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Childhood adiposity and fertility difficulties: the Bogalusa Heart Study

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Summary

Background—Adult obesity is associated with infertility; however, childhood obesity has received little consideration.

Objectives—The present study sought to evaluate the impact of childhood adiposity on fertility.

Methods—Associations between childhood adiposity and self-reported fertility difficulties were estimated among women participating in a long-term study of cardiovascular risks and reproductive health (n = 1061).

Results—Participants with obesity between ages 9 and 12 were more likely to report fertility difficulties (adjusted relative risk [aRR], 1.82, 95% CI 1.17–2.82) and inability to become pregnant when trying (aRR = 1.94, 95% CI 1.22–3.08) as were those with obesity prior to age 9 (aRR = 1.76, 95% CI 1.04–2.97). Similar associations were seen among those ever overweight or obese in childhood. High subscapular skinfold thickness (age < 12) increased risk of receiving help becoming pregnant (aRR = 2.16, 95% CI 1.15–4.06), inability to become pregnant (aRR = 1.46, 95% CI 1.05–2.04) and any fertility difficulties (aRR = 1.56, 95% CI 1.13–2.14); associations for triceps skinfold were attenuated. Participants with increased adiposity also had fewer pregnancies and live births. Effects persisted, excluding women with polycystic ovarian syndrome.

Conclusions—This study supports an association between childhood adiposity and infertility, not solely driven by polycystic ovarian syndrome.

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Conflict of interest statement
The authors have no conflict of interest to disclose.

Supporting information
Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Keywords

Body mass index; infertility; polycystic ovarian syndrome; subscapular skinfold

Introduction

Obesity in adulthood is associated with infertility (1,2). Women who are overweight or obese are at increased risk for menstrual cycle irregularities, oligoovolution or anovulation and decreased success following assisted reproduction. Excess fat accumulation may lead to insulin resistance and hyperinsulinemia, which inhibit normal ovulation through hormonal changes (1,3). Childhood obesity has previously been linked with polycystic ovarian syndrome (PCOS), one of the leading causes of infertility (2,4,5). However, little attention has been paid to subfertility overall, which may arise through other mechanisms. One early study suggested that married women who were never pregnant were more likely to have been obese as teenagers than married women who are ever pregnant (6), while others showed that adolescents and young adults with obesity had fewer children than their normal weight counterparts (7,8). Additional research demonstrated increased body weight at age 18 among subfertile women with an ovulatory disorder (9), although another study found no association between childhood body mass index (BMI) and inability to conceive within 1 year (10).

Still, gaps remain. First, with one exception (10), existing literature focuses on measures taken in mid to late adolescence and early adulthood (6–9), and therefore, do not truly address childhood obesity. Second, in industrialized settings with access to birth control, the number of children achieved is largely a choice. Thus, studies focusing on number of children provide limited knowledge compared with those that assess inability to conceive. Lastly, all but one investigation (8) relied solely on BMI, which may not be a suitable measure of adiposity in adolescents especially (10). We hypothesized that childhood adiposity, as measured by BMI and skinfold thickness, would be associated with infertility, both overall and in the absence of PCOS.

Methods

We performed a cohort study using data on women who had been followed prospectively from childhood as part of the Bogalusa Heart Study (BHS). The BHS, started by Dr Gerald Berenson, is a long-term study of cardiovascular risk factors among children and young adults from Bogalusa, LA, USA (11). Surveys of children aged 5–14 years began in 1973 and were repeated approximately every 2 years through 1994, examining both newly and previously enrolled children. As adults, participants were eligible for reexamination in surveys conducted from 1977 to 2010. Detailed study methods have been published previously (11). The Bogalusa Babies sub-study began in May 2013 to examine the role of cardiovascular risk factors in childhood on reproductive outcomes. Women with at least one BHS visit are eligible to participate. The telephone survey, conducted by a trained interviewer, includes a full reproductive history.

Parental permission and assent of the child were obtained prior to participation in the original study, and informed consent was obtained for participation as an adult. All study procedures received approval from the Institutional Review Board of Tulane University.

Childhood adiposity measures

At each BHS visit, replicate measures of height and weight, using a stadiometer and balance beam metric scale, were obtained; BMI (kg/m^2) was calculated using mean values. Subscapular and triceps skinfold thicknesses were measured to the nearest millimetre three times using Lange Skinfold Calipers (Cambridge Scientific Industries, Cambridge, MD, USA); the average of all three measures was used. For each study visit, the participant's BMI was classified as normal (< 85th percentile), overweight (85th–94th percentile) or obese (≥ 95th percentile) based on gender-specific age norms (12). Similarly, skinfold measurements were classified as normal (< 85th percentile), high (85th–94th percentile) or very high (≥ 95th percentile) (13). The participants were classified as ever overweight or obese if their BMI was ≥ 85th percentile at any age, and a skinfold measure ≥ 85th percentile at any visit was considered ever high skinfold thickness.

Periods of growth were defined as childhood (age < 9), early teen (ages 9–12) and late teen (ages 13–18), consistent with somatic growth velocity charts (14). For each time period, the participants were classified as normal, overweight or obese (BMI) and normal, high or very high (skinfold), if a study visit occurred when they were in that age category. In the participants with more than one measurement for a time period, the measurement closest to the midpoint of the timespan was used.

As inadequate body fat may also cause fertility difficulties (3,15), a sensitivity analysis was conducted using < 5th percentile as a cut-off, considering ever being underweight/low subscapular skinfold (SSSF) as an additional category.

Adult fertility measures

During the interview, the women were asked whether they had ever been pregnant, the outcome of each pregnancy and whether they took any fertility drugs or received any medical procedures to help them become pregnant. The women were also asked whether they ever tried to become pregnant and were unable to, and whether they had ever been to a doctor for help becoming pregnant. The women who answered 'yes' to any one of the three fertility-related questions were considered to have reported fertility difficulties. Reliability between self-reported use of fertility treatment and medical records has been found to be reasonably high (16), and although self-report may underestimate clinical fertility difficulties, it provides a reasonable estimate of infertility burden with high specificity (17).

Covariates

Self-reported race (White/Black) was recorded during study enrolment. Highest level of education achieved was categorized as ≤ high school, some college and college or more. Family's financial situation both as a child and currently was classified as barely enough (to cope), enough or more than enough. During the interview, the participants provided an estimate of their current weight; adult BMI was calculated using this value and the most recent height measured during a visit at age 16 or older (14). The multiplier method (18) was used to estimate height for the participants who did not have an adult height recorded. Finally, the women were asked whether they had ever been told by a doctor that they had PCOS; the women who said they were not sure were coded as no.

Tobacco use was considered as a dichotomous variable; the participants who answered 'yes' to either smoking currently or formerly at any visit were coded as 'ever smoked', whereas the participants who said that they did not currently smoke had only tried smoking, smoked < 1 cigarette/week or had never smoked were coded as 'never smoked'. While smoking around the time of trying to conceive likely has the greatest impact on reproductive efficacy, we were unable to measure smoking during this time specifically; we could not confirm the ages at which a woman smoked if she reported being a former smoker as an adult and did not know whether the participants who reported smoking during their teen years were still smoking during their prime reproductive ages if they did not have a visit in adulthood. Therefore, while considering any reported smoking as a measure of tobacco use may overestimate the number of women smoking during their reproductive years, it also ensures that probable smokers are not misclassified as non-smokers.

Study population

Female BHS participants who had at least one visit prior to age 19 were eligible for the current investigation ($n = 5824$). Of these, 1064 participated in Bogalusa Babies from May 2013 to March 2015. The women who participated had a slightly higher average BMI than those who did not (age ≤ 18, 19.7 vs. 18.8, $p < 0.01$). However, they were not more likely to have been categorized as obese at any point in childhood (13.5 vs. 12.4%, $p = 0.32$). No differences in race or age at first study visit were noted. The mean age at the interview was 45.5 years, and the study population was 65.3% White and 34.7% Black, consistent with the underlying BHS population (11). Three women did not answer to any of the fertility questions, leaving 1061 women.

Statistical analysis

Associations between BMI and skinfold thickness and all fertility outcomes were assessed using log-binomial regression. BMI and skinfold thickness were considered as three-level groupings by period of growth, as well as ever being at or above the 85th percentile prior to age 12 (before the average age of menarche [12.4 years] in the USA) (19) and ever in childhood through age 18. Crude and adjusted measures of association were estimated. Models were adjusted for covariates significant at $p \leq 0.05$, then $p \leq 0.10$ and finally, $p \leq 0.20$. Categorical variables with significant linear trend (based on Cochran–Armitage test) were treated as ordinal variables. At each step, the models were assessed by examining changes in relative risk estimates and model fit statistics (AIC). Following these analyses, the models were repeated, excluding women who reported having PCOS ($n = 81$, 7.7%). Finally, the mean number of pregnancies and live births for each adiposity group by period of growth were calculated using Poisson regression models adjusted for covariates included in final log-binomial models. All statistical analyses were completed using SAS 9.3; a p-value of < 0.05 was considered significant.

Results

The majority of the study participants had been pregnant (87.9%) and given birth (85.3%) at least once. The women who reported inability to become pregnant when they wanted to were more likely to have never been pregnant (18.5 vs. 10.8%, $p = 0.003$) or had a live birth (28.0 vs. 11.7%, $p < 0.0001$), as were those who reported ever seeking medical help to conceive (never pregnant: 16.5 vs. 10.4%, $p = 0.05$; no live births: 27.1 vs. 12.5%, $p < 0.0001$) and those who reported any fertility difficulties (17.7 vs. 10.5%, $p = 0.003$ and 26.2 vs. 11.5%, $p < 0.0001$ respectively). These women also reported a lower median number of total pregnancies and live births. Based on BMI, 19.1% of the participants were overweight or obese as children, 24.6% during early teen years and 21.9% during the late teen period. More than half (52.5%) were at or above the 85th percentile for subscapular skinfold thickness during childhood; however, this decreased during early (39.5%) and late (31.0%) adolescence. A similar pattern was noted for triceps skinfold. The participants who reported receiving medical help to become pregnant or ever sought medical help for fertility were more likely to be White (Table 1). Those with a high school education or less were less likely to report all fertility outcomes, and those who had more than enough financially were more likely to have received or sought help becoming pregnant and to report any fertility difficulties.

Adiposity and fertility

Compared with those with a normal BMI, the participants classified as obese prior to age 9 were more likely to report an inability to become pregnant when trying (aRR = 1.76, 95% CI 1.04–2.97), while those who were obese between ages 9 and 12 were more likely to report inability to become pregnant (aRR = 1.94, 95% CI 1.22–3.08) and any fertility difficulties (aRR = 1.82, 95% CI 1.17–2.82) (Table 2). The participants who were ever overweight or obese prior to age 12 were also at increased risk of inability to become pregnant when trying (aRR = 1.44, 95% CI 1.03–2.03) and any fertility difficulties (aRR = 1.42, 95% CI 1.03–1.95) compared with those who were never overweight.

The women who had at least one SSSF measure ≥ 85th percentile prior to age 12 or ever in childhood were more likely to report ever receiving help becoming pregnant (aRR = 2.16, 95% CI 1.15–4.06 and aRR = 2.32, 95% CI 1.29–4.18), inability to become pregnant when trying (aRR = 1.46, 95% CI 1.05–2.04 and aRR = 1.48, 95% CI 1.09–2.00) and any fertility difficulties (aRR = 1.56, 95% CI 1.13–2.14 and aRR = 1.37, 95% CI 1.04–1.80). Effects for triceps skinfold (TRSF) were not as robust (Table S1).

No significant associations between low BMI/SSSF and fertility difficulties were noted (data not shown).

Number of pregnancies and live-births

Compared with the participants with a normal BMI, the women who were obese during any of the three time periods had fewer total pregnancies (child: 1.6 vs. 2.4, $p = 0.008$; early teen: 1.8 vs. 2.4, $p = 0.003$; late teen: 1.6 vs. 2.5, $p < 0.0001$) and live births (child: 1.5 vs.

2.0, $p = 0.04$; early teen: 1.6 vs. 2.0, $p = 0.03$; late teen: 1.5 vs. 2.1, $p = 0.002$) (Figure S1). A similar pattern was seen for SSSF thickness.

Adiposity and fertility, non-PCOS

Excluding the women with PCOS, no associations were noted for childhood BMI (Table 3). However, compared with the women who had normal SSSF thickness, the women in the 85th–94th percentiles prior to age 9 were more likely to have experienced inability to become pregnant while trying, ever sought help for infertility and report any fertility difficulties. Additionally, those with a very high SSSF in childhood were more likely to have received medical interventions to help become pregnant. Ever having a SSSF thickness ≥85th percentile prior to age 12 led to increased risk of all fertility outcomes; comparable effects were noted when SSSF up to age 18 was considered, with the exception of ever seeking help.

Discussion

The results from the present study suggest that increased adiposity as a child may have long-lasting impacts on fertility. Women classified as overweight or obese in childhood were more likely to have experienced fertility difficulties in adulthood, as were women with high or very high subscapular skinfold thickness as children. The findings are supported by estimates of achieved fecundity; the women in the highest BMI and SSSF categories had fewer pregnancies and live births than those with normal adiposity measures across age categories. Triceps skinfold was not associated with fertility difficulties to the same degree. Additionally, when the women who reported PCOS were excluded, the increased risk of fertility difficulties was primarily with SSSF thickness, and associations with BMI were diminished. When all adiposity measures were included in a model simultaneously, SSSF thickness remained a significant risk factor, while BMI and TRSF fell out of previously significant models (data not shown). This suggests that early childhood SSSF thickness may be a better indicator of increased risk for adiposity-associated fertility difficulties than BMI alone.

The value of SSSF compared with BMI or TRSF in the current investigation is consistent with existing studies of adult adiposity and fertility; visceral fat may play a more important role in reproductive health than body size overall, as measured by BMI (1). Subscapular skinfold thickness provides a measurement of truncal body fat, which may be more applicable to fertility than triceps skinfold, which quantifies extremity fat accumulation. A recent study found that higher SSSF and TRSF measures in adult women with PCOS matched on BMI to women without PCOS, suggesting differential fat accumulation (20). Further, compared with total body fatness, central adiposity shows a stronger relationship with menstrual cycle abnormalities and decreased fecundity (21,22). Additional analyses considered centripetal fat ratio (CFR = SSSF/[SSSF + TRSF]); childhood CFR ≥ 0.5 was associated with receiving medical help to become pregnant (aRR = 1.87, 95% CI = 1.19–2.93), although associations were not significant for other outcomes or time periods.

Researchers caution that while BMI may serve as a marker of adiposity at the group level, it has limited value at the individual level as a result of wide variations in body fat percentages

(23,24). Skinfold thickness may be more highly correlated with body fat percentage than BMI, especially in thin individuals (25). Inclusion of skinfold measures has been shown to improve estimates of body fatness when considered in conjunction with BMI (26), and TRSF was found to perform better than BMI for obesity screening in adolescents (27). Racial differences in extremity fat and TRSF thickness, but not SSSF thickness, have also been documented (13), suggesting that SSSF measures may be more appropriate in populations with different racial distributions. Unfortunately, variability in skinfold measurements can be considerable, and no single cut-off has been determined (13), although 85th or 95th percentiles have traditionally been used.

A key finding in the present study is a differentiation in risk based on adiposity during various time periods of growth. Adiposity in childhood was consistently associated with fertility difficulties, whereas associations during early and late adolescence were either inconsistent or lacking. Ever being classified as ‘high adiposity’ prior to age 12 demonstrated an increased risk of fertility difficulties, with no value added when considering additional measures up to age 18. This may be important, as existing studies have primarily considered the mid-to-late teen years (6–9). The one study that considered early childhood adiposity did not find an association with conception within 1 year; (10) however, this study relied solely on BMI.

While this study provides a unique opportunity to examine the impact of childhood adiposity on adult fertility, there are a number of limitations. Although we tried to account for adult BMI by including BMI at the time of the interview in the final models, we were unable to adjust for BMI around the time of trying to conceive. Among the participants who had a study visit during peak childbearing years (ages 20–29), those who reported inability to become pregnant when trying and any fertility difficulties were significantly heavier (27.6 vs. 25.7, $p = 0.008$ and 27.2 vs. 25.9, $p = 0.05$ respectively). However, nearly one-third (30.3%) of the participants did not have a BMI measure during this time, and those without a visit during this time were more likely to report fertility difficulties and have been classified as overweight during childhood. Further, we were unable to account for spousal BMI, which may be important, as male obesity has been associated with decreased semen quality (28), and couples tend to share adiposity profiles. Still, female truncal adiposity is independently associated with impaired fecundity in the absence of poor semen quality (1).

Finally, although fertility outcomes were self-reported, our estimates are in line with infertility prevalence estimates in the USA (29), and objective measures of fecundity (number of pregnancies and live births) were associated with reported fertility outcomes in the expected manner. Likewise, PCOS was self-reported and is frequently underdiagnosed; therefore, a number of PCOS cases may have been missed. Nonetheless, reported PCOS prevalence is consistent with nationwide estimates under NIH diagnostic criteria (30). A major strength of the present investigation is the use of prospectively obtained clinical measurements of adiposity throughout childhood and the consideration of multiple adiposity measures in addition to BMI.

In conclusion, the present study supports an association between childhood adiposity and fertility difficulties in adulthood, which is not solely driven by PCOS. Confirmation of this relationship should provide supplementary incentive for early intervention regarding childhood obesity. Additional studies are necessary to further explore this relationship using both clinical and prospective measurements of fertility.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Characteristics of the study population by fertility outcome[a]

Characteristic	Overall	Received medical help becoming pregnant		Ever tried but unable to become pregnant		Ever sought medical help for fertility		Any reported fertility difficulties	
		Yes (n = 70)	No (n = 756)	Yes (n = 200)	No (n = 840)	Yes (n = 133)	No (n = 595)	Yes (n = 226)	No (n = 835)
Age at interview (mean)	45.5	45.8	45.6	45.5	45.4	45.7	45.6	45.5	45.4
Race (%)									
White	65.3	90.0†	64.0	68.5*	64.8	75.2†	64.0	69.9**	64.1
Black	34.7	10.0	36.0	30.5	35.2	24.8	36.0	30.1	35.9
Current BMI (mean)	30.9	28.8**	30.4	31.1	30.8	30.3*	31.3	30.9	30.9
Education level (%)[b]									
High school or less	34.0	7.1†	37.4	26.5***	35.5	14.3†	38.2	24.3†	36.6
Some college	33.2	35.7	32.0	35.5	32.5	37.6	31.3	35.0	32.8
College or more	32.8	57.1	30.6	38.0	31.9	48.1	30.5	40.7	30.6
Childhood finances (%)[b]									
Barely enough	24.5	15.7*	26.3	25.5	24.1	23.3	24.6	24.3	24.5
Enough	55.3	61.4	53.4	55.5	55.1	57.1	53.9	57.1	54.8
More than enough	20.2	22.9	20.3	19.0	20.8	19.6	21.5	18.6	20.7
Adult finances (%)[b]									
Barely enough	12.9	4.3†	12.7	10.0	13.3	9.0†	13.8	9.7†	13.8
Enough	47.5	37.1	49.0	45.5	48.2	37.6	47.1	44.3	48.3
More than enough	39.6	58.6	38.3	44.5	38.5	53.4	39.1	46.0	37.9
Ever smoked (%)	35.7	30.3*	38.5	30.3**	37.0	29.4**	37.1	30.8**	37.1

$^{*}p \le 0.20$;

$^{**}p \le 0.10$;

$^{***}p \le 0.05$;

$^{†}p \le 0.01$

[a] p-values are based on Pearson's chi-square for categorical variables and t-test for continuous variables.

[b] Cochran–Armitage test for trend assessed for ordinal variables.

Table 2

Childhood adiposity by time period and reported fertility difficulties in adulthood[a]

Adiposity measure	Fertility difficulties							
	Medical help		Tried unable		Ever sought help		Any difficulties	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
Body mass index (BMI)								
Child BMI (age < 9)								
Normal weight	Ref.	—	Ref.	—	Ref.	—	Ref.	—
Overweight	1.69	0.75–3.83	1.19	0.65–2.19	1.36	0.74–2.50	1.31	0.77–2.23
Obese	0.58	0.08–4.18	**1.76**	**1.04–2.97**	0.65	0.24–1.73	1.54	0.92–2.57
Early teen BMI (age 9–12)								
Normal weight	Ref.	—	Ref.	—	Ref.	—	Ref.	—
Overweight	1.08	0.49–2.41	1.45	0.97–2.16	1.26	0.78–2.02	1.35	0.93–1.97
Obese	1.00	0.24–4.10	**1.94**	**1.22–3.08**	1.37	0.68–2.74	**1.82**	**1.17–2.82**
Late teen BMI (age 13–18)								
Normal weight	Ref.	—	Ref.	—	Ref.	—	Ref.	—
Overweight	1.23	0.51–2.95	1.26	0.81–1.96	0.93	0.50–1.70	1.24	0.83–1.88
Obese	1.38	0.43–4.43	1.60	0.99–2.58	1.03	0.51–2.08	1.49	0.95–2.33
Ever overweight/obese age < 12	1.33	0.69–2.57	**1.44**	**1.03–2.03**	1.13	0.72–1.75	**1.42**	**1.03–1.95**
Ever overweight/obese age ≤ 18	1.10	0.62–1.94	1.25	0.92–1.69	0.95	0.65–1.39	1.23	0.93–1.63
Subscapular skinfold (SSSF)								
Child SSSF (age < 9)								
Normal (< 85th percentile)	Ref.	—	Ref.	—	Ref.	—	Ref.	—
High (85th–94th percentile)	1.62	0.79–3.32	1.43	0.96–2.15	1.46	0.89–2.39	1.43	0.98–2.10
Very high (≥ 95th percentile)	1.87	0.95–3.71	1.20	0.79–1.83	1.30	0.79–2.14	1.27	0.86–1.88
Early teen SSSF (age 9–12)								
Normal (< 85th percentile)	Ref.	—	Ref.	—	Ref.	—	Ref.	—
High (85th–94th percentile)	1.46	0.88–2.41	1.23	0.88–1.70	1.15	0.78–1.69	1.20	0.89–1.63
Very high (≥ 95th percentile)	0.75	0.27–2.06	1.37	0.92–2.04	1.08	0.58–1.74	1.26	0.86–1.85
Late teen SSSF (age 13–18)								
Normal (< 85th percentile)	Ref.	—	Ref.	—	Ref.	—	Ref.	—

Adiposity measure	Fertility difficulties							
	Medical help		Tried unable		Ever sought help		Any difficulties	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
High (85th–94th percentile)	1.55	0.87–2.75	1.37	0.99–1.91	**1.51**	**1.03–2.21**	1.22	0.89–1.67
Very high (≥ 95th percentile)	1.98	0.58–6.71	1.19	0.69–2.03	1.32	0.65–2.65	1.24	0.75–2.03
Ever ≥ 85th percentile age < 12	**2.16**	**1.15–4.06**	**1.46**	**1.05–2.04**	1.41	0.94–2.12	**1.56**	**1.13–2.14**
Ever ≥ 85th percentile age ≤ 18	**2.32**	**1.29–4.18**	**1.48**	**1.09–2.00**	1.43	0.99–2.06	**1.37**	**1.04–1.80**

[a]Results of log-binomial regression; estimates adjusted for education level, race, tobacco use history, current BMI and adult income; numbers in bold significant at $p < 0.05$

Table 3

Childhood adiposity by time period and reported fertility difficulties in adulthood among without polycystic ovarian syndrome[a]

Adiposity measure	Fertility difficulties							
	Medical help		Tried unable		Ever sought help		Any difficulties	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
Body mass index (BMI)								
Child BMI (age < 9)								
Normal weight	Ref.	—	Ref.	—	Ref.	—	Ref.	—
Overweight	2.17	0.92–5.12	1.21	0.59–2.48	1.61	0.81–3.21	1.34	0.72–2.46
Obese	—	—	1.82	0.92–3.58	0.59	0.14–2.40	1.51	0.78–2.94
Early teen BMI (age 9–12)								
Normal weight	Ref.	—	Ref.	—	Ref.	—	Ref.	—
Overweight	0.53	0.13–2.13	1.12	0.65–1.92	0.94	0.47–1.88	1.08	0.66–1.77
Obese	1.57	0.35–7.10	1.74	1.00–3.04	1.50	0.67–3.35	1.64	0.97–2.77
Late teen BMI (age 13–18)								
Normal weight	Ref.	—	Ref.	—	Ref.	—	Ref.	—
Overweight	1.00	0.32–3.12	1.01	0.58–1.77	0.72	0.32–1.60	1.05	0.63–1.75
Obese	0.53	0.07–3.93	1.33	0.74–2.38	0.83	0.33–2.09	1.27	0.74–2.19
Ever overweight/obese age < 12	1.18	0.51–2.72	1.29	0.85–1.97	1.05	0.60–1.84	1.28	0.87–1.90
Ever overweight/obese age ≤ 18	1.02	0.51–2.05	1.10	0.76–1.58	0.82	0.51–1.31	1.12	0.80–1.56
Subscapular skinfold (SSSF)								
Child SSSF (age < 9)								
Normal (< 85th percentile)	Ref.	—	Ref.	—	Ref.	—	Ref.	—
High (85th–94th percentile)	2.16	0.90–5.16	**1.65**	**1.04–2.65**	**1.89**	**1.02–3.50**	**1.62**	**1.05–2.51**
Very high (≥ 95th percentile)	**2.45**	**1.05–5.72**	1.20	0.72–2.01	1.82	0.98–3.39	1.31	0.82–2.08
Early teen SSSF (age 9–12)								
Normal (< 85th percentile)	Ref.	—	Ref.	—	Ref.	—	Ref.	—
High (85th–94th percentile)	1.63	0.93–2.88	1.30	0.89–1.90	1.26	0.81–1.98	1.26	0.89–1.77
Very high (≥ 95th percentile)	1.06	0.38–2.95	1.47	0.92–2.34	1.02	0.53–1.96	1.32	0.84–2.06
Late teen SSSF (age 13–18)								
Normal (< 85th percentile)	Ref.	—	Ref.	—	Ref.	–	Ref.	—

Adiposity measure	Fertility difficulties							
	Medical help		Tried unable		Ever sought help		Any difficulties	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
High (85th–94th percentile)	1.67	0.87–3.20	1.29	0.89–1.89	1.53	0.97–2.39	1.15	0.80–1.65
Very high (≥ 95th percentile)	1.69	0.38–7.58	0.93	0.48–1.82	1.14	0.46–2.86	1.04	0.57–1.91
Ever ≥ 85th percentile age < 12	**2.82**	**1.29–6.16**	**1.57**	**1.06–2.32**	**1.71**	**1.03–2.83**	**1.69**	**1.17–2.44**
Ever ≥ 85th percentile age ≤ 18	**3.28**	**1.57–3.84**	**1.50**	**1.07–2.11**	1.52	0.99–2.32	**1.40**	**1.03–1.89**

[a]Results of log-binomial regression; estimates adjusted for education level, race, tobacco use history, current BMI and adult income; numbers in bold significant at $p < 0.05$.