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Differences in mothers' and children's dietary intake during physical and sedentary activities: an ecological momentary assessment (EMA) study

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Abstract

Background—Physical activity and diet are major modifiable health behaviors contributing to obesity risk. Although patterns of these behaviors tend to cluster within individuals and within

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family units, it is unknown to what extent healthy and unhealthy dietary intake might differentially accompany sedentary and physical activities in mothers as compared to their children.

Objective—Our goal was to examine differences in co-occurrence of activities and dietary intake between mothers and children, as measured in real time using Ecological Momentary Assessment (EMA).

Participants/setting—This study examined cross-sectional data from 175 mothers and their 8–12 year old children.

Main Outcome Measures—Participants completed eight days of EMA surveys, reporting on whether the following activities had occurred in the past two hours: sedentary screen activity, physical activity, and intake of healthy (i.e., fruits and vegetables) and unhealthy (i.e., fast food, chips/fries, pastries/sweets, soda/energy drinks) foods.

Statistical analyses performed—Multilevel logistic regression models estimated the adjusted odds of consuming healthy and unhealthy dietary intake for mothers and children during time periods reporting physical activity (vs. no physical activity) or sedentary screen activity (vs. no sedentary screen activity). Post-hoc tests compared estimates for mothers vs. children.

Results—Children were significantly more likely than their mothers to consume unhealthy foods during two-hour windows that included physical activity (OR [children] = 1.85, 95% CI = 1.47 – 2.31; OR [mothers] = 0.83, 95% CI = 0.58 – 1.20, $p_{diff} < 0.05$), but not sedentary screen activity ($p_{diff} = 0.067$). Additionally, children and their mothers did not differ in their likelihood of consuming healthy foods during two-hour windows with sedentary screen activity ($p_{diff} = 0.497$) or physical activity ($p_{diff} = 0.170$).

Conclusions—Results indicate that the consumption of unhealthy foods may be more likely to co-occur within a two-hour window including physical activity in children as compared to their mothers. Future research should examine reasons for this difference, and potential areas for intervention. Differences in mothers' and children's dietary intake during physical and sedentary activities: an ecological momentary assessment (EMA) study

Keywords

EMA; sedentary behavior; physical activity; dietary intake; fruits and vegetables

Introduction

Sedentary behavior, deficient physical activity, intake of high-calorie, low-nutrient (HCLN) foods, and under-consumption of nutrient-dense foods (e.g., fruit and vegetables, F&V) are each modifiable health behaviors increasing obesity risk.^{1–4} Previous evidence suggests that these unique behaviors tend to cluster together within people.^{5,6} For example, regular engagement in physical activity in the form of sports or other exercise has been associated with a generally healthier diet, including greater intake of F&V.⁷ Conversely, time spent in TV viewing is associated with increased consumption of soda, snacks, and fast food,⁸ and decreased consumption of F&V.⁹ A more robust understanding of associations among weight-related behaviors may allow for more effective targeting of behavior change in prevention or intervention programs.

One limitation of previous studies examining associations of activity and dietary behaviors within individuals is an inability to determine temporal co-occurrence. Thus, although there appears to be an association between sedentary screen activities and HCLN intake over a period of days, months or years on a between-person level (e.g., those who engage in one unhealthy behavior tend to engage in other unhealthy behaviors),⁶ this association may not hold on a momentary, within-person level (e.g., at moments when an individual engages in one unhealthy behavior, he/she also tends to engage in other unhealthy behaviors simultaneously). Consequently, individuals who engage in frequent sedentary activities might eat more unhealthy food overall, but this excess HCLN intake may or may not aggregate among time spent engaging in sedentary activities. For example, children with higher sedentary screen time may consume more unhealthy foods across various circumstances (e.g., walking to school, during meal time, playing with friends) and not necessarily during sedentary activity, which would suggest that interventions should not necessarily assume that intervening on screen time would have collateral effects on HCLN intake. Although individuals who engage in physical activity generally have elevated intake of F&V,⁶ studies have shown that youth who participate in organized sports tend to have elevated intake of HCLN foods—including fast food¹⁰ and sugar-sweetened beverages, as well as elevated overall caloric intake.¹¹ Thus, when physically active children consume HCLN foods, it may be relatively limited to certain time windows, such as during periods of activity, which would call for interventions that identify periods of activity as possible triggers for HCLN intake and would require proactive planning (e.g., making healthy food and drinks available at sporting events). Therefore, general patterns of healthy and unhealthy activity and eating behaviors may cluster at the person level and differ across individuals, yet may or may not co-occur within the same periods of day.

Further, the strength and direction of these activities and dietary behavior clusterings may differ between adults and children. A review of the association between individuals' total time spent in TV viewing, a common indicator of sedentary behavior, and their overall unhealthy dietary intake concluded that there is a stronger association between these two behaviors in children and adolescents as compared to adults.⁹ Developmental differences between children and adults in dietary decision-making processes or access to foods may result in different degrees of clustering among activity and dietary behaviors. Thus, although mothers and children are part of the same family unit and weight-related behaviors tend to cluster in family units,¹² differences between the co-occurrence of these behaviors in children and mothers may suggest differing approaches to prevention and intervention programs.

This study used intensive repeated participant surveys obtained via Ecological Momentary Assessment (EMA) methods, to obtain ecologically valid information on mothers' and children's physical activity, sedentary screen activity, and dietary intake as they occur in daily life.¹³ Our goal was to determine whether mothers and children differ in the likelihood of consuming healthy or unhealthy foods during the same time periods where physical activity or sedentary screen activities were also reported. Increased consumption of unhealthy food intake in children during exercise or sports and during sedentary screen activities was expected based on evidence that youth sports¹¹ and TV viewing⁸ are

associated with unhealthy food intake. In addition, it was hypothesized that these associations would be weaker in mothers.

Methods

Participants

Participants were ethnically- and racially-diverse mother-child dyads from the Mothers' and Their Children's Health (MATCH) Study, a longitudinal study of the effects of maternal stress and behavior on their children's stress, weight-related behaviors, and obesity trajectories. Dyads were recruited from elementary schools and after school programs in the greater Los Angeles metropolitan area, through the distribution of informational flyers and in-person recruitment events from 2014 - 2015. Analysis for the current study was limited to the first wave (cross-sectional) of data collection. Inclusion criteria consisted of the following: (a) child currently in 3rd – 6th grade, (b) child resides with mother at least 50% of time, and (c) both mother and child able to speak and read in English or Spanish. Mothers provided written informed consent for themselves and their children, and children provided written informed assent prior to beginning any study procedures. The Institutional Review Board at the University of Southern California approved all aspects of this research.

Procedures

Following an initial visit to a local school or community center and the completion of anthropometric measurements, paper-and-pencil questionnaires, and instructions on how to use the study equipment, mothers and children each completed eight days of EMA, responding to randomly timed (i.e., signal contingent) survey prompts via a custom smartphone application (app) for the Android operating system (Google Inc., Mountain View, CA). Eight days were selected for the monitoring period in order to obtain a representation of at least a full week, while limiting participant burden. Mothers and children each used a unique phone; participants who owned their own Android phone were invited to download and use the app on their own phone, and participants who did not wish to use their own phone, who had an incompatible phone, or who had no phone borrowed a MotoG (Motorola, USA) study phone for the duration of the study period. Participants were instructed to complete a short (i.e., two-three minute) EMA survey upon hearing the signal, unless engaging in incompatible activities (e.g., sleeping). On weekdays after school time, surveys were prompted up to three times for children and four times for mothers, from 3:00pm to 8:00pm (children) or 9:30pm (mothers). On weekend days, children received up to seven and mothers up to eight surveys, from 7:00am to 8:00pm (children) or 9:30pm (mothers). Thus, children received up to 29 surveys, and mothers up to 36 across the study period. Detailed information on the full MATCH Study procedure is published elsewhere.¹⁴

Measures

EMA surveys asked participants to report whether they had engaged in any of the following activities in the past two hours: "Exercise or Sports," "TV/Videos/Video Games," (including tablet or phone) "Eaten Fruits or Vegetables", "Eaten Fast food", "Eaten Chips or Fries", "Eaten Pastries or Sweets", and "Drank Soda or Energy Drinks (not counting diet)". All response options were binary ("Yes" or "No"), and each response window was classified as

consisting of physical activity (i.e., “Exercise or Sports”), sedentary screen activity (i.e., “TV/Videos/Video Games”), healthy dietary intake (i.e., “Fruits or Vegetables”) as well as unhealthy dietary intake (at least one of the other dietary items).

Only “Fruits or Vegetables” were selected to represent ‘Healthy’ items due to concern over children’s ability to identify other healthy foods (e.g., whole grains, lean proteins), while the ‘Unhealthy’ items were selected to represent a range of HCLN foods commonly consumed by both children and adults and which have been associated with increased weight gain and obesity risk.^{15–17} In this sample, self-report EMA measures of physical activity and sedentary screen activity were comparable to waist worn accelerometry measurements. The EMA measure of past two-hour “Exercise or Sports” was associated with higher past two-hour moderate-to-vigorous physical activity in mothers (coef = 6.02, $p < 0.001$) and children (coef = 5.48, $p < 0.001$), and the EMA measure of “TV/Videos/Video Games” was associated with higher past two-hour sedentary activity in mothers (coef = 3.35, $p < 0.001$) and children (coef = 8.12, $p < 0.001$) (unpublished data). Additionally, there is evidence that EMA measures of dietary intake are comparable to 24-hour dietary recall reported by children for identical time windows. Concordance between EMA measures of dietary intake and 24-hour dietary recalls ranged from 66% – 90%, depending on food type (unpublished data).

Trained staff assessed height and weight on mothers and children using a digital scale and stadiometer. Measures were taken in duplicate to the nearest 0.1 kg and 0.1 cm, and in discrepant cases the average of the two measurements was taken. Body Mass Index (BMI) was calculated (kg/m^2), BMI z-score was calculated for children, and both mothers and children were classified according to CDC categories (e.g., underweight/normal weight, overweight, obese).^{18,19} Mothers completed paper questionnaires self-reporting on their age, ethnicity, highest level of education, and annual household income; children self-reported their age and gender.

Data Analyses

Data from the smartphone app were uploaded to a secure server, and analysis was conducted in SAS (V 9.4). The analytical sample included dyads of mothers and children in which each dyad member reported engaging in physical activity or sedentary screen activity at least once during the eight-day monitoring period. The first survey of each weekday was excluded from the present analysis, as it asked mothers and children to report on their activities and dietary intake over a longer period of time (i.e., “Since you woke up this morning”). Level-2 denotes the dyad level (i.e., number of dyads), and Level-1 denotes the survey level (i.e., number of surveys). The Level-1 sample size of 5,961 was calculated, using G*Power, as sufficient to detect a small sized effect.²⁰ Descriptive analyses were conducted separately for mothers and children to examine the person-level average proportions of prompts reporting each activity and eating type, as well as proportion of unhealthy and healthy dietary intake occurring within each activity type.

Multilevel models, which account for the clustering of observations within individuals, were used to screen several covariates for inclusion into our model, and final models included covariates that were significantly ($p < 0.05$) associated with any outcome (healthy foods vs. no healthy foods, unhealthy foods vs. no unhealthy foods). Time-variant covariates included

time of day (morning, afternoon, evening), and day of week (weekend vs. weekday). Time invariant (person-level) covariates included child gender, mother's ethnicity (Hispanic vs. not Hispanic), and annual household income quartiles (< \$35,000; \$35,001–\$74,999; \$75,000–\$104,999; \$105,000). Other screened but non-significant covariates included mother's education level (college vs. no college), BMI category and age (of mother or child). All variables were entered into the models simultaneously. Additionally, because we compared children to their own mothers, models also adjusted for dyad to account for within-dyad effects.

Two separate multilevel logistic regression models were conducted to estimate the adjusted odds of consuming (1) healthy (vs. no healthy) dietary intake for mothers and children during time periods reporting physical activity (vs. no physical activity) or sedentary screen activity (vs. no sedentary screen activity), and (2) unhealthy (vs. no unhealthy) dietary intake for mothers and children during time periods reporting physical activity (vs. no physical activity) or sedentary screen activity (vs. no sedentary screen activity). In all models, a binary indicator variable for both child (where =1 for child, and =0 for mother) and mother (where =0 for child, and =1 for mother) was entered, in order to produce separate estimates for mothers and children.²¹ Interaction terms (e.g., the product of each predictor variable and the binary child or mother term) were created to determine the associations of each activity type (physical activity vs. no physical activity, sedentary screen activity vs. no sedentary screen activity) with healthy and unhealthy dietary intake for each dyad member (mothers and children).²² Post hoc estimates comparing the log odds of each activity and dietary pairing for mothers vs. children were conducted to assess differences between the dyad members.

Results

There were 191 mother child dyads (Level 2) enrolled in the overall study, and the current analysis included 175 mother-child dyads where each dyad member had at least one valid EMA survey reporting physical activity or sedentary screen activity within the past two hours, and complete covariates. Thus, data from 16 dyads were excluded from the present analyses due to either having no EMA data, having no EMA survey reporting physical activity or sedentary screen activity, or missing covariates. Participant demographics for the analytical sample are shown in Table 1. Mothers ranged in age from 26–57 years (mean age=41.1, SD: 6.2) and children (52% female) ranged in age from 8–12 years (mean=9.6, SD: 0.9).

The analytical sample included 5,961 EMA surveys (Level 1) completed by the 175 dyads (Level 2). Mothers completed 3,402 surveys (mean per mother: 19, SD: 9.9, range: 2–29), and children completed 2,559 surveys (mean per child: 15, SD: 5.2, range: 2–23). Children reported engaging in past two-hour “TV/Video/Video games” in 49.8% of all answered prompts, and mothers in 21.3%; children reported participating in “Exercise or Sports” in 30.8% of all prompts and mothers in 7.6%. Although both children and mothers reported healthy dietary intake in a similar proportion of all answered prompts (25.0% and 24.8%, respectively), children reported greater intake of unhealthy dietary items than their mothers (27.7% and 18.9%, respectively). Within the unhealthy dietary reports, children reported

consuming “Pastries or Sweets” in 13.76%, “Chips or Fries” in 9.89%, “Soda or Energy Drinks (not counting diet)” in 9.57%, and “Fast food” in 7.54% of all prompts. Mothers reported consuming “Pastries or Sweets” in 8.14%, “Chips or Fries” in 5.09%, “Soda or Energy Drinks (not counting diet)” in 5.35%, and “Fast food” in 4.14%, of all prompts.

Table 2 shows that mothers and their children were both more likely to consume healthy foods (vs. no healthy foods) during two-hour windows with physical activity (vs. no physical activity) (OR [children] = 2.05, 95% CI = 1.63 – 2.58; OR [mothers] = 1.40, 95% CI = 1.04 – 1.88). Post hoc estimates of the differences in explicit parameterization estimates showed that this increased likelihood was not significantly different between mothers and their children ($p = 0.170$). Similarly, mothers and their children both were more likely to consume healthy foods (vs. no healthy foods) during two-hour windows with sedentary screen activities (vs. no sedentary screen activities) (OR [children] = 1.74, 95% CI = 1.38 – 2.19; OR [mothers] = 1.67, 95% CI = 1.36 – 2.04), and this association did not differ between mothers and their children ($p = 0.497$). Table 2 also shows that children but not mothers were more likely to consume unhealthy foods (vs. no unhealthy foods) during two-hour windows with physical activity (vs. no physical activity) (OR [children] = 1.85, 95% CI = 1.47 – 2.31; OR [mothers] = 0.83, 95% CI = 0.58 – 1.20). Post hoc estimates showed that the difference in OR estimate between mothers and their children was statistically significant ($p < 0.05$). Children, but not their mothers, were also more likely to consume unhealthy foods (vs. no unhealthy foods) during two-hour windows with sedentary screen activities (vs. no sedentary screen activities) (OR [children] = 1.62, 95% CI = 1.30 – 2.02; OR [mothers] = 1.19, 95% CI = 0.95 – 1.49). Post hoc estimates showed that this increased likelihood was not significantly different between mothers and their children ($p = 0.067$). Post hoc analyses also revealed no significant gender differences in the likelihood of consuming healthy or unhealthy foods in two-hour windows with physical activity or sedentary screen activities (interaction p 's > 0.05).

Discussion

The goal of this study was to determine whether mothers and children differ in the likelihood of consuming healthy or unhealthy foods during two-hour windows where physical activity or sedentary screen activities were also reported. Results from this study showed that mothers and their children show similar patterns of healthy food intake during two-hour windows with physical activity or sedentary screen activity. This finding is consistent with previous literature illustrating a general correlation between mothers' and children's consumption of healthy foods.²³

Results also showed that children were significantly more likely than their mothers to consume unhealthy food in time windows with physical activity. The finding that children are more likely than their mothers to consume unhealthy foods in time windows with physical activity mirrors other studies that have found an association between youth sports participation and elevated consumption of HCLN foods.²⁴ Whereas mothers who make an effort to be physically active may be acting on an overall desire to be healthy and thus also make healthful food choices, children who participate in regular sports may be subjected to an environment where food advertisements and HCLN snacks are freely available, in

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Table 1

Demographic characteristics of a cohort of 175 mother-child dyads participating in Wave 1 of the Mother's and their Children's Health (MATCH) Study

Variable	N (%)
Child Gender	
Male	84 (48.0)
Female	91 (52.0)
Mother Race [*]	
White	75 (42.9)
Asian	21 (12.0)
Black	28 (16.0)
Other	59 (33.7)
Child Race	
White	77 (44.0)
Asian	25 (14.3)
Black	32 (18.3)
Other	64 (36.6)
Mother Ethnicity	
Hispanic	82 (46.9)
Non-Hispanic	93 (53.1)
Child Ethnicity	
Hispanic	92 (52.6)
Non-Hispanic	83 (47.4)
Annual Household Income	
Less than \$35,000	47 (26.8)
\$35,001–\$74,999	49 (28.0)
\$75,000–\$104,999	36 (20.6)
\$105,000 and above	43 (24.6)
Type of Household	
Single parent	40 (22.9)
Two-parents	113 (64.6)
Multigenerational	22 (12.6)
Mother Education Level ^a	
Less than high school	11 (6.5)
High school graduate	55 (31.4)
College graduate	59 (34.7)
Attended graduate or prof. school	44 (25.9)
Mother Weight Category ^b	
Normal/Underweight	59 (34.3)
Overweight	55 (32.0)
Obese	58 (33.7)

Variable	N (%)
Child Weight Category ^c	
Normal/Underweight	106 (62.0)
Overweight	40 (23.4)
Obese	25 (14.6)
Mean (Standard Deviation)	
Mother Age (years) ^d	41.1 (6.2)
Child Age (years) ^e	9.6 (0.9)

Note: N=175 mother and child dyads.

* Mothers and children selected all race categories that applied, thus proportions for race add up to greater than 100%.

^a Mother education level was missing for six participants.

^b Mother weight category was based on BMI (kg/m²) categories and were assigned according to CDC guidelines.¹⁹ Mother weight category was missing for three participants.

^c Child weight categories were assigned based on BMI z-score, adjusted for child age and sex.¹⁸ Child weight category was missing for four participants.

^d Mother age was missing for two participants.

^e Child age was missing for one participant.

Results of Multilevel Logistic Regression Predicting Healthy and Unhealthy Dietary Intake During Physical Activity and Sedentary Screen Activity in Mothers and Children

Table 2

	Healthy ^a Intake		Unhealthy ^b Intake		
	<i>n</i>	OR	95% CI	OR	95% CI
Level-1 (prompts) ^c	5961				
Level-2 (dyads) ^d	175				
Intercept					
Mother Intercept		0.06**	0.03 – 0.12	0.04**	0.02 – 0.07
Child Intercept		0.04**	0.02 – 0.08	0.04**	0.02 – 0.08
Mother Effects					
Phys. Act. (vs. No Phys. Act)		1.40*	1.04 – 1.88	0.83	0.58 – 1.20
Sed. Screen (vs. No Sed. Screen)		1.67**	1.36 – 2.04	1.19	0.95 – 1.49
Child Effects					
Phys. Act. (vs. No Phys. Act)		2.05**	1.63 – 2.58	1.85**	1.47 – 2.31
Sed. Screen (vs. No Sed. Screen)		1.74**	1.38 – 2.19	1.62**	1.30 – 2.02

Note: Each column represents a separate model. Column 1 represents the adjusted odds of healthy vs. no healthy dietary intake for mothers and children, in time windows where sedentary or physical activity was also reported. Column 2 represents the adjusted odds of unhealthy vs. no unhealthy dietary intake for mothers and children, in time windows where sedentary screen or physical activity is also reported. E.g., in Column 1, significant results indicate that the odds of healthy vs. no healthy intake is significantly greater in both mothers and children in time windows when they report engaging in physical activity or sedentary screen activities as compared to time windows when they do not report engaging these activities. All odds ratios represent the Level-1 findings, describing the odds of consuming each food type within a given prompt reporting each activity type. All models adjusted for annual household income (quartiles), mother's ethnicity (Hispanic vs. not Hispanic), child gender, day of week (weekend day versus weekday), and time of day.

^aHealthy vs. no healthy intake; Indicates fruits or vegetables were eaten.

^bUnhealthy vs. no unhealthy intake; Indicates at least one of the following were eaten: chips or fries, pastries or sweets, fast food, soda or energy drinks.

^cLevel-1 indicates the lower level of the analysis, the individual EMA survey prompt (n=5,961).

^dLevel-2 indicates the higher level of analysis, the mother-child dyad (n=175).

* p < 0.05

10000>d
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