rathbun, Tiffany Gary-Webb, Esa Davis, Lora Burke, Dara Méndez. Originally published in *JMIR Human Factors* (<https://humanfactors.jmir.org>), 08.10.2025. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in *JMIR Human Factors*, is properly cited. The complete bibliographic information, a link to the original publication on <https://humanfactors.jmir.org>, as well as this copyright and license information must be included.