Lower Body Mass Index Z-Score Trajectory During Early Childhood After the Birth of a Younger Sibling

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Received for publication January 5, 2018; accepted June 9, 2018.

ABSTRACT

OBJECTIVE: The objectives of this study were to examine differences in body mass index z-score (BMIZ) trajectory during early childhood among children with a younger sibling compared with those without and to test potential mediators.

METHODS: This longitudinal cohort study included 6050 participants of the Early Childhood Longitudinal Study, Birth Cohort (ECLS-B). Focal children's weight, height, sibship status, screen time, active play time, family dinner frequency, and diet quality were assessed at 9 months, 24 months, preschool, and kindergarten when available. A piecewise linear regression model was used to examine the association between sibling birth and focal child's subsequent BMIZ trajectory to kindergarten. Mediation by screen time, active play time, family dinner frequency, and diet quality was tested.

RESULTS: BMIZ trajectory was lower among children who had a new sibling join the family before kindergarten compared to children who did not have a new sibling join the family by kindergarten. The association was strongest when new sibship occurred when the focal child was 48 to 66 months ($b = -0.026$, $P = .044$). The association was not mediated by screen time, active play time, family dinner frequency, or diet quality.

CONCLUSION: Among a nationally representative cohort of US children, new sibship before kindergarten was associated with a lower BMIZ trajectory. Several common obesogenic risk factors did not explain the association.

KEYWORDS: childhood obesity; pediatrics; weight status

ACADEMIC PEDIATRICS 2019;19:51–57

WHAT'S NEW

In a large, nationally representative cohort of children born in 2001, body mass index z-score trajectory to kindergarten was lower among children who had a younger sibling. The association was not mediated by screen time, active play time, family dinner frequency, or diet quality.

OBESITY AMONG CHILDREN and adolescents is a serious public health problem.[1,2] Parents play a key role in modeling healthy behaviors and modifying obesogenic risk factors,[3] and they have been a common target of family-based interventions to prevent childhood obesity.[4] There is now growing recognition that sibship and birth order are also associated with childhood obesity. Multiple cross-sectional studies demonstrate that last-born children have a greater risk of obesity when compared with children with younger siblings.[5–12]

In contrast, only one study, to our knowledge, has examined the prospective association between new sibship and child body mass index z-score (BMIZ) trajectory.[10] This study shows that having a sibling born between 24 months and 54 months of age is associated with a significantly lower subsequent BMIZ trajectory and obesity prevalence in first grade.[10] However, this study was conducted among a relatively small cohort of US children (N = 697) who were born in 1991, and it is unknown whether the relationship between sibship and BMIZ trajectory is present in today's obesogenic environment.[13] The mechanisms explaining the association between new sibship and child BMIZ are not established; yet, understanding these factors may have important implications for future childhood obesity prevention initiatives. The association may be mediated by favorable changes in known obesity-related factors such as decreased screen time,[14,15] increased physical activity,[14] increased frequency of family dinners,[15–17] or improved dietary quality.[7,12]

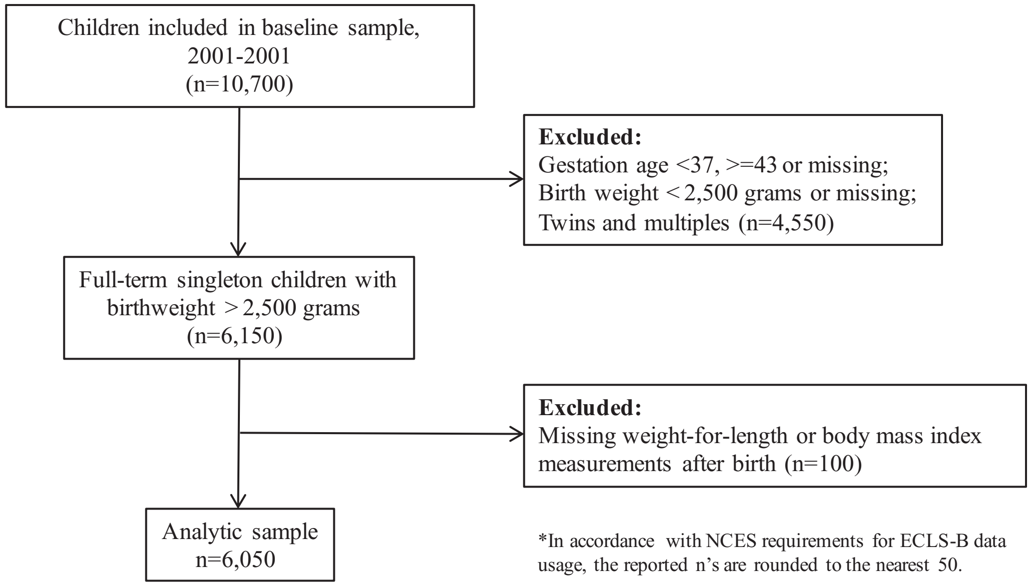

Figure 1. *Flow diagram showing cohort selection. (In accordance with National Center for Education Statistics requirements for Early Childhood Longitudinal Study, Birth Cohort, data usage, the reported n values are rounded to the nearest 50.)*

For example, a child may be more active if he plays with his new sibling or assists with simple caregiving responsibilities (eg, getting a clean diaper). Changes in screen viewing time may also occur after a new sibling joins the family. Screen viewing time may decrease if the child engages with the new sibling or seeks increased parental attention while adjusting to the new sibling.[18] Screen viewing time may also decrease if a non-parental caregiver (eg, grandparent) is present to specifically assist with caring for the older child. Alternatively, it is possible that screen viewing time may increase as a result of parents' attempts to occupy the older child while caring for the new infant.[19] Finally, after a sibling's birth parents may choose to serve meals at the same time each day for more efficient household management, thereby fostering healthier dietary habits in the near term.[17,20] Such improvements in diet quality are supported by cross-sectional data demonstrating an association between sibship and reduced sugar and fast-food consumption[7] and increased intake of fruits and vegetables.[12]

This study had 2 objectives. The first objective was to characterize the relationship between new sibship and child BMIZ trajectory among a large, nationally representative cohort of children ages 9 months to 74.5 months old. Consistent with prior work,[5–11] we hypothesized new sibship to be associated with a lower subsequent BMIZ trajectory and lower risk of obesity. The second objective was to test 4 potential mediators of the association between new sibship and BMIZ trajectory: 1) screen time, 2) active play time, 3) family dinner frequency, and 4) diet quality. We hypothesized that the association between having a new sibling and child BMIZ would be mediated by a reduction in screen time, increases in active play time or family dinner frequency, or improved diet quality after the addition of a new sibling to the family.

METHODS

PARTICIPANTS

The Early Childhood Longitudinal Study, Birth Cohort (ECLS-B), is a longitudinal survey of a national sample of over 10,000 children born in the United States in 2001. The study was sponsored by the US Department of Education's National Center for Education Statistics in the Institute for Education Science. Data were collected from children and their parents at 9 months (2001), 24 months (2003), preschool (2005), and kindergarten (2006 or 2007). Data collection consisted of parent interviews and direct child assessments during home visits by trained interviewers. The full details regarding the ECLS-B recruitment, procedures, and participant characteristics have been previously described.[21]

Figure 1 shows the cohort selection process. Inclusion criteria for our analytic sample were 1) singleton gestation, 2) full-term birth defined as birth at 37 to 41 weeks' gestation, 3) birth weight greater than 2500 g, and 4) at least one weight-for-length or body mass index measurement available after birth. The total number of children in our analytic sample was 6050. In accordance with National Center for Education Statistics requirements for ECLS-B data usage, the reported sample size was rounded to the nearest 50.[22]

MEASURES

DEPENDENT VARIABLE

The primary outcome was child weight-for-length or body mass index z-score (WLZ/BMIZ) measured from 9 months to kindergarten. Children's lengths/heights and weights were measured by trained staff using standardized procedures during home visits at 9 months, 24 months, preschool, and kindergarten.[23] Weight-for-length and

BMI were calculated, and age- and sex-specific WLZ and BMIZ were calculated based on the US Centers for Disease Control and Prevention reference growth curves.[24]

INDEPENDENT VARIABLE

The primary predictor variable, new sibship, was determined by assessing household composition at 9 months, 24 months, preschool, and kindergarten. Parent respondents were asked to report the total number of siblings within the focal child's household, which included full, foster, step, and adoptive siblings. We defined new sibship as an increase in the reported number of siblings compared to the prior data collection time point. Although ECLS-B did not differentiate among full, foster, step, and adoptive siblings, the majority of mother respondents (99%) reported a biological relationship to the focal child. Few children (n = 296) had more than 1 sibling enter the family during the study period, and half (n = 143) experienced the new sibship event between preschool and kindergarten. As a result, we did not have sufficient power to detect change in BMIZ that may have occurred as a result of the second new sibship event. To ensure that any change in BMIZ trajectory would be attributed to the first new sibship event, we did not include height/weight data that were collected after the second new sibship event in our analyses.

POTENTIAL COVARIATES

At the 9-month interview, parents reported child sex (male vs female), race as defined by the US Census,[25] and number of siblings in the household For this analysis, we categorized race as white, black, or other.

Potential maternal covariates included age in years as reported on the focal child's birth certificate, baseline BMI, and education (categorized to indicate less than high school, high school graduate, or beyond high school).

Socioeconomic status was included as a single composite measure created by ECLS-B using data collected at first-wave interviews, which included parental education, parental occupation, and household income.[21] This composite measure included maternal education, which was significant when added to our model as an independent covariate. The composite measure was non-significant; thus we included only maternal education as a covariate in our final model.

POTENTIAL MEDIATORS

Parents reported screen time at 24 months, preschool, and kindergarten as the number of hours per weekday the child watched television or DVDs or videos in the household (continuous measure). At 9 months, screen time was not assessed and was therefore imputed to be 0 hours for all children in the cohort.

Parents reported active play time at 24 months and preschool as the frequency with which the parent played indoor games or engaged in outdoor activities with their child. Response options included 1) more than once a day, 2) about once a day, 3) a few times a week, 4) a few times a month, 5) rarely, and 6) not at all. Because this question was not asked at the 9-month or kindergarten interviews, data at these time points were imputed to be equal to 24-month and preschool responses, respectively.

At 24 months, preschool and kindergarten, parents reported the number of days per week the family ate the evening meal (dinner) together. Because this question was not asked at the 9-month interview, data at this time point were imputed to be equal to 24-month responses.

Diet quality was assessed at preschool and kindergarten by asking parents to report how many times during the prior 7 days the child consumed the following items: 1) sugar-sweetened beverages (eg, soda pop, sports drinks); 2) fresh fruit; 3) vegetables not including French fries or chips; 4) fast food; 5) candy, ice cream, or baked goods; and/or 6) salty snack foods. Response options for each item ranged from 0 to 6. Consistent with prior literature,[26] we created a composite measure to indicate diet quality by summing scores on these 6 dietary components (with vegetable and fruit items reverse coded). Because this question was not asked at the 9-month or 24-month interviews, these data were imputed to be equal to preschool responses.

STATISTICAL ANALYSIS

All analyses were conducted using F 9.4 (SAS Institute, Cary, NC) and Stata/SE 15.1 (StataCorp, College Station, Texas). Because of the complex sampling design, sample weights were used to account for stratification, clustering, and survey non-response. Results are reported for the weighted analyses.

Descriptive statistics were used to assess sample characteristics. Analyses were performed by using mixed models with random intercept and slope using an unstructured correlation matrix to account for having repeated WLZ/BMIZ measures for each individual participant over time. This statistical modeling technique uses the full information maximum-likelihood estimation approach to account for missing data.[27] Both linear and quadratic growth curve models were considered, with linear growth having a better fit as assessed by Bayesian information criteria. Thus we used a piecewise linear regression model to examine the association of new sibship with children's WLZ/BMIZ trajectory to kindergarten. A piecewise linear regression model allows the WLZ/BMIZ growth curve to be altered in correspondence to new sibship. To examine age-related variation in the focal child's WLZ/BMIZ trajectory, the age of the focal child was assigned to be the midpoint between the 2 ages during which the new sibship event occurred.

For children who had more than one new sibling enter the household during the 6-year period, WLZ/BMIZ data after the birth of the second sibling were not included in the analysis; therefore, any modification in WLZ/BMIZ trajectory would be attributed to the first new sibship event. We adjusted for child factors (ie, sex, race, number of siblings at baseline, and birth weight z-score), maternal factors (ie, age, BMI, and education), and household socioeconomic status. Our final model included only those covariates that were statistically significant: child's birth weight, child's sex, child's number of siblings at baseline, child's race, maternal education, and maternal BMI.

To further describe the association between new sibship and child WLZ/BMIZ trajectory, we included an interaction term between the WLZ/BMIZ slope and the focal child's age when a new sibling entered the family. In this way, we assessed whether the effect of new sibship on WLZ/BMIZ trajectory varied depending on the focal child's age at the time of new sibship. All analyses were adjusted for the sampling weight, and the significance level was set at 0.05.

Additionally, we implemented the same approach using the piecewise linear regression model described above to assess the influence of new sibship on each of the 4 potential mediators. We then tested the mediational role of screen time, active play time, family dinner frequency, and diet quality on the association between new sibship and child WLZ/BMIZ trajectory. These factors were added to the fully adjusted model. We then examined the beta coefficient, *P* value, and other model change parameters.

RESULTS

Table 1 shows characteristics of our complete analytic sample and characteristics of children with and without new sibship during the study period. Most of the children were male (52%) and white (57%). Mean ages of children in months at each assessment time point were 10.4 (standard deviation [SD] 1.9) at 9 months, 24.5 (SD 1.4) at 24 months, 53 (SD 4.2) at preschool, and 65.1 (SD 3.8) at kindergarten. At baseline, the mean number of siblings was 0.9 (SD 1.1). At 24 months, the mean screen time was 3.0 (SD 7.4) hours per day among children without new siblings and 3.1 (SD 8.1) among children with new siblings; mean family dinner frequency was 6.0 (SD 1.8) days per week among children without new siblings and 6.0 (SD 1.8) days per week among children with new siblings. At 24 months, the mean active play time was 4.3 (SD 1.7) for children with and without new siblings, indicating that they engaged in active play on average "a few times per month." At 24 months, the mean diet quality was 4.3 (SD 0.6) for children with and without new siblings, which correlates with "2 times per day" on the composite diet quality measure.

Figure 2 shows the WLZ and BMIZ trajectory from 9 months to kindergarten among children with and without new sibship during the study period. Children who had a new sibling join the family before kindergarten had a lower WLZ/BMIZ trajectory compared to children without new sibship during this time period. The interaction between WLZ/BMIZ slope and the focal child's age at the time of new sibship was significant ($b = -0.026$, $P = .044$). The WLZ/BMIZ trajectory was not significantly different among children without new siblings and children who had new siblings enter the family between 9 and 24 months. The magnitude of the relationship between new sibship and child WLZ/BMIZ trajectory increases after 24 months and is strongest among children who were older (ie, 48 to 66 months) when the new sibling joined the family.

New sibship significantly altered the trajectory of family dinner frequency but not screen time, active play, or diet quality. The interaction between family dinner frequency slope and the focal child's age at the time of new sibship was significant ($b = -0.045$, $P = .043$). Specifically, among focal children that experienced new sibship, family dinner frequency increased compared to children who did not experience new sibship (Fig. 3). However, this increase in family dinner frequency did not relate significantly to changes in BMIZ trajectory following the new sibship event.

Table 1. Sample Characteristics for the Entire Sample and Stratified by Having or Not Having a New Sibling by Kindergarten

Variables	Total (n = 6050)	Children with No New Siblings by Kindergarten (n = 3650)	Children with a New Sibling by Kindergarten (n = 2400)
Child sex, %			
Male	52.0	52.0	52.1
Female	48.0	48.0	47.9
Child race,%			
White	57.2	59.1	61.2
Black	16.2	16.9	15.2
Other	27.0	27.9	25.7
Hispanic ethnicity, %	20.9	20.3	21.9
Number of siblings at baseline, M (SD)	0.9 (1.1)	1.1 (1.1)	0.7 (1.0)
Child birth weight z-score, M (SD)	−0.02 (0.95)	0.00 (0.94)	−0.04 (0.95)
Maternal education, %			
Less than high school	18.5	17.2	20.4
High school graduate	53.3	54.7	51.4
Beyond high school	28.2	28.1	28.2
Maternal age in years, M (SD)	27.4 (6.3)	28.3 (6.4)	26 (5.8)
Maternal BMI, M (SD)	26.5 (6.7)	26.5 (6.7)	26.5 (6.7)
Socioeconomic status*	−0.01 (0.86)	0.02 (0.86)	−0.04 (0.87)

M indicates mean; SD, standard deviation; and BMI, body mass index.
*Composite measure of average z-scores for parental education, parental occupation, and household income.

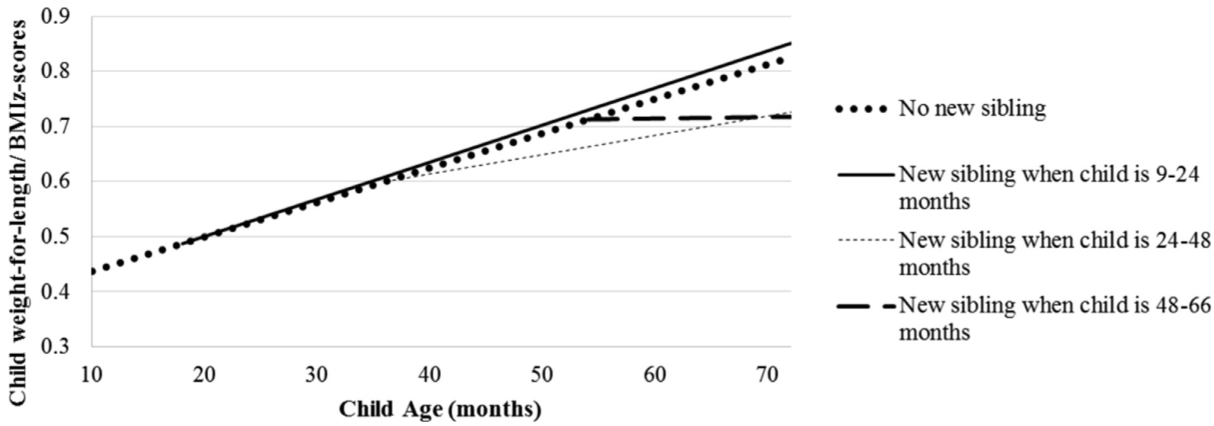

Figure 2. *Child weight-for-length/body mass index z-score trajectory from 9 months to kindergarten, adjusted for child factors (birth weight, sex, baseline number of siblings, race) and maternal factors (education, body mass index).*

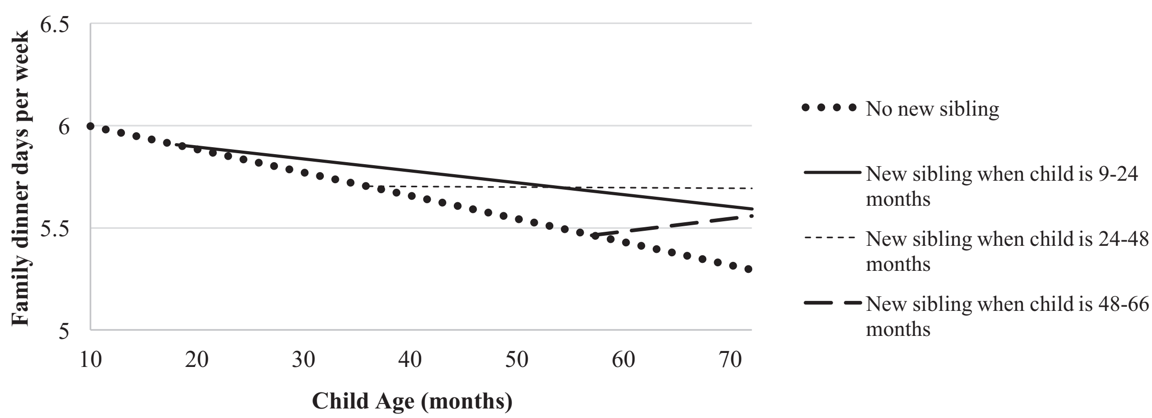

Figure 3. *Family dinner frequency by sibship status from 9 months to kindergarten, adjusted for child factors (birth weight, sex, baseline number of siblings, race) and maternal factors (education, body mass index).*

The relationship between new sibship and child BMIZ was not mediated by screen time, active play time, family dinner frequency, or diet quality. Specifically, no parameter changed more than 10% after including these potential mediators in the model.

Discussion

In a national, prospective study, we found children who had a new sibling join the family before kindergarten had a lower BMIZ trajectory than children who did not experience new sibship during this time frame. This association was independent of child birth weight z-score, child sex, maternal age, and maternal weight. Further, the association was not mediated by screen time, active play time, family dinner frequency, or diet quality.

Our findings corroborate prior work demonstrating a prospective association between new sibship and lower BMIZ trajectory over 6 years among a relatively small and geographically limited cohort of children born more than 25 years ago.[10] Similarly, we found that the strength of the association between new sibship and BMIZ trajectory varied according to the focal child's age and was strongest among children who had a new sibling join the family when they were 48 to 66 months old. To our knowledge, this is the first study to test and confirm the association between new sibship and BMIZ trajectory among a large, nationally representative, and contemporary cohort of US children. This is the first study to explore potential mechanisms of the association between new sibship and lower BMIZ trajectory. We tested 4 hypothesized mediators: 1) screen time, 2) active play time, 3) family dinner frequency, and 4) diet quality. Contrary to our hypothesis, the association between a new sibship and lower child BMIZ trajectory was not mediated by screen time, active play time, family dinner frequency, or diet quality. Although family dinner frequency increased following the new sibship event, this was not associated with subsequent BMIZ trajectory among our cohort. This may be because the association between new sibship and lower BMIZ is not mediated by family dinners; however, it is also possible that we did not detect a mediational role due to the short follow-up period after the new sibship event. A recent study of the Early Childhood Longitudinal Study, Kindergarten Cohort, demonstrated that children with siblings compared to those without siblings had lower BMI and were significantly more likely to eat family dinners, further suggesting that this factor may, in fact, mediate the relationship between new sibship and child

Table 2. Child WLZ/BMIZ at 9 Months, 24 Months, Preschool, and Kindergarten for Entire Sample and Stratified by Having or Not Having a New Sibling by Kindergarten

Interview Wave	Mean (SD) Child Age in Months	Mean Child WLZ/BMIZ*		
		Total (n = 6050)	Children with No New Siblings by Kindergarten (n = 3650)	Children with a New Sibling by Kindergarten (n = 2400)
9 months	10.4 (1.9)	0.44	0.46	0.42
24 months	24.5 (1.3)	0.53	0.55	0.50
Preschool	53 (4.2)	0.69	0.73	0.65
Kindergarten	65.1 (3.8)	0.77	0.81	0.71

WLZ indicates weight-for-length z-score; BMIZ, body mass index z-score; and SD, standard deviation.
*Child WLZ/BMIZ values are predicted from the model and adjusted for the child's birth weight, child's sex, child's number of siblings at baseline, child's race, maternal education, and maternal body mass index.

BMIZ.[12] Although prior work demonstrated less screen time among children with siblings,[12] we did not observe a significant alteration in screen time after a new sibling joined the family. This, too, may be due to the short follow-up period after the new sibship event. Alternatively, it is possible that secular trends in digital media use may attenuate the influence of new sibship on screen viewing among this more contemporary cohort.[28–30] Among our cohort, new sibship did not influence the focal child's physical activity or diet quality; however, both physical activity and diet quality were assessed at only 2 time points, which limits the power to detect change after the new sibship event.

Several alternative mechanisms may warrant investigation. First, new sibship may lead to other alterations in a child's routine or exposure to obesogenic risk factors. For example, sleep quality and duration are positively associated with healthier child weight status[31,32] and may improve if parents put an older child to bed earlier or transition him to his own room to facilitate uninterrupted care of a newborn. Second, gut microbiomes play a role in health and disease processes,[33] and reduced bacterial diversity is associated with obesity.[34] Having a sibling may lead to new exposures that diversify the older child's gut microbiota and promote healthier BMIZ. Third, the association between sibship and BMIZ may be mediated by changes in the parent–child relationship. Prior studies show a decline in positive mother–child interactions,[35,36] changes in maternal feeding behavior,[8] and resultant behavioral changes among older children after a sibling's birth,[18] which may alter a child's eating patterns and subsequent BMIZ.

Our findings should be interpreted in the context of several important limitations. First, this manuscript describes a cohort of children born in 2001 and thus may not reflect current obesogenic factors and exposures; however, to our knowledge, these are the most contemporaneous data available. Second, although we included multiple covariates in our model, there may be unmeasured confounders of the association between new sibship and child BMIZ. We aimed to minimize potential confounding by selecting covariates known to be associated with childhood obesity. Third, our findings suggest that screen time, active play time, family dinner frequency, and diet quality do not mediate the association between new sibship and child BMIZ. However, these constructs were measured with blunt instruments, which may not have adequately captured the relevant behaviors. Future work may consider strategies to measure these factors with greater rigor to further explore their mediational role. Fourth, our data did not permit us to distinguish new siblings born into the family from step, adoptive, or foster siblings; yet, these relationships may have unique associations with child BMIZ. Finally, although our cohort consisted of 6050 US children, the results may not be generalizable to children in other countries.

Conclusion

In this study, we demonstrate that BMIZ trajectory is lower among children who have a new sibling join the family before kindergarten compared to those who do not. Notably, this association was not mediated by screen time, active play time, family dinner frequency, or diet quality. Novel interventions that leverage the child–sibling relationship may be a promising approach to reduce the risk of childhood obesity. Future work should aim to elucidate the mechanism(s) of this association to inform such programs.

References

1. Ogden CL, Carroll MD, Lawman HG, et al. Trends in obesity prevalence among children and adolescents in the United States, 1988–1994 through 2013–2014. *JAMA*. 2016;315:2292.
2. Yanovski JA. Pediatric obesity. An introduction. *Appetite*. 2015;93:3–12.
3. Gicevic S, Aftosmes-Tobio A, Manganello JA, et al. Parenting and childhood obesity research: a quantitative content analysis of published research 2009–2015. *Obes Rev*. 2016;17:724–734.
4. Epstein LH, Paluch RA, Roemmich JN, et al. Family-based obesity treatment, then and now: twenty-five years of pediatric obesity treatment. *Health Psychol*. 2007;26:381–391.
5. Chen AY, Escarce JJ. Family structure and childhood obesity, Early Childhood Longitudinal Study–Kindergarten Cohort. *Prev Chronic Dis*. 2010;7:A50.
6. Haugaard LK, Ajslev TA, Zimmermann E, et al. Being an only or last-born child increases later risk of obesity. *PLoS ONE*. 2013;8:e56357.
7. Hunsberger M, Formisano A, Reisch LA, et al. Overweight in singletons compared to children with siblings: the IDEFICS study. *Nutr Diabetes*. 2012;2:e35.
8. Mosli RH, Lumeng JC, Kaciroti N, et al. Higher weight status of only and last-born children. Maternal feeding and child eating

behaviors as underlying processes among 4−8 year olds. *Appetite*. 2015;92:167–172.
9. Ochiai H, Shirasawa T, Ohtsu T, et al. Number of siblings, birth order, and childhood overweight: a population-based cross-sectional study in Japan. *BMC Public Health*. 2012;12:1.
10. Mosli RH, Kaciroti N, Corwyn RF, et al. Effect of sibling birth on BMI trajectory in the first 6 years of life. *Pediatrics*. 2016;137:e20152456.
11. Hesketh K, Crawford D, Salmon J, et al. Associations between family circumstance and weight status of Australian children. *Int J Pediatr Obes*. 2007;2:86–96.
12. Datar A. The more the heavier? Family size and childhood obesity in the U.S. *Soc Sci Med*. 2017;180(suppl C):143–151.
13. Kirk SFL, Penney TL, McHugh T-LF. Characterizing the obesogenic environment: the state of the evidence with directions for future research. *Obes Rev*. 2010;11:109–117.
14. Jago R, Baranowski T, Baranowski JC, et al. BMI from 3−6 y of age is predicted by TV viewing and physical activity, not diet. *Int J Obes*. 2005;29:557–564.
15. Gable S, Chang Y, Krull JL. Television watching and frequency of family meals are predictive of overweight onset and persistence in a national sample of school-aged children. *J Am Diet Assoc*. 2007;107:53–61.
16. Fulkerson JA, Strauss J, Neumark-Sztainer D, et al. Correlates of psychosocial well-being among overweight adolescents: the role of the family. *J Consult Clin Psychol*. 2007;75:181–186.
17. Fulkerson JA, Larson N, Horning M, et al. A review of associations between family or shared meal frequency and dietary and weight status outcomes across the lifespan. *J Nutr Educ Behav*. 2014;46:2–19.
18. Dunn J, Kendrick C, MacNamee R. The reaction of first-born children to the birth of a sibling: mothers' reports. *J Child Psychol Psychiatry*. 1981;22:1–18.
19. He M, Irwin JD, Sangster Bouck LM, et al. Screen-viewing behaviors among preschoolers: parents' perceptions. *Am J Prev Med*. 2005;29:120–125.
20. Valdés J, Rodríguez-Artalejo F, Aguilar L, et al. Frequency of family meals and childhood overweight: a systematic review: family meals and children overweight. *Pediatr Obes*. 2013;8:e1–e13.
21. Nord C, Edwards B, Hilpert R, et al. User's manual for the ECLS-B nine-month public-use data file and electronic code book- *2005013. pdf*. Available at: https://nces.ed.gov/pubs2005/2005013.pdf. Accessed July 31, 2017.
22. NCES. Early Childhood Longitudinal Program (ECLS): data information. Available at: https://nces.ed.gov/ecls/birthdatainformation.asp. Accessed October 16, 2017.
23. Early Childhood Longitudinal Study NCES. Early Childhood Longitudinal Study, Birth Cohort (ECLS-B) psychometric report for the 2-year data collection. Available at: https://files.eric.ed.gov/fulltext/ED497762.pdf. Accessed July 31, 2017.
24. Ogden CL, Flegal KM. Changes in terminology for childhood overweight and obesity. *Age*. 2010;12:12.
25. US Census Bureau. Questions and answers for Census 2000 data on race. Available at: https://www.census.gov/census2000/raceqandas.html. Accessed September 11, 2017.
26. Jackson DB. The link between poor quality nutrition and childhood antisocial behavior: a genetically informative analysis. *J Crim Justice*. 2016;44:13–20. https://doi.org/10.1016/j.jcrimjus.2015.11.007.
27. Larsen R. Missing data imputation versus full information maximum likelihood with second-level dependencies. *Struct Equ Model Multidiscip J*. 2011;18:649–662.
28. Piernas C, Popkin BM. Trends in snacking among U.S. children. *Health Aff (Millwood)*. 2010;29:398–404.
29. Radesky JS, Christakis DA. Increased screen time. *Pediatr Clin North Am*. 2016;63:827–839.
30. Certain LK, Kahn RS. Prevalence, correlates, and trajectory of television viewing among infants and toddlers. *Pediatrics*. 2002;109:634–642.
31. Li L, Zhang S, Huang Y, et al. Sleep duration and obesity in children: a systematic review and meta-analysis of prospective cohort studies. *J Paediatr Child Health*. 2017;53:378–385.
32. Felső R, Lohner S, Hollódy K, et al. Relationship between sleep duration and childhood obesity: systematic review including the potential underlying mechanisms. *Nutr Metab Cardiovasc Dis*. 2017;27:751–761.
33. Blum HE. The human microbiome. *Adv Med Sci*. 2017;62:414–420.
34. Turnbaugh PJ, Hamady M, Yatsunenko T, et al. A core gut microbiome in obese and lean twins. *Nature*. 2009;457:480–484.
35. Baydar N, Greek A, Brooks-Gunn J. A longitudinal study of the effects of the birth of a sibling during the first 6 years of life. *J Marriage Fam*. 1997;59:939.
36. Dunn J, Kendrick C. The arrival of a sibling: changes in patterns of interaction between mother and first-born child. *J Child Psychol Psychiatry*. 1980;21:119–132.