Original Article
PEDIATRIC OBESITY

Obesity

The Longitudinal Association Between Early Childhood Obesity and Fathers' Involvement in Caregiving and Decision-Making

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Objective: Fathers have increased their involvement in child caregiving; however, their changing role in childhood obesity is understudied. This study assessed the longitudinal association between changes in obesity among children aged 2 to 4 years and changes in fathers' involvement with raising children.
Methods: Longitudinal data from the Early Childhood Longitudinal Study–Birth Cohort were used to conduct child fixed-effects linear and logistic regression analyses to assess the association between changes in childhood obesity-related outcomes (sugar-sweetened beverage consumption, screen time, BMI *z* score, overweight/obesity, obesity) and fathers' involvement with raising children (caregiving and influencing child-related decisions). Fixed-effects models control for all time-invariant characteristics. Analyses were controlled for time-varying confounders, including child age, maternal and paternal employment, and family poverty status.
Results: Children whose fathers increased their frequency of taking children outside and involvement with physical childcare experienced a decrease in their odds of obesity from age 2 to age 4. Obesity-related outcomes were not associated with fathers' decision-making influence.
Conclusions: Increases in fathers' involvement with some aspects of caregiving may be associated with lower odds of childhood obesity. Encouraging fathers to increase their involvement with raising children and including fathers in childhood obesity prevention efforts may help reduce obesity risk among young children.

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Introduction

Preventing obesity in young children is essential to addressing the current obesity epidemic (1), and there has been recent progress (2). Young children with high BMI are more likely to have obesity as adults (3) and develop obesity-related chronic conditions (4).

Parents strongly influence their child's weight status during early childhood. They control and shape their child's dietary preferences and activity level (5,6). To date, most of the research on parental influences on children's weight has focused on mothers (7). However, in the past 4 decades, the role of fathers in child caregiving has increased (8). Caregiving includes the time spent with children and activities dedicated to caring for children, such as physical childcare (e.g., grooming the child), supervising the child, and playtime activities. From 1965 to 2011, fathers increased the time they spent with children by nearly threefold (9). While they have increased their involvement in all aspects of caregiving, most of their time is devoted to playtime (10,11). Despite their increased role, fathers remain significantly underrepresented in research about the influence of parents on childhood obesity (7).

Limited available research has primarily focused on fathers' parenting styles and factors directly related to child nutrition and exercise, including knowledge of nutrition and physical activity and child

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feeding habits (12,13). These studies found that some fathers' behaviors, such as lower monitoring of child food intake, were associated with higher child BMI (12,13). Additionally, fathers' nutritional knowledge was not always accurate (12). Fathers' feeding behaviors may also differ based on father characteristics such as education and resident status (14).

Missing from the literature is an examination of the role of fathers in general child caregiving (not directly related to child nutrition and exercise) or influence on decision-making in relation to children's BMI. For example, by helping to prepare meals, bathing children, or assisting with child-related decisions, fathers may alleviate maternal stress, which is associated with increased child BMI (15), and increase the quality of care provided by both parents. Paternal involvement may be particularly important for children who have other obesity risk factors, including living in poverty or maternal employment (16,17). Fathers with higher levels of education may confer positive health benefits to their child when they assist with caregiving and decision-making (18). To our knowledge, no study has considered the relationship between childhood obesity with broader measures of fathers' involvement, including general caregiving (e.g., looking after the child) and influence on child-related decisions. Additionally, existing studies on fathers' feeding behavior and knowledge were primarily cross-sectional (13) or qualitative (14) and conducted among fathers from higher socioeconomic status families (13).

In our study, we examined the longitudinal association between changes in obesity-related outcomes (sugar-sweetened beverage [SSB] consumption, screen time, BMI *z* score, overweight/obesity, and obesity) and changes in fathers' involvement with raising children, specifically in child caregiving and influence on child-related decision-making from age 2 to age 4. We also assessed whether fathers' education, family poverty status, and maternal employment modified these associations. We hypothesized that increasing fathers' involvement with caregiving and decision-making would be associated with decreases in obesity-related outcomes. We further hypothesized that these relationships would be stronger in children living in poverty, whose mothers were employed, or whose fathers had higher levels of education.

Methods

Data and study sample

Our analysis used longitudinal data from the Early Childhood Longitudinal Study–Birth Cohort (ECLS-B), which followed a nationally representative cohort of ~10,700 children (all sample sizes have been rounded to the nearest 50 to comply with ECLS-B's restricted-use data reporting guidelines) born in 2001 from birth through first grade. Sponsored by the National Center for Education Statistics, the ECLS-B was designed to collect information on child, home, and family influences on the child's development during the first 6 years of life (19). The ECLS-B administered separate surveys to the primary caregiver (>95% were biological mothers) and resident fathers. Resident fathers responded to self-administered questionnaires assessing their involvement with raising the child.

Our study used data collected from children at approximately age 2 and age 4. Our study sample included children whose fathers lived with them but were not the primary caregivers and who had completed the resident father survey at both time points. We excluded children with missing BMI *z* scores, implausibly large BMI *z* scores (<−5 or >5 standard deviations [SD]) at either time point, or an implausibly large change in BMI *z* score (>5 SD) from age 2 to age 4, as these observations may have unreliable data on BMI. Our final analytic sample of ~3,900 children was comparable to the full sample of children with resident fathers, with minor differences in child and father race/ethnicity, family poverty, and father educational attainment. Supporting Information Table S1 shows the sample sizes at each exclusion step.

Study measures

Dependent variables. Study outcomes included children's obesity-related behaviors and weight status. Measures of obesity-related behaviors included daily screen time hours during weekdays from television or videos and SSB consumption (regular vs. infrequent/never). Regular SSB consumption at age 2 was defined as usually consuming SSBs with either meals or snacks and at age 4 as drinking ≥ 1 SSB per day. Soda, < 100% fruit drinks, and sports drinks were considered SSBs. Because measures of SSB consumption changed from age 2 to age 4, we dichotomized this measure using a classification of regular SSB consumption used in previous research on SSB consumption among young children (20).

For weight status, we separately modeled a continuous measure of BMI *z* score and indicators of overweight or obesity status (overweight/obesity vs. no overweight/obesity) and obesity status (obesity vs. no obesity). Trained ECLS-B staff measured child height and weight. We calculated a child's *z* score from BMI (weight divided by recumbent length or standing height squared) using sex-specific BMI-for-age World Health Organization (WHO) child growth standards, which are appropriate for children from birth to age 5 (21). We defined overweight/obesity and obesity as being > 2 and > 3 SD above the WHO growth standard mean for all children, respectively (22).

Main independent variables. Our independent variables of interest were fathers' involvement in two domains: child caregiving and child-related decision-making. Measures of fathers' involvement in caregiving included how often, in the past month, fathers (1) prepared meals for their child; (2) took their child outside for walks or play in the yard, a park, or playground; (3) looked after their child while the mother did other things; and (4) performed physical childcare tasks. Frequency for meal preparation and taking children outside responses included rarely/never, a few times a month, a few times a week, about once a day, and more than once a day. Frequency of looking after the child responses included never, once or twice, a few times a month, a few times a week, and every day or almost every day. Physical childcare was assessed through a combined measure, ranging from 0 to 4, of the following tasks performed on at least a daily basis (i.e., once a day or more than once a day): helping children go to bed, brush teeth, get dressed, and bathe.

Our second set of independent variables assessed fathers' influence on decisions about the child's nutrition, health care, discipline, and childcare. Responses included no, some, and a great deal of influence. Decision measures were assessed in separate models.

Although frequency response categories were ordinal, we modeled both sets of independent variables as continuous measures to

TABLE 1 Sample characteristics at child age 2 and age 4

	Age 2 ($n \sim 3{,}900$)	Age 4 ($n \sim 3{,}900$)
Child characteristics		
Age, mo (SD)	24.26 (1.04)	52.29 (4.02)
Sex		
Female	48.69%	48.69%
Race/ethnicity		
NH white	63.69%	63.69%
NH black	5.33%	5.33%
Hispanic	16.46%	16.46%
NH Asian	7.80%	7.80%
NH other	6.72%	6.72%
Family characteristics		
Poverty		
Below poverty	13.72%	15.08%
Father race/ethnicity		
NH white	66.78%	66.78%
NH black	6.06%	6.06%
Hispanic	22.02%	22.02%
NH Asian	3.12%	3.12%
NH other	2.01%	2.01%
Father education		
High school degree or less	43.83%	43.83%
More than a high school degree	56.17%	56.17%
Maternal employment, h/wk (SD)	17.81 (19.07)	19.06 (19.61)
Fathers' employment, h/wk (SD)	45.95 (11.44)	46.47 (11.07)
Fathers' involvement in caregiving		
Meal preparation		
More than once a day	22.34%	16.31%
Once a day	24.40%	22.17%
A few times a week	30.17%	35.56%
A few times a month	13.52%	14.95%
Rarely/never	9.58%	11.01%
Takes child outside for walks/play		
More than once a day	10.90%	6.07%
Once a day	22.26%	17.43%
A few times a week	44.04%	46.06%
A few times a month	18.19%	24.94%
Rarely/never	4.61%	5.51%
Physical childcare tasks (SD)[a]	1.71 (1.38)	1.44 (1.38)
Frequency of looking after child		
Every day or almost every day	36.29%	34.67%
A few times a week	38.95%	39.53%
A few times a month	18.65%	19.32%
Once or twice	5.13%	5.73%
Never/usually does not take care of child	0.99%	0.75%
Fathers' influence on child-related decision-making		
Influence on child nutrition		
No influence	6.36%	4.78%
Some influence	51.32%	46.73%
A great deal of influence	42.32%	48.49%
Influence on child health		
No influence	3.92%	4.02%
Some influence	34.14%	30.09%
A great deal of influence	61.94%	65.88%
Influence on child discipline		
No influence	0.71%	1.02%
Some influence	24.87%	20.87%
A great deal of influence	74.42%	78.11%
Influence on childcare		
No influence	4.44%	4.34%
Some influence	33.53%	32.35%
A great deal of influence	62.03%	63.31%
Child obesity-related behaviors and weight status		
Screen time, weekday h/d (SD)	2.28 (2.15)	2.13 (2.04)
Regular SSB consumption	7.69%	24.41%
BMI z score (SD)	1.05 (1.28)	0.74 (1.13)
Weight status		
Overweight	13.71%	7.59%
Obesity	6.93%	4.37%

Data were calculated using ECLS-B survey weights. Sample size rounded to the nearest 50 to comply with ECLS-B's restricted data requirements.
[a]Scale from 0 to 4: fathers' daily involvement (more than once a day or daily) in the following tasks: help child get dressed, help child to bed, help child brush teeth, and bathe child.
Overweight defined as >2 SD and ≤ 3 SD based on WHO growth standards.
Obesity defined as >3 SD based on WHO growth standards.
Missingness for father caregiving: meal preparation ($n \sim 3{,}450$), takes child outside ($n \sim 3{,}450$), physical childcare ($n \sim 3{,}600$), frequency of looking after child ($n \sim 3{,}450$).
Missingness for decision-making influence on: nutrition (n $\sim$ 3,550), health (n $\sim$ 3,550), discipline (n $\sim$ 3,500), and childcare ($n \sim 4{,}100$).
Missingness for obesity-related outcomes: screen time (n $\sim$ 1,720), regular SSB consumption (n $\sim$ 1,500), and BMI *z* score, overweight/obesity, and obesity (n $\sim$ 2,600).
NH, non-Hispanic; SSB, sugar-sweetened beverage.

maintain sample size and increase power in our analysis. Fixed-effects models typically have reduced power because they rely entirely on within-unit changes. By modeling independent variables as continuous measures, we assumed that one-category changes produced the same effect for all response categories. We checked this assumption by examining residuals from linear outcome models to check for violations of functional form and by comparing one-category changes for different response categories on dichotomous outcomes, and we found our assumptions to be reasonable.

Effect modifiers and potential confounding variables. We examined fathers' baseline education (high school degree or less vs. $>$ high school degree), baseline maternal employment status (not

TABLE 2 Proportion of fathers who changed their involvement in caregiving and influence on decision-making from the age 2 to age 4 surveys

	Decrease	No change	Increase
Fathers' involvement in caregiving			
Meal preparation[a]	35.5	39.4	25.1
Take child outside for walks/play[a]	36.8	40.7	22.5
Physical childcare tasks[b]	39.7	33.3	27.0
Frequency of looking after child[a]	28.7	20.9	25.1
Fathers' influence on child-related decision-making			
Influence on child nutrition[c]	16.5	60.0	40.0
Influence on child health[c]	16.2	63.5	20.3
Influence on child discipline[c]	11.3	73.5	15.2
Influence on childcare[c]	17.4	62.8	19.9

[a]Per one unit increase in the frequency in fathers' involvement.
[b]Per increase in one of the following tasks (help child get dressed, help child to bed, help child brush teeth, and bathe child) on at least a daily basis (daily or more than once a day).
[c]Per one unit increase in the level of decision-making influence.

employed vs. employed), and baseline family poverty status at child's age 2 (< 100% federal poverty line [FPL] vs. ≥100% FPL) as potential effect modifiers (10,23-25).

We controlled for potential time-varying confounders, including child age (continuous, months), father employment (continuous, hours/week), mother employment (continuous, hours/week), and poverty status (< 100% FPL or ≥ 100% FPL) at each time point. We did not need to explicitly control for time-invariant confounders (e.g., child gender) in our analysis, because fixed-effects models control for all observed and unobserved characteristics that do not change over time (described below).

Statistical analysis

We calculated descriptive statistics on all key sample characteristics at both time points. We then used child fixed-effects linear and logistic regression models to assess the relationship between changes in obesity-related behaviors and weight status with changes in fathers' caregiving and decision-making from child age 2 to age 4, controlling for time-varying characteristics described above. Similar to a pre-post test, these fixed-effects models compared children to themselves over time between the two time points (26). Fixed-effects models estimate within-unit (in this case, child) effects; the two-period case with continuous outcomes is equivalent to a first difference model. For each outcome, we ran separate models for each of the caregiving and decision-making measures while controlling for specified time-varying confounders.

To test whether baseline fathers' education, baseline maternal employment, and baseline poverty status modified these associations, we also ran separate fixed-effects models for each potential modifier that included an interaction term between the modifier and the fathers' caregiving or decision-making variable. We considered the interaction statistically significant if the interaction term had a $P < 0.05$. Then we estimated the association between changes in childhood obesity behaviors and outcomes with changes in fathers' caregiving and decision-making, stratified by each modifier. For all descriptive and statistical analyses, we used the ECLS-B–provided survey weights, strata, and variance for the resident father survey at age 4, adjusted to account for survey nonresponse during the age 2 survey. Statistical analyses were performed in Stata/IC 14, 1 (StataCorp, College Station, Texas).

This secondary analysis of the restricted-use ECLS-B data was determined to be non–human subject research by the Johns Hopkins Institutional Review Board.

Results

The weighted sample represents 2,608,286 children in the United States. Survey-weighted sample characteristics are presented in Table 1. More than half of the children (64%) and fathers (67%) were non-Hispanic white. Families living below the poverty line increased slightly from child age 2 to age 4 (14% to 15%). Fifty-six percent of fathers had more than a high school degree. On average, mothers worked part time (18 h/wk at child age 2; 19 h/wk at child age 4), while fathers worked full-time (46 h/wk at child age 2 and age 4).

Mean BMI *z* scores decreased from 1.1 (SD: 1.2) to 0.7 (SD: 1.1), the proportion of children with overweight decreased from 13.7% to 7.6%, and the proportion of children with obesity decreased from 6.4% to 4.4% from age 2 to age 4 (Table 1). From age 2 to age 4, screen time was similar (2.3 h to 2.1 h), while regular SSB consumption increased (7.7% to 24.4%).

Table 2 shows the proportion of fathers who changed their involvement in caregiving and influence on decision-making. For each caregiving task, more than 20% of fathers increased their involvement from age 2 to age 4. The proportion of fathers who increased their influence on child-related decisions ranged from 15% for discipline to 40% for nutrition.

TABLE 3 Adjusted associations between changes in child behaviors and weight status and changes in fathers' involvement in caregiving and influence on decision-making

	Screen time (h)		Regular SSB consumption		BMI *z* score		Overweight or obesity		Obesity	
	Estimated change	95% CI	OR	95% CI	Estimated change	95% CI	OR	95% CI	OR	95% CI
Fathers' involvement in caregiving										
Meal preparation[a]	0.01	(−0.09 to 0.12)	1.02	(0.82 to 1.27)	−0.03	(−0.08 to 0.03)	0.92	(0.76 to 1.12)	0.73	(0.52 to 1.03)
Takes child outside for walks/ play[a]	−0.08	(−0.19 to 0.03)	1.07	(0.87 to 1.32)	−0.05	(−0.11 to 0.02)	0.87	(0.68 to 1.12)	**0.70**	**(0.50 to 0.97)**
Physical childcare tasks[b]	0.00	(−0.10 to 0.10)	1.10	(0.93 to 1.30)	−0.02	(−0.07 to 0.02)	0.98	(0.81 to 1.17)	**0.67**	**(0.52 to 0.88)**
Frequency of looking after child[a]	0.08	(−0.04 to 0.20)	0.87	(0.69 to 1.10)	−0.01	(−0.07 to 0.04)	0.98	(0.76 to 1.26)	0.75	(0.55 to 1.03)
Fathers' influence on child-related decision-making										
Influence on child nutrition[c]	−0.09	(−0.30 to 0.11)	0.73	(0.49 to 1.09)	−0.05	(−0.14 to 0.04)	0.80	(0.56 to 1.14)	0.68	(0.37 to 1.25)
Influence on child health[c]	0.03	(−0.17 to 0.22)	0.76	(0.53 to 1.10)	0.03	(−0.04 to 0.11)	1.15	(0.80 to 1.66)	1.48	(0.76 to 2.92)
Influence on child discipline[c]	0.09	(−0.19 to 0.36)	0.96	(0.53 to 1.73)	0.02	(−0.10 to 0.13)	0.96	(0.59 to 1.56)	0.70	(0.33 to 1.51)
Influence on childcare[c]	0.01	(−0.16 to 0.18)	0.74	(0.52 to 1.06)	0.02	(−0.06 to 0.10)	0.96	(0.64 to 1.45)	0.56	(0.29 to 1.09)

Bolded text denotes statistical significance at $P < 0.05$. The sample size is rounded to the nearest 50 to comply with ECLS-B's restricted data requirements.
Calculated using survey weights.
Models controlled for the following time-varying potential confounders: child age (in months), fathers' employment (hours/week), maternal employment (hours/week), and poverty status (< 100% federal poverty line).
Overweight or obesity is defined as > 2 SD based on WHO growth standards.
Obesity is defined as > 3 SD based on WHO growth standards.
[a]Per one unit increase in the frequency in fathers' involvement.
[b]Per increase in one of the following tasks on at least a daily basis (daily or more than once a day): help child get dressed, help child to bed, help child brush teeth, and bathe child.
[c]Per one unit increase in the level of decision-making influence.
SSB, sugar-sweetened beverage.

Involvement with caregiving

Table 3 presents results from our adjusted fixed-effects models. We found that increases in fathers' caregiving were associated with decreases in childhood obesity. A one-category increase in the frequency that fathers took the child out for walks or play was associated with a 30% decrease in the odds of childhood obesity (odds ratio [OR] = 0.70, 95% CI: 0.5-0.97). Each additional physical caregiving task performed by fathers on a daily basis was associated with a 33% decrease in the odds of childhood obesity (OR = 0.67, 95% CI: 0.52-0.88). Although not statistically significant, we also observed similar relationships between decreases in the odds of childhood obesity with increases in the frequency of fathers' involvement with meal preparation (OR = 0.73, 95% CI: 0.51-1.03) and looking after the child (OR = 0.75, 95% CI: 0.55-1.03). These relationships approached significance at $P < 0.1$. Fathers' caregiving was not associated with other obesity-related outcomes.

Influence on decision-making

Fathers' influence on decision-making was not associated with childhood obesity behaviors or weight status outcomes. However, each level increase of fathers' influence on childcare decisions approached statistical significance with decreases in odds of regular SSB consumption (OR = 0.74, 95% CI: 0.52-1.06) and obesity (OR = 0.56, 95% CI: 0.29-1.09).

Effect modifiers

We also examined whether these associations varied by baseline fathers' education, baseline family poverty status, and baseline maternal employment (Supporting Information Tables S2-S7). The tests of whether each of these variables modified the associations between each childhood obesity-related outcome and each measure of fathers' involvement with caregiving and decision-making indicated that, generally, these relationships were not modified by any of these variables. However, there were a few exceptions. Increases in the frequency that fathers took their children outside to walk or play were associated with decreases in the child's BMI *z* score (−0.07, 95% CI: −0.13 to −0.01) among children above the FPL but not among children below the FPL (0.10, 95% CI: −0.07 to 0.27) (interaction $P = 0.048$). Among children with more educated fathers, an increase in fathers' physical caregiving participation was associated with an increase in the odds of regular SSB consumption (OR = 1.39, 95% CI: 1.09 to 1.76) but not among children with less educated fathers (OR = 0.93, 95% CI: 0.74 to 1.16) (interaction $P = 0.013$). Conversely, increases in fathers' physical caregiving tasks were associated with decreases in the odds of obesity among children with less educated fathers (OR = 0.58, 95% CI: 0.41 to 0.80) but not among more educated fathers (OR = 0.93, 95% CI: 0.64 to 1.36) (interaction $P = 0.043$). The significant relationship between child obesity and fathers' physical childcare in the pooled analyses may be primarily driven by less educated fathers. None of the relationships varied by baseline maternal employment.

Discussion

This study used a nationally representative sample of children to examine the longitudinal association between changes in early childhood obesity-related outcomes and changes in fathers' involvement with raising children. Comparing children to themselves over time allowed us to control for all potential time-invariant variables, including unobserved confounding variables that may not be accounted for in cross-sectional studies. We found that for children living in two-parent, heterosexual households, increases in fathers' caregiving were associated with decreases in a child's odds of obesity from age 2 to age 4.

There is strong consensus on the importance of fathers' involvement during early childhood for child social, behavioral, and cognitive development (27-30). Our study suggests that fathers' involvement with child caregiving in some domains may have child health benefits related to obesity risk. We found that increases in fathers' participation in physical childcare (e.g., bathing and dressing children) and the frequency of taking their child outside for a walk or to play were associated with decreases in the odds of childhood obesity from age 2 to age 4. Prior research has found that, compared to mothers, fathers devote more of their caregiving time to playtime activities than to physical childcare (10). However, in recent years, fathers have become more involved with physical childcare, although still unequally to mothers (11). Their increased involvement with physical childcare may potentially provide additional support to the mother and augment the time and quality of care provided to children (31). Because fathers devote more caregiving to playtime, they may have a compensatory role of taking children outside for a walk or to play when mothers, who typically shoulder the majority of caregiving (11), do not have sufficient time or energy to do so. Fathers may also play a unique role by engaging in more active, "roughhouse" playtime (32), resulting in children being more physically active when fathers take children outside than when mothers do.

However, many expected associations between obesity-related outcomes and fathers' caregiving were not observed. Early childhood obesity was not associated with paternal involvement with meal preparation or looking after the child. Childhood obesity prevention efforts, including healthy cooking interventions, typically focus on mothers (33,34). As a result, fathers might be less knowledgeable in supporting a healthy lifestyle for their child. Compared to mothers, they may prepare less nutritious meals and allow permissive snacking habits or screen time when looking after their child.

Fathers' caregiving was not associated with other weight status outcomes. This might potentially be due to a nonlinear relationship between BMI *z* scores and fathers' involvement, such that fathers' involvement might be most important for young children with obesity or at risk of developing obesity. Our significant findings for decreased odds of childhood obesity are still important, because developing obesity during this developmentally important period poses substantial health risks in later life (35).

We did not find associations between obesity-related behavioral outcomes and father caregiving involvement. However, changes in fathers' caregiving might influence other obesity-related behaviors not assessed in this study, such as physical activity. Future studies should examine other obesity-related behavioral outcomes.

Few studies have considered the role of fathers' influence on child-related decision-making, as mothers often manage child caregiving (10). Our study did not find any relationship between fathers' influence on decision-making with childhood obesity-related outcomes at age 4. However, our null findings may be due to fathers both positively and negatively influencing child-related decisions. For

example, fathers may encourage physical activity in children through more active play (32) but also allow more permissive feeding (13). More research is needed to explore the complex role of fathers in child-related decision-making and its potential impact on childhood obesity.

We also explored whether family poverty, father education, and maternal employment modified the relationship between childhood obesity outcomes with fathers' caregiving and decision-making. We found few significant interactions, which might point to the general benefits of fathers' involvement in maintaining a healthy weight for children regardless of family poverty, father education, and maternal employment. Clear patterns did not emerge among the few significant interactions.

Our study had several limitations. First, due to the lack of precision in the measures of fathers' involvement with caregiving and influence on decision-making, and the challenges of modeling categorical exposures in fixed-effects models, we modeled these measures as continuous variables despite the fact that they had ordinal response categories. Our robustness checks, including an examination of residuals to check for violations of functional form and a comparison of whether one-category changes were similar for all categories, suggest that this is a reasonable approach. Fixed-effects analysis models the relationship of changing into a response category; thus, coefficients for the middle categories include both individuals who increased and decreased into that category and become inappropriate for this assessment. This prevented us from making meaningful inferences about specific changes in the odds of obesity associated with each unit change in fathers' involvement or influence. However, our goal was to understand the direction of the relationship between child obesity outcomes and fathers' involvement and influence more generally. The underlying data provided in these questions are adequate for this purpose.

We did not have external validation of father-reported involvement with caregiving and influence on decision-making. Studies have found that fathers' self-reports overestimate (36) or agree with mothers' reports (37). While fixed-effects models account for all time-invariant maternal characteristics, there may be important time-varying confounders that we omitted, such as maternal and nonparental (e.g., grandparent) involvement in raising children. We could not control for maternal involvement in raising children because this was not assessed in the ECLS-B. Because fixed-effects models are powered by changes in the outcome measures, we may have been underpowered to detect significant interactions. Screen time might be underreported because it was based specifically on television and video. This study was conducted in a cohort of children born in 2001, but recent changes to family dynamics might limit generalizability to children born more recently. Finally, we limited our sample to two-parent heterosexual families, so results may not be generalizable to other family structures.

Conclusion

Although fathers are participating more in child caregiving, the effects of their increased involvement on childhood obesity have been understudied. Using models that controlled for all observed and unobserved time-invariant confounders, we found evidence that increases in fathers' involvement in caregiving are associated with lower odds of early childhood obesity. Findings from this study suggest that children may benefit from additional involvement from fathers. Efforts to increase fathers' involvement might include actively including fathers in parenting childhood obesity interventions and child health care providers actively engaging with fathers during their child's health care visits. To date, parenting childhood obesity interventions primarily target mothers (34). Fathers have noted feeling neglected during visits with their child's pediatricians (38). Future studies can utilize more precise information on both mothers' and fathers' caregiving involvement and influence, such as time-use data, to allow for more definitive estimates of these relationships and more detail on fathers' involvement (e.g., what they do when outside with their child). Information on maternal involvement can also help elucidate pathways through which fathers' involvement and influence might confer child weight benefits.O

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