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Associations between parent and child physical activity and eating behaviours in a diverse sample: an ecological momentary assessment study

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Abstract

Objective: This study is a secondary data analysis that examines the association between parent modelling of dietary intake and physical activity and the same child behaviours among different races/ethnicities using innovative, rigorous and objective measures.

Design: Ecological momentary assessment surveys were sent to parents to assess whether their child had seen them exercise or consume food. Dietary recall data and accelerometry were used to determine dietary intake and physical activity behaviours of children.

Setting: Participants were randomly selected from primary care clinics, serving low-income and racially/ethnically diverse families in Minnesota, USA.

Participants: Participants were families with children aged 5–7 years old who lived with parents 50 % of the time and shared at least one meal together.

Results: A 10 percentage point higher prevalence in parent modelling of fruit and vegetable intake was associated with 0·12 higher serving intake of those same foods in children. The prevalence of parent modelling of eating energy dense foods (10 % prevalence units) was associated with 0·09 higher serving intake of sugar-sweetened beverages. Furthermore, accelerometry-measured parent sedentary hours was strongly correlated with child sedentary time (0·37 child sedentary hours per parent sedentary hours). An exploratory interaction analysis did not reveal any statistical evidence that these relationships depended on the child's race/ethnic background.

Conclusions: Interventions that increase parent modelling of healthy eating and minimise modelling of energy dense foods may have favourable effects on child dietary quality. Additionally, future research is needed to clarify the associations of parent modelling of physical activity and children's physical activity levels.

Keywords
Parent modelling
Healthy eating
Physical activity
Race/ethnicity

Obesity in children has steadily increased since the 1970s, and today more than one in ten children, aged 5–17 years, are overweight or obese around the world[1,2]. Due to the increased risk for comorbidities, such as type 2 diabetes, metabolic disorders, CVD and other conditions, associated with obesity, childhood obesity has been declared a public health crisis[3–5].

Previous research demonstrates that nutrition and physical activity play a vital role in preventing childhood obesity[6,7]. In recent years, children have been consuming more sugar-sweetened beverages (SSB) and foods that are high in fat and added sugar[8]. The United States Department of Agriculture's Dietary Guidelines for Americans 2015–2020 reported that children aged 2–18 years have significantly lower fruit/vegetable consumption than all other age groups[9]. Increasing fruit and vegetable intake and decreasing less nutrient dense foods in children's diets may decrease childhood obesity[1,9]. In recent years, the amount of physical activity that children participate in has decreased while sedentary time has increased[10–12]. Children who are less active and spend more time watching television or

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engaging with screens such as computers, tablets or smart phones are more likely to gain weight and become overweight[11].

Given that healthful dietary intake and adequate physical activity are important aspects of a child's health and have been shown to reduce childhood obesity[6,7,13], it is important to identify what factors influence child engagement in physical activity and healthful eating. Prior research on childhood obesity has suggested that parents play a vital role in the health of their children. Specifically, parent modelling of fruit and vegetable consumption has been associated with increased intake of fruits and vegetables among children[14–16]. Additionally, a positive association between parent modelling of physical activity and increased physical activity in children has been observed[10,17]. The current study relies on observational learning, a construct within the social cognitive theory. Observational learning posits that an individual will observe others' behaviour within social situations or context, retain these behaviours and then replicate the behaviours themselves[18]. Thus, for the current study, we hypothesise that parent modelling of healthy behaviours will provide children with increased opportunities to observe these behaviours and in turn engage in these same behaviours themselves. According to observational learning, if a child is only told to eat healthfully or be active and continually must learn by trial, behaviour change is less likely; however, if a child watches someone perform the desired activities, the child is more likely to also participate in these activities[19].

In addition, there are limitations with the prior research. The majority of previous research on parent modelling of eating behaviours has used one-time surveys asking parents if they model eating fruits and vegetables in front of their children[14,17,20,21]. Reliance on static measures (e.g., one-time self-report measures) of dietary intake fails to account for change in modelling behaviours across time and context. Other studies exploring parental modelling of physical activity have used accelerometers or survey data to assess parent physical activity but have not assessed whether the child saw the parent modelling this behaviour for their children[11,17,22]. It is important to capture perceived parental modelling of physical activity across time and context to gain a better understanding of this relationship. Ecological momentary assessment (EMA) is one such method that can measure fluctuations in behaviour across time and context[23]. There is limited prior research utilising this method in examining the association between parent and child physical activity and dietary behaviours[23].

Previous research examining parent modelling of health behaviours and child dietary intake and physical activity has been limited by the lack of representation from diverse samples. Some parent modelling research has been conducted in African American and Latino populations in the USA; however, it is not extensive[24–28]. Little is known about parental modelling of healthy behaviours and child health outcomes among culturally diverse populations. Additionally, there has not been any research done on parent modelling among Hmong, Somali and Native American, which are populations with large representation in Minneapolis/St. Paul, where this study occurred. Understanding how parent modelling and child health outcomes operate in culturally diverse populations will help inform future interventions and provide guidance to practitioners working with diverse families.

The overall purpose of this study was to examine associations between parent modelling of physical activity and dietary intake and children's physical activity and dietary intake in a diverse sample residing in a metropolitan area in the USA. The current study addresses limitations with prior research by improving representation of diverse samples and utilising measures (i.e., EMA) than can capture fluctuations in behaviour over time. By using these innovative data collection methods rather than solely relying on self-report survey data, this study is positioned to advance the field with regard to parent modelling behaviours and child health outcomes.

The main hypothesis of the current study is that there will be a significant positive association found between parent modelling of dietary intake (e.g., fruits and vegetables, snack foods, SSB and fast food) and physical activity with child dietary intake and physical activity. This study also includes exploratory analysis investigating differences by race/ethnicity.

Methods

This study is a secondary data analysis of data from the *Family Matters* study, a mixed-methods study examining risk and protective factors for childhood obesity in the home environment of racially/ethnically diverse families. The *Family Matters* study has two phases: a mixed-methods, cross-sectional phase that assessed the home environment of diverse families (Phase I), and a longitudinal cohort study (Phase II). Phase I was conducted between 2015 and 2016. Data from Phase I were analysed here. Details of study methods were published elsewhere[23].

Families participating in Phase I were recruited from primary care clinics. These clinics serve low-income and racially/ethnically diverse families. To ensure sample diversity, recruitment was stratified so that equal numbers of Hmong, Somali, African American, Hispanic, Caucasian and Native American families (twenty-five per group, n 150) were recruited to participate. In addition, children were pre-stratified on overweight (BMI ≥ 85th percentile) v. normal weight status (BMI < 85th percentile). A letter was sent to parents who had a child aged 5–7 years with a recent well-child appointment. If the parent did not respond to the letter within approximately 1 week, the parent also received a phone call from researchers to invite them to participate.

Eligibility to participate in the study required that the family had a child between the ages of 5–7 years who lived with the parent/guardian more than 50 % of the time, had a sibling that was 2–12 years old also living in the same home and shared at least one meal per day with their parent or guardian. Children aged 5–7 years old were intentionally recruited for this study because they are becoming more responsible for making decisions about dietary intake and physical activity behaviours as they start school. Surveys were conducted either in English, Spanish, Hmong or Somali.

In Phase I, families participated in two home visits scheduled 10 d apart. During the home visits, researchers collected consent/assent forms, measured heights and weights of all family members, administered a 24-h dietary recall to the parent/guardian for their child, trained the child and parent on accelerometer wear time protocols and trained the parent/guardian to use the iPads for the EMA surveys.

In between the two home visits, the second 24-h dietary recall was conducted by telephone with the parent/guardian. In addition, participants filled out the daily EMA surveys and wore the accelerometer until the second home visit (for 7 d on average).

At the second home visit, the parent/guardian completed a detailed quantitative survey. During the second home visit, the third 24-h recall was conducted in person with the parent/guardian. Equipment for the study was collected, including collection of the accelerometers for data processing, and the iPad Mini and $100 USD gift card incentive were given. The current study uses three 24-h dietary recalls, accelerometer and EMA data from Phase I.

24-H dietary recalls

Child dietary intake data were collected and analysed using the Nutrition Data System for Research software version 2015, developed by the Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN, USA. Three 24-h recalls were collected on nonconsecutive days (two weekdays and one weekend day) for the target child. The parent/guardian that was involved in the study reported what the child ate, due to the child's age and the possible inability for them to correctly recall their intake[29]. The parent/guardian was provided a food amounts booklet that had detailed information on portion sizes including dimensional and volume aids, to facilitate accurate reporting of the amount of food consumed. Parents were also provided with a food diary to write down what the child ate to reduce the burden of recall and potentially reduce recall bias as well to use when participating in the 24-h recall. School and daycare menus were also utilised when possible. Two of the three 24-h dietary recalls were scheduled to coincide with timing of the home visits; the other 24-h recall was collected over the phone. Detailed quality assurance reviews were performed on all recalls collected. Data were excluded when the recall was deemed unreliable because the parent/guardian was unable to recall one or more meals. Due to the cost of carrying out three 24-h dietary recalls, only child dietary recalls were collected in the study.

Measures

Dietary intake

Dietary intake was measured using Nutrition Data System for Research as mentioned above. Fruit and vegetable intake was determined by measuring non-snack fruit categories (e.g., citrus fruits) and non-fried vegetable categories (e.g., dark green, tomatoes and starchy vegetables). SSB intake was determined by measuring sweetened coffee, tea and water, and soft drinks and fruit drinks[30].

Diet quality

Diet quality was assessed by using Healthy Eating Index (HEI) 2010. HEI-2010 scores were calculated using guidance from the Nutrition Coordinating Center[31–34]. This score was calculated by averaging the dietary recall intake data, computing scores for each adequacy and moderation component and summing the component scores to compute individual HEI-2010 scores (i.e., mean ratio method). The HEI is a tool that was developed by the United States Department of Agriculture to evaluate how diets compare to the Dietary Guidelines for Americans. HEI is calculated by the sum of scores for twelve categories: total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, fatty acids, refined grains, Na and empty energy content. Possible HEI scores ranged from 0 to 100 with a higher score indicating a better-quality diet[31,32].

Physical activity

Parent and child physical activity was measured using ActiGraph GT1M accelerometers (ActiGraph LLC), set to measure the frequency and intensity of motion in 15 s epochs. During the first home visit, the parent and the child were instructed on how the accelerometer works and to wear it on the right hip. In addition to verbal instructions, written instructions were left at the home as well as given to schools and daycare facilities to further increase the likelihood that the child and parent would wear it. To be included in the study and receive the incentive, participants had to wear the accelerometer for at least 4 d for 8 h each day, including a weekend day. If a child had at least 4 h of wear time, then the day was considered eligible for inclusion in the analytic sample (n 143). To increase participation, the child was given a sticker tracking sheet and a bag of small prizes (e.g., toys, pencils/erasers) so that the child

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received a prize every day they wore the accelerometer for the complete 8-d observation period. Parents' reports of sedentary, light, moderate and vigorous physical activity classifications were set in ActiGraph software using metabolic equivalent cut points for children aged 5–8 years[35].

Ecological momentary assessment surveys

Parents' reports of modelling of dietary intake and physical/sedentary behaviours were captured via EMA. EMA surveys were administered every day for eight consecutive days on an iPad that was provided to the participant. During the home visit, participants were set up on an iPad provided to them to take the surveys, and written instructions were given for taking the EMA surveys. Participants practised using EMA with research staff to ensure they were comfortable with how it worked before the research team member left the home visit.

Signal-contingent EMA surveys were used in this study. Signal-contingent recordings were researcher initiated and each parent received a prompt via text message, in a stratified random manner, to fill out a survey five times a day, within a 3-h time block (e.g., 07.00–10.00, 10.00–13.00, 13.00–16.00 and 19.00–22.00 hours). Timing of EMA prompts was adjusted for parent shifts at work and wake times, to accommodate differing life situations. Signal-contingent recordings allowed for examining different contexts that occurred day-to-day, moment-by-moment, in the families' lives. Parent modelling of eating, physical activity and sedentary behaviour, parent stress levels and depressed moods, and parent feeding practices were assessed using EMA. The final signal-contingent survey that was taken at the end of the day asked about meal planning, parent feeding practices and child physical activity and sedentary activity. Parents had 6 h to complete the end-of-day survey and had to fill out at least three of the five surveys sent to them every day, or their observation period was extended in order to have eight complete days of EMA surveys.

For the current study, parent modelling of physical activity and eating behaviours was assessed via the end-of-day EMA signal-contingent survey. The parent was asked the following questions: 'Today how often did (**child's name**) see you eat fruits or vegetables (not French fries)?' 'Today how often did (**child's name**) see you exercise or engage in physical activity today?' 'Today how often did (**child's name**) see you watch TV/movies or play video games?' 'Today how often did (**child's name**) see you eat snack foods such as chips, French fries, candy, or other sweets/baked goods?' 'Today how often did (**child's name**) see you eat fast food (e.g., McDonalds, Burger King, Taco Bell?' and 'Today how often did (**child's name**) see you drink soda/pop, fruit drinks, sports drinks (e.g., Gatorade) or energy drinks (e.g., Red Bull)?' A dichotomous variable for parent modelling was calculated for each observation day. Parent response that the child never/rarely saw the parent model the behaviour was set to the reference category and responses moderately/often were assigned to the contrast. The average of all modelling responses was calculated for the EMA observation period and multiplied by 10 (scale range 0–10) to reflect 10 % unit differences on the scale measure, where a score of zero indicates the child never saw the parent model the respective behaviour and ten indicates the child always saw the parent engage in the behaviour.

Statistical methods

A series of data visualisation procedures, descriptive analyses and cross-tabulations were used to evaluate modelling assumptions (e.g., participant missing data). Directed acyclic graphs were used to avoid overfitting in regressions. General linear models with robust SE were used to examine the relationship between parent modelling (continuous predictor variable) and the following continuous outcomes: (1) HEI-2010 dietary intake score calculated from dietary recall data, (2) servings of fruits and vegetables calculated from dietary recall data and (3) child minutes in moderate–vigorous physical activity (MVPA) measured by accelerometer. An interaction analysis was performed to examine if the relationship between parent modelling and the three outcome variables depended on the race/ethnicity of the target child. All analyses were performed using Stata 15.1SE.

Results

Demographics

Table 1 presents results for participant demographics. A total of 150 participants with the breakdown of race/ethnic groups are displayed. Child time spent in daycare and parent work hours are also included. The analytic sample (*n* 143 participants) was not found to be statistically different on demographic characteristics from the full recruitment sample. Child mean sedentary activity was 6·9 h per day (SD = 1·5), mean light physical activity was 4·8 h (SD = 1·3) and mean MVPA was 51·4 min (SD = 19·1). The within-parent frequency of modelling of TV viewing was 22·5 % (SD = 28·3 %) and the within-parent frequency of parent modelling of exercise was 41·4 % (SD = 32·1 %). Mean diet intake as measured by the HEI-2010 was 57·1 (SD = 9·3) and mean daily servings of fruit and vegetable intake and SSB intake were 2·6 (SD = 1·5) and 0·53 (SD = 0·61), respectively.

Parent modelling and child dietary intake

Table 2 presents results for parent modelling of dietary intake and associations with child intake of fruits and vegetables, SSB and overall dietary quality (HEI-2010). Results indicated that there were significant associations between

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Table 1 Family matters Phase I demographic characteristics (*n* 150)

	Primary caregiver (*n* 150)			Target child (*n* 150)		
Participant characteristics	*n*		%	*n*		%
Female	137		91	71		47
Age in years						
Mean		34·5			6·4	
SD		7·1			0·8	
Weekly hours child spent in daycare						
Mean		–			8·5	
SD		–			12·8	
Adult BMI/Child BMI percentile						
Mean		30·9			75·9	
SD		7·2			23·1	
Weight status						
Underweight/healthy weight	35		23	77		51
Overweight	38		25	28		19
Obese	77		51	45		30
Race/ethnicity						
American Indian or Alaskan Native	21		14	25		17
Hmong	25		17	25		17
Black or African American	22		15	25		17
White	27		18	25		17
Somali	25		17	25		17
Hispanic	23		15	25		17
Mixed/Other	7		5	0		0
Work status						
Working full-time	63		42			
Working part-time	32		21			
Stay at home caregiver	25		17			
Currently unemployed, seeking work	18		12			
Not working for pay (unable to work, retired, student, etc.)	11		7			
Not Applicable (e.g., significant other not present)	<1					

Table 2 Adjusted association between parental modelling and child physical activity and dietary intake (*n* 143)*

	Outcome: fruit and vegetable intake (servings)			Outcome: sugar-sweetened beverage (servings)			Outcome: HEI-2010 index		
	Beta	95 % CI	*P* values	Beta	95 % CI	*P* values	Beta	95 % CI	*P* values
Dietary intake modelling predictor variable									
Eat fruits or vegetables (not French fries)	**0·12**	**0·04 0·2**	**0·01**	–0·01	–0·04 0·02	0·48	–0·03	–0·51 0·44	0·89
Eat snack foods such as chips, French fries, candy or other sweets/baked goods	–0·03	–0·13 0·06	0·46	**0·09**	**0·03 0·15**	**0·01**	–0·83	–1·78 0·13	0·09
Eat fast food (e.g., McDonalds, Burger King, Taco Bell)	–0·20	–0·42 0·02	0·08	**0·15**	**0·03 0·27**	**0·02**	–0·98	–2·69 0·72	0·26
Drink soda/pop, fruit drinks, sports drinks (e.g., Gatorade) or energy drinks (e.g., Red Bull)	–0·02	–0·11 0·07	0·65	**0·06**	**0·01 0·11**	**0·03**	–0·61	–1·43 0·21	0·14
	Outcome: sedentary activity (h)			Outcome: moderate vigorous physical activity (min)					
Activity modelling predictor variable									
Watch TV/movies or play video games	–0·03	–0·15 0·09	0·64	–0·29	–1·42 0·84	0·61			
Exercise or engage in physical activity	0·01	–0·07 0·09	0·80	0·70	–0·24 1·63	0·14			

Bold values are based of the statistical significance of $P < 0·05$.

*Models adjusted for: parent and child age, sex, and weight status, race, and household income. *Interpretation Example*: EMA-measured parent modelling of physical activity and dietary intake was measured daily over the 8-d observation period (e.g., 'Today, how often did child see you exercise or engage in physical activity'). The fraction of observation days during which the parents reported the child observing their behaviour was calculated and multiplied by ten to scale the measure to 10 percentage units. The relationship between a 10 % unit difference in modelling was examined for child time spent in moderate/vigorous physical activity (MVPA) measured by accelerometer in minutes. The adjusted analysis indicates that a 10 % unit difference in parent exercise modelling was associated with 0·70 min greater child time spent in MVPA (95 % CI –0·24 min, 1·63 min; $P = 0·14$), but the association was not statistically significant. Dietary intake modelling, however, was positively associated with several child dietary intake categories ($P < 0·05$).

parent modelling of dietary intake and child dietary intake. For example, a 10 % increase in parent daily modelling of fruit and vegetable intake was associated with a 0·12 unit increase in servings of fruit and vegetables eaten by the child (95 % CI 0·04, 0·20; $P = 0·01$). There was also a significant association between parent-reported modelling of

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chips, French fries, candy or other sweets or baked foods intake and increased child SSB intake ($P = 0{\cdot}01$). In addition, there was a significant association between parent-reported modelling of fast food intake and increased child SSB intake ($P = 0{\cdot}02$), and between parent-reported modelling of soda/pop, fruit drinks, sports drinks or other energy drinks consumption and increased child SSB intake ($P = 0{\cdot}03$). There were no significant associations between parent modelling of dietary intake and child overall HEI-2010 score.

Parent modelling and child physical activity

Table 2 presents results regarding the association between parent modelling of physical activity and child sedentary and MVPA. No statistically significant association was found between parent modelling of screen time (i.e., watching TV/movies or playing video games) and child engagement in sedentary activity or MVPA, although the trend was in the hypothesised direction. Similarly, no significant association was observed between parent modelling of physical activity and child sedentary activity ($P = 0{\cdot}80$) or child time MVPA ($P = 0{\cdot}14$).

Parent physical activity and child physical activity using accelerometry

Associations between parent time spent in physical and sedentary activity and child time spent in physical and sedentary activity from accelerometer data are presented in Table 3. Results indicated that when parent's sedentary time increased, child sedentary time also increased. For example, for every 1 h increase in parent sedentary activity, the child engaged in almost 40 more minutes per day of sedentary activity (95 % CI 0·20, 0·54; $P < 0{\cdot}001$). A similar relationship was found for light physical activity (e.g., walking, leisure sports like playing catch or table tennis and light yard/housework). For every 1-h increase in parent light physical activity, the child engaged in almost 25 more minutes per day of light physical activity (95 % CI:0·01,0·47; $P = 0{\cdot}04$). While not statistically significant ($P = 0{\cdot}13$), the direction of the association between parent and child MVPA was as expected.

Interactions by race/ethnicity

An exploratory analysis examined whether the association between parent modelling and child physical activity or dietary intake differed by the six race/ethnic subpopulations; there was no evidence that the direction or the strength of the modelling associations differed by participant race or ethnicity ($P > 0{\cdot}05$).

Discussion

The purpose of this study was to examine associations between parent modelling of physical activity and dietary intake and child dietary intake and physical activity using

Table 3 Adjusted association between accelerometer-assessed parent and child average daily time spent in physical activity (PA) categories (*n* 134)*

	Outcome: average daily child time spent in PA category								
Parent physical activity category	Sedentary (h) beta	95 % CI	*P* Value	Light (h) beta	95 % CI	*P* values	Moderate–vigorous physical activity (min) beta	95 % CI	*P* values
Sedentary (h)	**0·37**	**0·2, 0·54**	**<0·001**	−0·04	−0·25, 0·17	0·71	1·36	−0·68, 3·4	0·19
Light (h)	**−0·21**	**−0·49, 0·07**	0·14	0·24	0·01, 0·47	**0·04**	1·46	−1·43, 4·35	0·32
Moderate vigorous physical activity (min)	**0**	**−0·03, 0·03**	0·92	0	−0·03, 0·03	0·91	0·21	−0·06, 0·49	0·13

*Models adjusted for: parent and child age, sex, and weight status, race, and household income. *Interpretation Example*: Parent and child physical activity was classified as sedentary, light, moderate and vigorous physical activity as measured by accelerometer over a minimum of 4 days. The relationship between parent time spent in the four physical activity categories (i.e., sedentary, light and moderate plus vigorous physical activity) and child activity in each of the categories was examined. Parent time spent in sedentary and light physical activity was positively associated with child time spent in the same activity category ($P < 0{\cdot}05$). For example, a 1-h increase in parent sedentary activity was associated with 0·37 more hours of child sedentary activity (95 % CI 0·20, 0·54; $P < 0{\cdot}001$). Parent time spent in moderate–vigorous physical activity (MVPA) was positively associated with child MVPA, but the relationship was not statistically significant or substantively meaningful ($P = 0{\cdot}13$).

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innovative (i.e., EMA) and gold-standard measures (i.e., accelerometry, dietary recalls) among six different racial/ethnic and immigrant groups living in a metropolitan area in the USA. With regard to dietary intake, the results of this study both align with and extend findings from previous studies[13–18,25]. Specifically, there was a significant association between parent modelling of dietary intake and child dietary intake. This finding suggests that when parents increase the occasions in which they model consumption of fruits and vegetables, children will likely also increase their fruit and vegetable consumption. The same was observed for energy dense foods such as French fries, candy or fast food. In addition, study results extended prior research by using measures such as EMA with dietary recalls to potentially measure associations more accurately.

Results related to physical activity were mixed. Specifically, findings about perceived modelling of physical activity measured via EMA did not show significant associations with child physical activity. However, results measured by accelerometry did show significant findings. For example, parent sedentary behaviour was associated with child sedentary behaviour, which confirms previously published literature[10–12]. Furthermore, previous research has indicated that there is a significant association between parent hours of physical activity and child hours of physical activity[10,17,20,21]. This study showed a similar pattern for light physical activity but deviated from the extant literature with regard to findings associated with MVPA. The lack of consistent patterns between parent and child physical activity might be due to the fact that there are fewer opportunities for children to see their parents participate in physical activity, as compared to the number of opportunities to see them eat. Furthermore, physical activity, particularly for adults, is often done individually or as a part of an 'adults only' class or group (e.g., yoga or fitness classes). Parents may choose to participate in physical activity when their child is at school, at daycare or otherwise not present. This may have caused misreporting by participants because they may have participated in physical activity without their children seeing them as stated above; however, accelerometry data suggested that children do not have to see their parents being active for them to be physically active[23,36]. These results suggest the need for more research, especially qualitative, to better understand how parent modelling of physical and sedentary activity is perceived by children. It may also be the case that the current findings are related to the overall small sample size within race/ethnicity, which reduces the power to detect a significant effect between parent and child MVPA.

Results of the current study also indicated that the relationship between parent modelling of dietary intake and physical activity and child dietary intake and physical activity was not dependent on race/ethnicity. This information is important for health professionals when working with racially/ethnically diverse families. For example, health professionals may want to counsel all parents similarly regarding the importance of modelling a healthy lifestyle in order for their children to follow suit, regardless of race/ethnicity.

Strengths

Strengths of this study include the use of innovative techniques to measure parental modelling across the week. Many previous studies have focused on one-time self-report surveys asking parents if they model eating healthy around their children[11,17,22]. The current study used real-time measures (i.e., EMA) at multiple points throughout the day, to provide a richer picture of behaviour and potentially more accurate, time contingent response. In addition, using accelerometry and dietary recalls to examine associations between child physical activity and dietary intake and parent EMA responses is a strength of the study. These gold standard measures may potentially provide a more accurate picture of the tested associations, because these measures are less prone to bias than self-reported physical activity assessments or FFQ.

Limitations

One limitation was that the overall sample size was relatively small (n 150), and even smaller within each individual race/ethnic group (n 25), which may have reduced our ability to detect statistical significance due to reduced power. Also, the study did not assess parent dietary intake by 24-h recall, so we were unable to make direct comparisons between parent and child intake as we did for accelerometry data. Another possible limitation could be that the majority of parent participants were mothers. Collecting data on fathers may provide different results. Another possible limitation is the use of the accelerometers. While the use of accelerometry data is objective and provided valuable data, we cannot be sure that the child saw their parents modelling physical activity.

Conclusions

The results of the current study show associations between parent modelling and child dietary intake and physical activity behaviours that may be useful for the development of future interventions. For example, future interventions may want to involve family oriented physical activities, focusing on being active as a family. In addition, findings may be relevant for health care providers who work with parents and children and who may be in a position to make recommendations for healthful behaviours. For example, when talking with parents and families, physicians may want to emphasise the importance of the parent modelling healthy eating for their children.

Results related to parent modelling of fruit and vegetable intake and child intake of fruit and vegetables may be

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useful for providers who work in public health nutrition settings as well. For example, community programmes that promote healthful eating should incorporate education on parent modelling. An example of a site that can use this information is Women, Infant, and Children clinics. By educating parents on modelling of eating fruits and vegetables, children may try more fruits and vegetables as a result.

Overall, results from the current study suggest that increasing the focus on teaching parents to model healthy behaviours such as eating fruits and vegetables may increase the likelihood that their child will eat more fruits and vegetables. While more research related to parent and child physical activity is needed to clarify the results of the current study, the physical activity patterns observed suggest similar results as dietary intake. When children have good role models for healthy behaviours, they may be more likely to participate in those healthy behaviours, which have the potential to decrease childhood obesity over time.

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