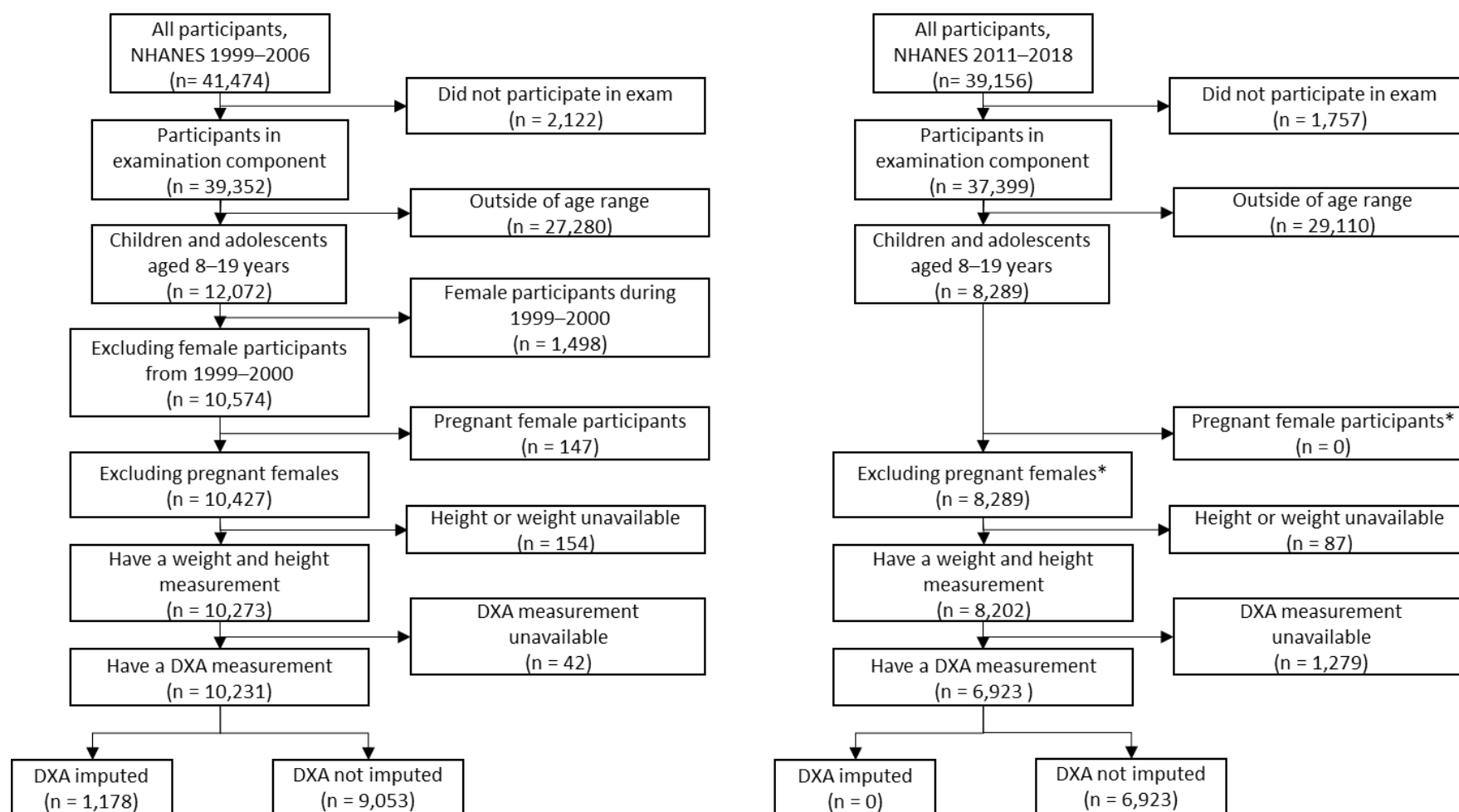


Online Supplementary Material

Changes in adiposity among children and adolescents in the United States, 1999–2006 to 2011–2018

Bryan Stierman; Cynthia L. Ogden; Jack A. Yanovski; Crescent B. Martin; Neda Sarafrazi;
Craig M. Hales

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Supplementary Figure 1. Flow chart showing inclusion criteria for the current analyses using the National Health and Nutrition Examination Survey (NHANES) separated into A) 1999–2006 and B) 2011–2018. Abbreviation: DXA, dual-energy X-ray absorptiometry.

*Pregnancy status was not released for females under age 20 during 2011–2018 due to disclosure risk. Pregnant females did not have a DXA measurement and are therefore excluded as part of “DXA measurement unavailable” exclusion criteria. The percentage of pregnant females aged 8–19 is less than 1%.

Supplementary Table 1. Crude mean percentage body fat, mean fat mass index, and mean BMI among children and adolescents aged 8–19 by age group, race and Hispanic origin, and BMI category — United States, 1999–2006.¹

	Mean percentage body fat in % (95% CI)	Mean fat mass index in kg/m ² (95% CI)	Mean body mass index in kg/m ² (95% CI)
Males²			
All	25.4 (25.0, 25.8)	5.9 (5.7, 6.0)	21.8 (21.6, 22.1)
Age group			
8–11	28.1 (27.5, 28.8)	5.7 (5.5, 5.9)	19.1 (18.8, 19.4)
12–15	25.3 (24.8, 25.8)	5.9 (5.7, 6.1)	21.8 (21.4, 22.1)
16–19	22.9 (22.4, 23.4)	6.0 (5.8, 6.3)	24.6 (24.2, 25.0)
Race and Hispanic origin group			
Non-Hispanic white	25.4 (24.8, 26.0)	5.8 (5.6, 6.0)	21.6 (21.3, 22.0)
Non-Hispanic black	23.3 (22.8, 23.7)	5.5 (5.3, 5.7)	22.1 (21.8, 22.4)
Mexican American	28.0 (27.5, 28.4)	6.7 (6.5, 6.9)	22.7 (22.3, 23.0)
BMI category			
<85 th percentile	21.3 (21.1, 21.6)	4.1 (4.1, 4.2)	19.1 (18.9, 19.2)
85 th – <95 th percentile	29.7 (29.2, 30.2)	7.1 (7.0, 7.3)	23.9 (23.6, 24.1)
≥95 th percentile	36.7 (36.3, 37.2)	11.2 (11.0, 11.4)	30.1 (29.7, 30.5)
Females³			
All	33.0 (32.6, 33.4)	7.7 (7.5, 7.9)	22.1 (21.8, 22.5)
Age group			
8–11	32.1 (31.5, 32.6)	6.5 (6.3, 6.8)	19.4 (19.0, 19.8)
12–15	32.5 (31.8, 33.1)	7.7 (7.4, 8.0)	22.5 (22.1, 22.9)
16–19	34.5 (33.9, 35.0)	8.9 (8.5, 9.2)	24.5 (24.0, 25.0)
Race and Hispanic origin group			
Non-Hispanic white	32.8 (32.2, 33.4)	7.5 (7.2, 7.8)	21.8 (21.4, 22.2)
Non-Hispanic black	32.5 (32.0, 33.1)	8.3 (7.9, 8.6)	23.8 (23.2, 24.3)
Mexican American	34.8 (34.3, 35.3)	8.2 (8.0, 8.5)	22.5 (22.1, 22.9)
BMI category			
<85 th percentile	29.4 (29.1, 29.7)	5.8 (5.7, 5.9)	19.2 (19.1, 19.4)
85 th – <95 th percentile	37.1 (36.7, 37.6)	9.2 (9.0, 9.4)	24.5 (24.2, 24.8)
≥95 th percentile	43.0 (42.6, 43.5)	13.7 (13.4, 14.1)	31.3 (30.7, 31.9)

¹ For 1999–2006 time period, female data includes only 2001–2006. Estimates were calculated using examination sample weights and accounted for the survey's complex, multistage probability design. Means were averaged across imputations. Standard errors were pooled across imputations using within-imputation and between-imputation variances. Source: National Center for Health Statistics, National Health and Nutrition Examination Survey.

² Overall sample size for males for 1999–2006: n = 5,933.

³ Overall sample size for females for 2001–2006: n = 4,298.

Supplementary Table 2. Changes in mean percentage body fat, mean FMI, and BMI among children and adolescents aged 8–19 from 1999–2006¹ to 2011–2018 by age group, race and Hispanic origin, and BMI category — United States.^{2,3}

	Percentage Body Fat Change in % (95% CI)	FMI Change in kg/m ² (95% CI)	BMI Change in kg/m ² (95% CI)
Males³			
All	0.7 (0.2, 1.2)**	0.2 (0.0, 0.4)	0.3 (-0.1, 0.6)
Age group			
8–11	1.0 (0.1, 1.8)*	0.2 (-0.2, 0.5)	0.1 (-0.4, 0.5)
12–15	0.8 (0.1, 1.5)*	0.3 (0.0, 0.6)*	0.6 (0.1, 1.1)*
16–19	0.3 (-0.4, 1.1)	0.1 (-0.3, 0.5)	0.2 (-0.4, 0.8)
Race and Hispanic origin group			
Non-Hispanic white	0.5 (-0.3, 1.3)	0.1 (-0.2, 0.4)	0.0 (-0.4, 0.5)
Non-Hispanic black	0.7 (0.0, 1.5)	0.3 (-0.1, 0.6)	0.5 (-0.1, 1.1)
Mexican American	0.8 (0.1, 1.5)*	0.3 (0.0, 0.7)*	0.7 (0.1, 1.2)*
BMI category			
<85 th percentile	0.5 (0.2, 0.9)**	0.1 (0.0, 0.2)*	0.1 (-0.1, 0.2)
85 th – <95 th percentile	0.4 (-0.3, 1.2)	0.1 (-0.1, 0.3)	0.0 (-0.4, 0.4)
≥95 th percentile	0.1 (-0.6, 0.7)	0.0 (-0.2, 0.3)	0.3 (-0.3, 0.8)
Females⁴			
All	0.7 (0.2, 1.2)*	0.3 (0.0, 0.6)*	0.5 (0.2, 0.9)**
Age group			
8–11	0.3 (-0.4, 1.0)	0.0 (-0.3, 0.3)	0.0 (-0.5, 0.4)
12–15	1.0 (0.2, 1.9)*	0.5 (0.0, 0.9)*	0.8 (0.1, 1.4)*
16–19	0.7 (-0.1, 1.5)	0.4 (-0.1, 0.9)	0.9 (0.1, 1.6)*
Race and Hispanic origin group			
Non-Hispanic white	0.5 (-0.4, 1.4)	0.3 (-0.1, 0.7)	0.6 (0.0, 1.2)
Non-Hispanic black	0.1 (-0.6, 0.9)	0.0 (-0.4, 0.4)	0.1 (-0.5, 0.8)
Mexican American	1.1 (0.4, 1.8)**	0.5 (0.1, 0.9)**	0.8 (0.2, 1.4)**
BMI category			
<85 th percentile	0.5 (0.1, 0.9)**	0.1 (0.0, 0.2)	0.0 (-0.1, 0.2)
85 th – <95 th percentile	0.0 (-0.6, 0.7)	0.1 (-0.2, 0.3)	0.3 (-0.1, 0.7)
≥95 th percentile	-0.6 (-1.3, 0.0)*	-0.1 (-0.6, 0.3)	0.4 (-0.4, 1.1)

¹ For 1999–2006 time period, female data includes only 2001–2006.

² Data for 1999–2006 (2001–2006 in females) is standardized to the sex-specific, race and Hispanic origin-specific, and 6-month age-specific distributions of 2011–2018 to allow for comparison across time frames. Values calculated for percentage body fat, FMI, and BMI calculated only among participants with both DXA and BMI data. Estimates were calculated using examination sample weights and accounted for the survey's complex, multistage probability design. Mean differences were averaged across imputations. Standard errors were pooled across imputations using within-imputation and between-imputation variances. Significance testing performed using a t-

distribution with adjusted degrees of freedom. Source: National Center for Health Statistics, National Health and Nutrition Examination Survey. Abbreviation: FMI, fat mass index.

³ Overall sample size for males for 1999–2006: $n = 5,933$. Overall sample size for males for 2011–2018: $n = 3,584$.

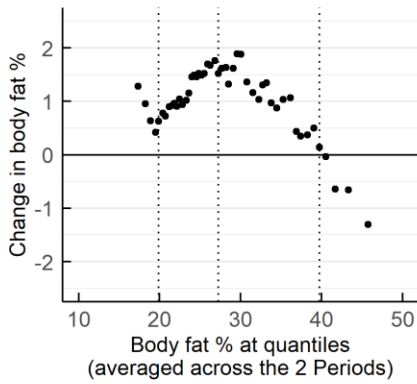
⁴ Overall sample size for females for 2001–2006: $n = 4,298$. Overall sample size for females for 2011–2018: $n = 3,339$.

* $P < 0.05$

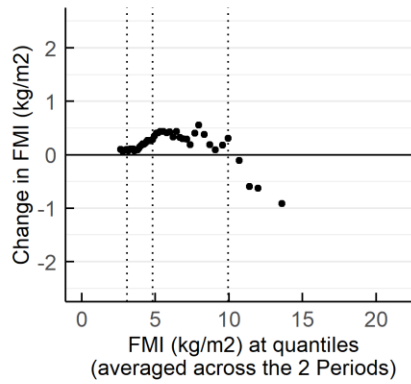
** $P < 0.01$

Males

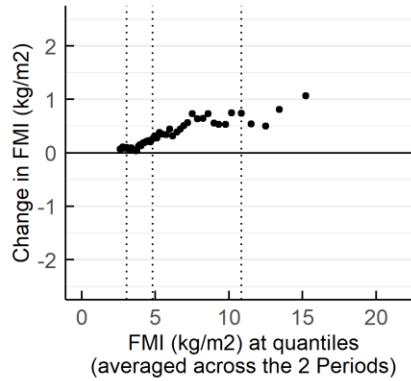
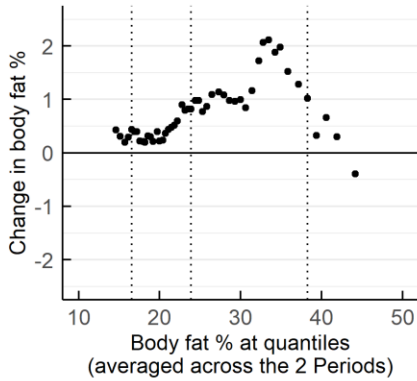
Body Fat
Ages 8 to 11 years



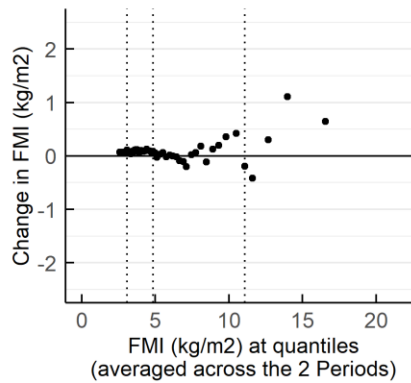
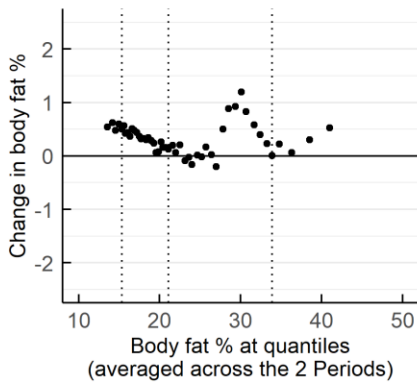
Fat Mass Index



Ages 12 to 15 years



Ages 16 to 19 years

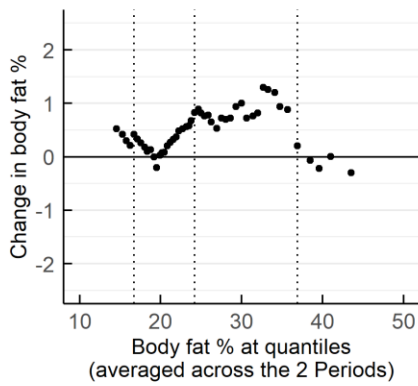


Supplementary Figure 2. Mean-difference plots for the differences in distribution of body fat percentage and FMI between 1999–2006 and 2011–2018 among males aged 8–19 years by age group. Plots show the difference for each quantile across time periods compared to the average of each quantile across time periods. For 1999–2006, imputed data was included; quantiles were averaged across imputations. Estimates were calculated using examination sample weights and accounted for the survey’s complex, multistage probability design. The 10th,

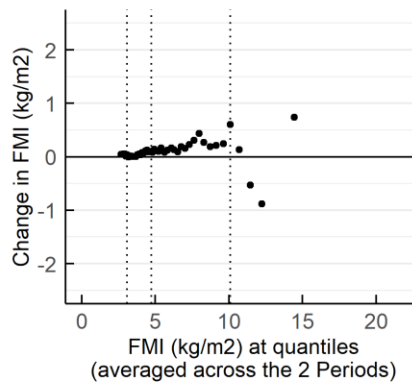
50th, and 90th percentiles are marked by dotted lines. Data for 1999–2006 is standardized to the sex-specific, race and Hispanic origin-specific, and 6-month age-specific distributions of 2011–2018 to allow for comparison across time frames. Sample sizes for 1999–2006: 1) ages 8–11 years, $n = 1,389$; 2) ages 12–15 years, $n = 2,234$; 3) ages 16–19 years, $n = 2,310$. Sample sizes for 2011–2018: 1) ages 8–11 years, $n = 1,387$; 2) ages 12–15 years, $n = 1,164$; 3) ages 16–19 years, $n = 1,033$. Source: National Center for Health Statistics, National Health and Nutrition Examination Survey. Abbreviation: FMI, fat mass index.

Males

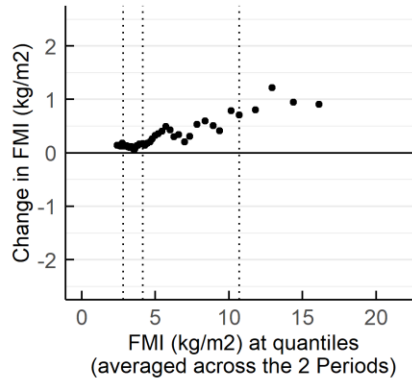
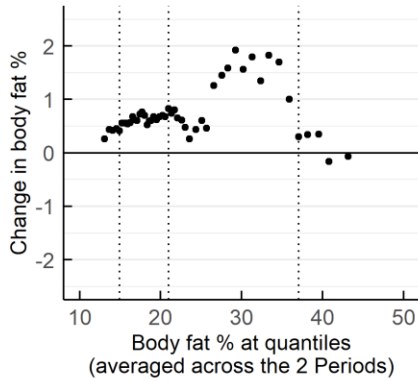
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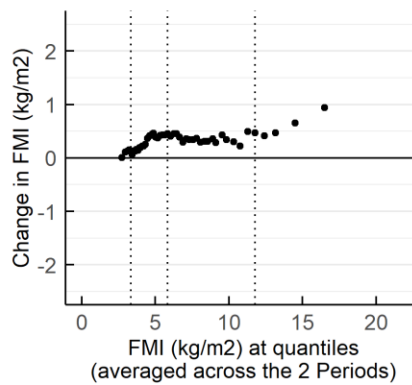
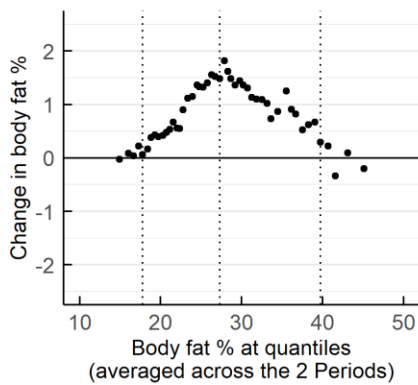
Fat Mass Index



Black non-Hispanic



Mexican American

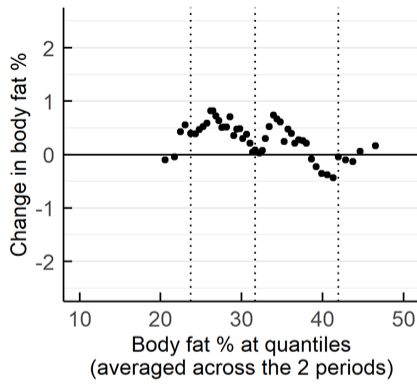


Supplementary Figure 3. Mean-difference plots for the differences in distribution of body fat percentage and FMI between 1999–2006 and 2011–2018 among males aged 8–19 years by race and Hispanic origin group. Plots show the difference for each quantile across time periods compared to the average of each quantile across time periods. For 1999–2006, imputed data was included; quantiles were averaged across imputations. Estimates were calculated using examination sample weights and accounted for the survey’s complex, multistage probability

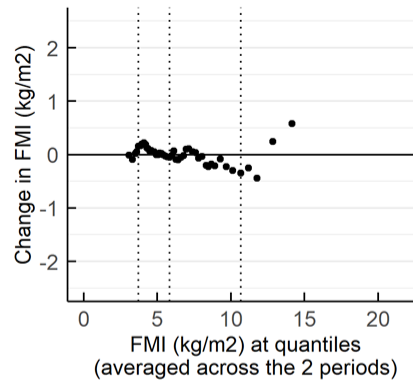
design. The 10th, 50th, and 90th percentiles are marked by dotted lines. Data for 1999–2006 is standardized to the sex-specific, race and Hispanic origin-specific, and 6-month age-specific distributions of 2011–2018 to allow for comparison across time frames. Sample sizes for 1999–2006: 1) non-Hispanic white, $n = 1,525$; 2) non-Hispanic black, $n = 1,952$; 3) Mexican American, $n = 2,004$. Sample sizes for 2011–2018: 1) non-Hispanic white, $n = 987$; 2) non-Hispanic black, $n = 897$; 3) Mexican American, $n = 717$. Source: National Center for Health Statistics, National Health and Nutrition Examination Survey. Abbreviation: FMI, fat mass index.

Females

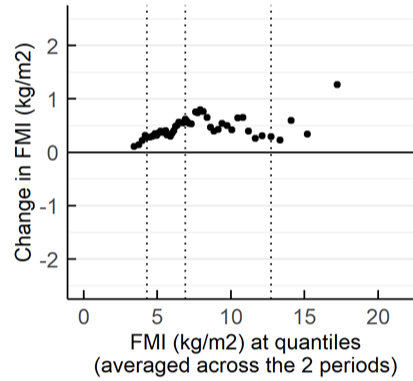
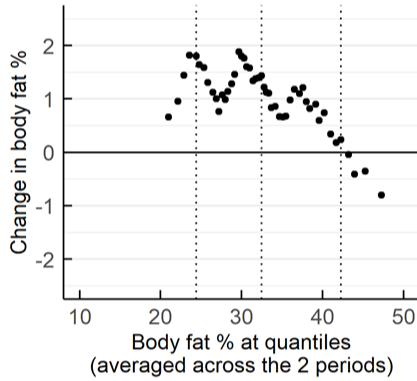
Body Fat
Ages 8 to 11 years



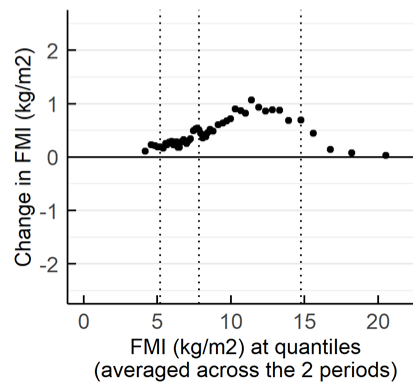
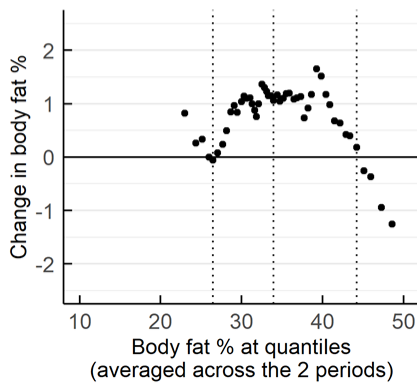
Fat Mass Index



Ages 12 to 15 years



Ages 16 to 19 years

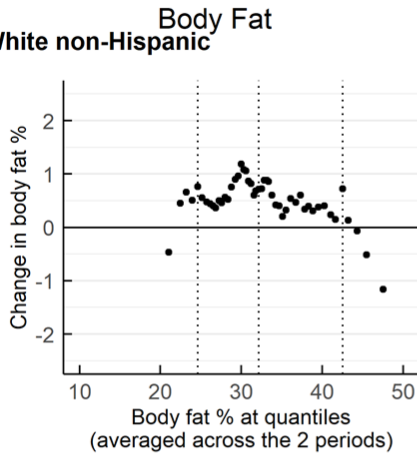


Supplementary Figure 4. Mean-difference plots for the differences in distribution of body fat percentage and FMI between 2001–2006 and 2011–2018 among females aged 8–19 years by age group. Plots show the difference for each quantile across time periods compared to the average of each quantile across time periods. For 1999–2006, imputed data was included; quantiles were averaged across imputations. Estimates were calculated using examination sample weights and accounted for the survey’s complex, multistage probability design. The 10th,

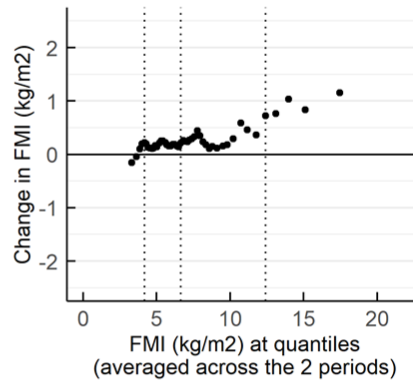
50th, and 90th percentiles are marked by dotted lines. Data for 2001–2006 is standardized to the sex-specific, race and Hispanic origin-specific, and 6-month age-specific distributions of 2011–2018 to allow for comparison across time frames. Sample sizes for 2001–2006: 1) ages 8–11 years, $n = 1,089$; 2) ages 12–15 years, $n = 1,694$; 3) ages 16–19 years, $n = 1,515$. Sample sizes for 2011–2018: 1) ages 8–11 years, $n = 1,347$; 2) ages 12–15 years, $n = 998$; 3) ages 16–19 years, $n = 994$. Source: National Center for Health Statistics, National Health and Nutrition Examination Survey. Abbreviation: FMI, fat mass index.

Females

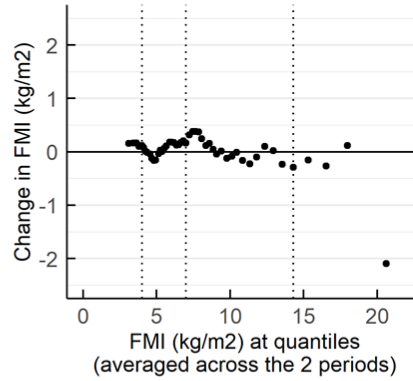
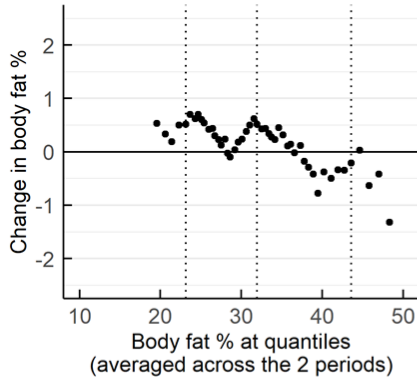
White non-Hispanic



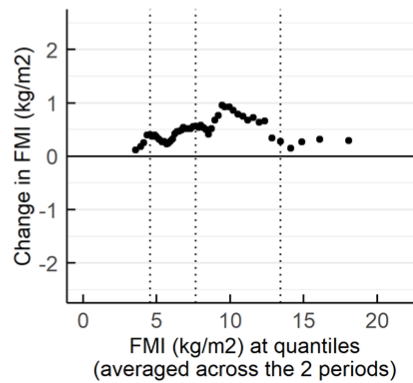
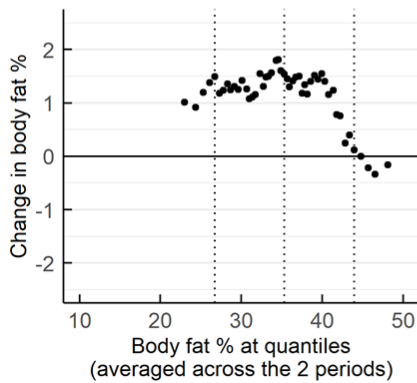
Fat Mass Index



Black non-Hispanic



Mexican American



Supplementary Figure 5. Mean-difference plots for the differences in distribution of body fat percentage and FMI between 2001–2006 and 2011–2018 among females aged 8–19 years by race and Hispanic origin group. Plots show the difference for each quantile across time periods compared to the average of each quantile across time periods. For 1999–2006, imputed data was included; quantiles were averaged across imputations. Estimates were calculated using examination sample weights and accounted for the survey’s complex, multistage probability

design. The 10th, 50th, and 90th percentiles are marked by dotted lines. Data for 2001–2006 is standardized to the sex-specific, race and Hispanic origin-specific, and 6-month age-specific distributions of 2011–2018 to allow for comparison across time frames. Sample sizes for 2001–2006: 1) non-Hispanic white, $n = 1,191$; 2) non-Hispanic black, $n = 1,392$; 3) Mexican American, $n = 1,372$. Sample sizes for 2011–2018: 1) non-Hispanic white, $n = 880$; 2) non-Hispanic black, $n = 788$; 3) Mexican American, $n = 745$. Source: National Center for Health Statistics, National Health and Nutrition Examination Survey. Abbreviation: FMI, fat mass index.