Childcare Attendance and Obesity Risk

Inyang A. Isong, MD, MPH, ScD,[a,b] Tracy Richmond, MD, MPH,[b] Ichiro Kawachi, MD, PhD,[a] Mauricio Avendaño, PhD[a,c]

abstract

BACKGROUND AND OBJECTIVES: Several observational studies have revealed that children who receive nonparental childcare are at increased risk of obesity. However, this may be due to unmeasured confounding or selection into different types of childcare. It is not well established whether this association reflects a causal effect of childcare attendance on obesity risk. We examined the effect of attending childcare on children's BMI *z* scores, using nationally representative data of ~10 700 children followed from age 9 months through kindergarten entry.

METHODS: We first employed ordinary least squares regression to evaluate longitudinal associations between childcare attendance at 24 months and BMI *z* scores at kindergarten entry, controlling for child, family, and neighborhood characteristics. Because type of childcare is associated with unobserved confounding factors, we repeated the analysis by using 2 quasi-experimental approaches: (1) individual fixed effect models, which control for all observed and unobserved time-invariant confounders; and (2) instrumental variable (IV) analysis.

RESULTS: At 24 months, 48.7% of children were in nonparental childcare, and 35.1% of children were overweight/obese at kindergarten entry. In ordinary least squares models, compared with children in parental care, children in nonparental childcare at 24 months had higher BMI *z* scores at kindergarten entry (0.08 [SE 0.03], $P = .01$). By contrast, fixed effects and IV models revealed no significant effect of childcare on BMI *z* score (fixed effects model: $\beta = 0.02$ [SE 0.02], $P = .62$); IV model: $\beta = 1.12$ [SE 0.76], $P = .14$).

CONCLUSIONS: We found no consistent associations between nonparental childcare and obesity. Previously reported significant associations may be confounded by unobserved family circumstances resulting in selection into different types of childcare.

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[a]*Department of Social and Behavioral Sciences, Harvard T.H. Chan School of Public Health, Boston, Massachusetts;* [b]*Boston Children's Hospital, Boston, Massachusetts; and* [c]*Department of Social Science, Health and Medicine, King's College London, London, United Kingdom*

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Address correspondence to Inyang A. Isong, MD, MPH, SM, Primary Care at Longwood, Boston Children's Hospital, 300 Longwood Ave, Boston, MA 02115. E-mail: inyang.isong@childrens.harvard.edu

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WHAT'S KNOWN ON THIS SUBJECT: Several observational studies have revealed that children who receive nonparental childcare are at increased risk of obesity, but this may be due to unmeasured confounding or selection into childcare, and not to the effect of childcare attendance on obesity risk.

WHAT THIS STUDY ADDS: Using 2 quasi-experimental approaches that attempted to minimize bias inherent in observational studies did not provide strong evidence for a significant relationship between nonparental childcare attendance and obesity.

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Childhood obesity remains a significant public health challenge in the United States, with ~22.8% of children aged 2 to 5 years, being classified as overweight or obese (BMI ≥85th percentile) in 2011–2012.[1] Public health efforts have been directed toward childhood obesity prevention, with a recent emphasis on the early childhood period.

In 2011, ~60% of US children <5 years were in some kind of regular childcare.[2] Given the significant amount of time that preschool-aged children spend in nonparental childcare, researchers have hypothesized that childcare attendance may be another contributor to childhood obesity. Several studies have evaluated whether there is an association between childcare attendance and children's weight status.[3–8] Most of these studies revealed an increased risk of obesity among children in nonparental childcare, compared with those cared for by their parents.[3–8] However, a major challenge is the fact that children in nonparental childcare and those in parental care may differ across many unmeasured variables not accounted for in existing studies. If the decision to place a child in nonparental childcare is correlated with unmeasured characteristics that are also associated with the child's weight status (eg, degree of parental concern, vigilance over the child's health, or dietary choices), conventional multivariable modeling approaches may yield biased estimates.

Given recent increased focus on childcare programs as a critical component of obesity prevention efforts, a better understanding of the association between childcare and obesity is essential. Ideally, a randomized controlled trial would help resolve this research question, but true experiments are expensive, time consuming, and difficult to launch. In the absence of experimental evidence, quasi-experimental analytical approaches can be useful to shed light on the extent to which childcare attendance may be linked to obesity. The goal of this study was to examine the association of attending childcare with children's BMI *z* scores, using both conventional methods as well as quasi-experimental techniques to account for selection bias and unmeasured confounding. Using data from a unique birth cohort study of ~10 700 children in the United States followed from age 9 months through kindergarten entry, we compare findings from conventional multivariable ordinary least squares (OLS) modeling approaches to findings on the basis of 2 quasi-experimental approaches designed to minimize the effect of selection bias and unmeasured confounding, namely fixed effects analysis and instrumental variable (IV) estimation. To our knowledge, this is the first study to use quasi-experimental techniques to examine the links between childcare attendance and children's weight status, a question with important policy implications for childhood obesity prevention.

METHODS

We used data from the Early Childhood Longitudinal Study Birth Cohort (ECLS-B), a study conducted by the National Center for Education and Statistics (NCES).[9] ECLS-B includes a nationally representative sample of ~10 700 US children from diverse socioeconomic and racial/ethnic backgrounds, born in 2001 and followed over ~6 years. Children's physical, social, and emotional development characteristics were measured in multiple settings. Data were also collected from parents/guardians, teachers, and childcare and early education providers. Five waves of data were collected as follows: wave 1 (9 months, 2001–2002), wave 2 (2 years, 2003–2004), wave 3 (preschool, 2005–2006), wave 4 (kindergarten, 2006–2007), and wave 5 (a sample of children who entered kindergarten in 2007–2008). Twins, low birth weight, American-Indian and Alaska Native, Chinese, other Asian and Pacific-Islander children were oversampled. Data from waves 1 to 4 were used for this study.

Outcome Variable

The outcome variable for this study was children's BMI *z* score at waves 2 to 4. Children's length or height and weight were measured at each wave of ECLS-B data collection. A measure mat, stadiometer, and a digital bathroom scale were used to obtain children's length, height, and weight measurements, respectively. For all children ≥24 months, we used the Centers for Disease Control and Prevention sex-specific growth charts to calculate BMI percentile ranking and *z* scores.[10] For longitudinal analyses, we used repeated continuous measures of the BMI *z* scores.

Exposure Variable

Childcare Arrangement

Parents were asked questions about different types of childcare (other than occasional babysitting) the child received on a regular basis, regardless of whether there was a charge or fee. Using parent responses, ECLS-B developed a composite variable that indicated the childcare arrangement for each child, based on where the child spent the most hours per week. We dichotomized this variable as parental care (reference category) versus nonparental childcare.

Other Covariates

Additional model covariates included the child's age, gender, race/ethnicity, maternal age and maternal weight (in kilograms), family socioeconomic status (SES), household structure (2-parent versus single-parent), and neighborhood-level (neighborhood safety) characteristics. We selected these variables as confounders because previous studies suggest they are associated with both type of childcare attendance and BMI.[11–20] The SES variable was an ECLS-B derived composite variable that was categorized into quintiles. It comprised information on the mother and father's educational attainment, occupational status, and household income. We used the ECLS-B SES composite variable from wave 1 (baseline) of data collection. Neighborhood safety was based on a question to assess parent's perception of their neighborhood safety: "Do you consider your neighborhood very safe from crime, fairly safe, fairly unsafe, or very unsafe." Possible responses included very safe, fairly safe, very unsafe, and fairly unsafe. If parents' response was very unsafe and fairly unsafe, the child's neighborhood safety was categorized as unsafe (versus safe).

Statistical Analysis

Information on several demographics was assessed by using wave 1 data. However, the outcome variable for this study was children's BMI z score at waves 2 to 4 only. We examined weight and height trajectories over time, excluding children with implausible values ($n = 100$), who were born with low or very low birth weight (birth weight <2500 g; $n = 3000$), had height and weight values missing at every wave ($n = 150$) or extreme BMI values (z score >3 SD or ≤ -3 SD; $n = 400$), with a final overall sample size of ~7200. We first conducted descriptive analyses, and then employed standard multivariable OLS regression to evaluate longitudinal associations between childcare attendance at 24 months and BMI z scores at kindergarten entry, adjusting for additional covariates. To further examine the role of selection and unmeasured confounding, we used 2 quasi-experimental techniques to improve causal inference using nonexperimental data, namely individual fixed effect and IV models. Individual fixed effect models, used to analyze longitudinal data with repeated measures, attempts to adjust for both observed and unobserved time-invariant confounders.[21] In this within-subject design, each individual is used as his or her own control, and average differences are used to estimate the treatment effect.[21] This approach was feasible in our study because changes in the type of childcare were fairly common among children in our sample (ie, ~56% of children transitioned from parental to childcare [or vice versa] at some point during the follow-up). Overall, only 5.7% of children were only ever in parental care, indicating that most of the variation was within individuals over time. We estimated the "childcare effect" for each child by comparing each child's BMI z score in parental care versus nonparental childcare, and then averaged differences across the population, to obtain the average treatment effect. The fixed effects models also included the following time-varying covariates: employment status, household structure, change in place of residence, and SES for each wave. To isolate effects of unidirectional transitions from parental care to nonparental childcare, we carried out supplementary analyses on a subset of children who had only moved from parental care to nonparental childcare across waves. Last, to evaluate a potential delayed effect of childcare on future BMI z scores, we also estimated models that examined the lagged effects of childcare transitions on BMI z scores.

IV analysis, a known econometric technique, examined whether "semirandom" variation in childcare attendance caused by a third variable believed to be unrelated to BMI might lead to increased BMI z scores. We used 2-stage least squares regression to estimate effects. Three assumptions must be met for IV analysis to yield unbiased estimates. The instrument must (1) affect the exposure; (2) be unrelated to the outcome, except through its effect on the exposure; and (3) be independent of the unmeasured confounding.[22] The main challenge in IV analysis is to identify an instrument that meets all 3 conditions. After exploring several potential alternatives, we chose as instrument the number of relatives who live close to the family, assessed by the question: "How many of your relatives live in the area?" Our rationale was that the number of relatives living in the area would make the need for nonparental childcare more or less, but it would not necessarily be directly associated with BMI other than through influencing the risk of childcare attendance. To minimize the impact of confounding variables that could invalidate the third criterion, we adjusted for a wide array of additional covariates, conditional on which we expected the instrument to be valid. We evaluated the strength of the instruments (criterion 1 above) by using conventional F statistics from the first stage in the 2-stage least squares approach. The F statistic was 19.6, indicating the absence of a weak instrument problem.[23] We repeated the analyses including the children with delayed kindergarten entry and the results did not change. Descriptive analyses accounted for the ECLS-B complex sample design and response rates, using appropriate ECLS-B weights. We conducted regression analyses with and without sample weights,[24] and obtained qualitatively similar results. Results from unweighted analyses are presented. All analyses were performed by using statistical software (SAS version 9.3; SAS Institute, Inc, Cary, NC). The study was approved by NCES and Harvard

School of Public Health Institutional Review Board. Per ECLS-B data reporting requirements, all figures are rounded to the nearest 50.

RESULTS

Table 1 shows sociodemographic characteristics of the sample, by childcare status. Overall, approximately half of the children were white (54.6%), boys (51.7%), and had parents with less than or equal to high school/GED education (46%). At 24 months, 48.7% of children were in nonparental childcare and 35.1% of children were overweight/obese at kindergarten entry. African-American children comprised 11.1% of children in parental care, and 20.6% of children in nonparental childcare. A greater proportion of Hispanic children was in parental childcare; they comprised 26.6% of children in parental care, and 19.4% of children in nonparental childcare. Children with mothers with less than or equal to high school diploma/GED comprised 52.1% of children in parental care and 39.7% of children in nonparental childcare. The average BMI *z* score of children in nonparental childcare was significantly higher than those in parental care at each wave of data collection ($P < .05$; Fig 1).

Results from multivariable linear regression models are summarized in Table 2, alongside results from fixed effect and IV models. In regular OLS models, children in nonparental childcare at 24 months had higher BMI *z* scores at kindergarten entry than children in parental care (β = 0.08 [SE 0.03], $P = .01$; $n = 4700$). This represents ~12% of the mean BMI *z* score. However, results from fixed effects regression models (column 2), which controlled for time-varying and time-invariant confounding, indicated no significant relationship between nonparental childcare and BMI *z* score (β = 0.02 [SE 0.02], $P = .41$; $n = 4700$). Sensitivity analyses to assess the impact of unidirectional changes in childcare arrangements across waves, as well as the lagged childcare variable yielded very similar results (model using subset of children: β = 0.05 [SE 0.06], $P = .39$; $n = 2400$); model using lagged childcare variable: β = 0.01 [SE 0.02], $P = .66$; $n = 4700$).

Results from the first stage of the IV estimation are shown in the third column of Table 2 and suggest that

TABLE 1 Sociodemographic Characteristics of the Sample Population, Overall and by Childcare Arrangement Status: Early Childhood Longitudinal Survey, Birth Cohort

Characteristic	Overall (n ~ 7200[a])	Parental Care, %	Nonparental Childcare, %
Prevalence		51.3	48.7
Boys	51.7	49.6	53.1
Child race			
African-American	15.7	11.1	20.6
Hispanic	23.1	26.6	19.4
Asian	3.4	3.7	3.1
Other	3.2	3.1	3.1
White	54.6	55.4	53.9
Household income			
≤$25 000	33.9	37.0	30.3
$25 001–50 000	29.3	31.9	27.4
>$50 000	36.8	31.1	42.3
Parent education			
≤High school/GED	46.0	52.1	39.7
Vocational school/some college	29.3	27.3	31
≥Some college	24.8	20.6	29.3
Two parent household	80.6	85.6	75.3
Unsafe neighborhood	8.1	9.4	7.2
Overweight/obesity prevalence, %			
2 y (2003–2004)	17.1	14.9	19.4
Preschool (2005–2006)	34.4	33.1	35.7
Kindergarten (2006)	35.1	33.2	37.1

[a] Unweighted sample size rounded to the nearest 50, in compliance with NCES ECLS-B data reporting requirements.

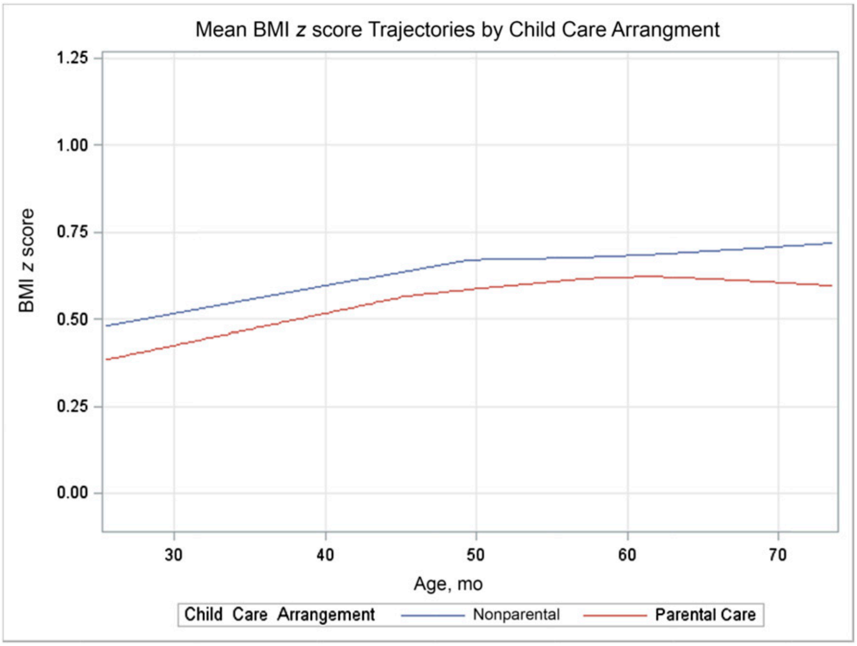

FIGURE 1
Mean BMI *z* score trajectories by childcare arrangement: Early Childhood Longitudinal Survey, Birth Cohort.

TABLE 2 OLS, Fixed Effects, and IV Multivariable Models Examining the Association of Childcare Attendance and BMI *Z* Scores: Early Childhood Longitudinal Survey, Birth Cohort

	OLS Multivariable Regression Analysis[a]	Fixed Effects Model Analysis[a,b]	First Stage IV Analysis	IV Analysis[a]
	β (SE)	β (SE)	β (SE)	β (SE)
Childcare	0.08 (0.03)*	0.02 (0.02)		1.12 (0.76)
Close relative (first stage IV analysis)[c]			0.04 (0.01)	
Age, mo	0.01 (0.01)	0.003 (0.003)	0.02 (0.01)	−0.01 (0.02)
Boys	0.07 (0.03)*	0.09 (0.03)	0.01 (0.01)	0.05 (0.03)
SES	−0.06 (0.01)	−0.07 (0.02)*	0.06 (0.01)	−0.13 (0.05)*
Race				
African-American	0.12 (0.05)*	0.05 (0.05)	0.14 (0.03)	−0.02 (0.12)
Hispanic	0.19 (0.04)*	0.12 (0.04)*	0.03 (0.02)	0.16 (0.05)*
Asian	−0.18 (0.05)*	−0.15 (0.04)*	−0.02 (0.02)	−0.15 (0.06)*
Other	0.19 (0.05)*	0.14 (0.05)*	0.03 (0.02)	0.16 (0.06)*
Maternal age, y	0.00 (0.003)	0.000 (0.003)	−0.001 (0.001)	0.001 (0.003)
Unsafe neighborhood	0.04 (0.06)	−0.02 (0.05)	−0.06 (0.03)*	0.10 (0.08)
Two-parent household	−0.04 (0.04)	−0.01 (0.05)	−0.17 (0.02)*	0.13 (0.14)
Maternal weight, kg	0.002 (0.00)*	0.002 (0.00)	0.00 (0.00)	0.002 (0.001)*

[a] Confounders in all models included child age, race/ethnicity, sex, maternal age, maternal weight (in kg), household structure, family SES, and neighborhood safety.
[b] Model also controlled for other time varying covariates: employment status, change in residence, household structure, and SES for each wave of data.
[c] Close relative variable only included in IV analysis.
* $P < .05$.

our main instrument, the number of family members living in the area significantly increased the likelihood that children received nonparental childcare (β = 0.04 [SE 0.01], *F* statistic =19.6). (The type of nonparental childcare received was relative care.) Although estimates were imprecise and had large SEs, results from the second stage of the IV (column 4) suggest that receiving nonparental childcare was not significantly associated with BMI *z* score at kindergarten entry (β = 1.12 [SE 0.76], *P* = .14; *n* = 4700). We assessed the impact of SES quintiles at later waves, and results remained consistent. Because children in nonparental childcare comprised 3 different childcare categories (relative care, nonrelative care, and center-based childcare), we conducted sensitivity IV analyses by using pairwise comparisons between parental childcare and each type of nonparental childcare. None of these models yielded significant results.

DISCUSSION

Nonparental childcare in early childhood has been associated with obesity.[3–8] In particular, children in relative, friend, or home-based nonparental childcare have been previously reported to gain more weight, compared with children in parental care.[5,25] Our study, using 2 quasi-experimental approaches that attempt to minimize bias inherent in observational studies, does not provide strong evidence for a relationship between nonparental childcare and obesity.

Conventional analytical approaches, although often controlling for a rich set of measured confounders, may not fully account for unmeasured or unobservable differences between children in different childcare arrangements. For example, parents who choose to take care of their children at home may also be more likely to cook healthier diets or emphasize healthy habits than parents who send their children to child care. This would imply that it is not childcare per se that increases the risk of obesity but other unmeasured behaviors that tend to cluster among parents who stay home with their children, and which are correlated with child weight.

It is noteworthy that not all studies evaluating the association between childcare and children's weight status have yielded a positive association. Some studies revealed no significant association,[26–29] whereas 1 study revealed an inverse association among children with limited center-based childcare attendance in preschool years.[26] Inconsistencies in results may be due to differences in sample characteristics, analytical approach, or confounders controlled for in the studies. Some studies have also revealed effect modification in the relationship by some familial characteristics. A UK-based study revealed that the positive childcare/obesity relationship was limited to children of parents who had more socioeconomically advantaged backgrounds.[6]

Despite many strengths in our data and approach, several limitations in this study should be considered. Children in our sample were only followed through kindergarten entry; if the impact of childcare on weight status only manifests after this age, we would not have detected any effects using our data. However, a study that assessed the long-term impact of childcare on weight status in female adults did not reveal any significant associations.[29] Fixed effects models control for time-invariant confounders but not time-varying confounders, some of which may be correlated with changes in BMI. We tried to minimize this bias by including as many time-varying confounders as possible in the model, but could still have omitted some important variables. Additional limitations of fixed effects analysis include the possibility that lag times were mis-specified, potential simultaneity, and sample size limitations because data on kids whose childcare arrangements did not change were not used. Finally, the IV technique could be biased when there are sample size limitations.[30] As such, results from the IV analysis should be interpreted with caution, given the large SEs and the possibility that our analysis may have been underpowered. We did not evaluate the impact of timing of nonparental childcare, but pairwise comparisons between parental childcare and each type of nonparental childcare yielded qualitatively similar results. The IV analysis relies on strong assumptions that cannot be fully verified empirically. For example, the presence of direct effects of the instrument on BMI can never be fully tested empirically in an IV analysis, and our results therefore rely on the assumption of no direct effects. We repeated our analyses by using 3 strong instruments, and results remained consistent. Overall, although quasi-experimental techniques are not without limitations, our results do provide a richer picture that casts doubt on the hypothesis that nonparental childcare is associated with higher risk of obesity.

CONCLUSIONS

We found no consistent associations between nonparental childcare and obesity. Earlier reported associations may be confounded by unobserved family circumstances resulting in selection into different types of childcare arrangement. Results of previous studies have led to calls to revamp childcare policies and promote reorganization of childcare settings to address obesity risk factors among children in nonparental childcare. Because an increasing proportion of US children spend a significant amount of time in nonparental care, efforts to enhance the quality of care provided in these settings are reasonable approaches. However, there is a need for a better understanding of factors that inform parents' childcare decisions to fully tease apart the association between childcare attendance and children's weight in the short or long term. Future studies, particularly rigorous randomized controlled trials may be required to fully address this complex question. Findings from such studies could inform how best to allocate limited obesity prevention resources.

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As is required by the terms of the National Center for Education and Statistics (NCES) restricted-use data license, this manuscript was submitted to the NCES Data Security Office for disclosure review and clearance prior to submission.

ABBREVIATIONS

ECLS-B: Early Childhood Longitudinal Study Birth Cohort
IV: instrumental variable
NCES: National Center for Education and Statistics
OLS: ordinary least squares
SES: socioeconomic status

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