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Social Determinants of Health and Body Mass Index in American Indian/Alaska Native Children

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Abstract

Objective: To examine the associations between social determinants of health (SDOH) and prevalent overweight/obesity status and change in adiposity status among American Indian and Alaska Native (AI/AN) children.

Methods: The study sample includes 23,950 AI/AN children 2–11 years of age, who used Indian Health Service (IHS) from 2010 to 2014. Multivariate generalized linear mixed models were used to examine the following: (1) cross-sectional associations between SDOH and prevalent overweight/obesity status and (2) longitudinal associations between SDOH and change in adiposity status over time.

Results: Approximately 49% of children had prevalent overweight/obesity status; 18% had overweight status and 31% had obesity status. Prevalent severe obesity status was 20% in 6–11-year olds. In adjusted cross-sectional models, children living in counties with higher levels of poverty had 28% higher odds of prevalent overweight/obesity status. In adjusted longitudinal models, children 2–5 years old living in counties with more children eligible for free or reduced-priced lunch had 15% lower odds for transitioning from normal-weight status to overweight/obesity status.

Conclusions: This work contributes to accumulating knowledge that economic instability, especially poverty, appears to play a large role in overweight/obesity status in AI/AN children. Research, clinical practice, and policy decisions should aim to address and eliminate economic instability in childhood.

Keywords: Alaska Native; American Indian; body mass index; childhood; obesity; overweight; social determinants

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Introduction

Overweight/obesity status is an important health concern among American Indian/Alaska Native (AI/AN) peoples,[1–5] with both conditions increasingly affecting youth. Approximately 19% of AI/AN of 9th–12th grade adolescents (mean: 16 years) have obesity status, double the percentage seen in non-Hispanic White adolescents,[6] and nearly 50% of AI/AN youth 2–19 years of age have overweight/obesity status.[7–9]

Overweight/obesity status increases the risk of developing several chronic diseases, including type 2 diabetes mellitus (T2DM).[10–12] AI/AN youth have a higher prevalence of T2DM than youth from all other racial and ethnic groups,[13–15] with rates doubling from 9% in 1994 to 17% in 2004 in AIs younger than 35 years.[16] Relative to other racial and ethnic groups, AI/ANs have younger ages of onset for both overweight and obesity status, thus predisposing them to cardiovascular disease, T2DM, and other chronic conditions earlier in life.[17] Adolescents with obesity status have a 3.5 times higher risk of all-cause cardiovascular disease mortality compared to their normal-weight status counterparts.[18,19]

The foundation for life-limiting health conditions, such as overweight and obesity status, begins early in life.[20–22] Social determinants of health (SDOH), defined as ''the conditions in which people are born, grow, live, and work,''[23] influence racial and ethnic health disparities.[24–26] Neighborhood and built environment characteristics consistently account for racial and ethnic differences in prevalent overweight and obesity status, although AI/AN youth are not represented in most of these studies.[21,22]

One study reported that neighborhood socioeconomic status, physical activity, and healthy food opportunities explained all the differences in body mass index (BMI) z-scores for non-Hispanic White, Black, and Hispanic children.[27] Trauma and stress in childhood are known risk factors for overweight and obesity status,[28,29] particularly given the historical context of cultural oppression, discrimination, and colonial displacement that AI/AN peoples have faced for generations.[30] Given the disproportionate burden of overweight and obesity status among AI/AN children and adolescents, prevention efforts would be informed by greater knowledge regarding SDOH that influence these health outcomes early in life.[2,31,32]

The objective of this project was to examine the cross-sectional and longitudinal associations of SDOH with overweight and obesity in AI/AN children 2–11 years of age. This analysis takes similar approaches to previously conducted work examining the association between SDOH and overweight/obesity status in childhood and adolescence,[24,33] thus replicating results in a historically marginalized population that has not been thoroughly evaluated to date. There are two important contributions of this replication: (1) we cannot assume that results in non-Hispanic White populations are representative of historically marginalized communities such as AI/ANs and (2) replication work provides the opportunity to identify gaps in SDOH frameworks.

Little research has examined the longitudinal association between SDOH and incident overweight and obesity among AI/AN children, and cross-sectional associations were relevant to leverage the generalizability and larger sample size of the study sample. This work was guided by the Healthy People 2020 Social Determinants of Health Framework,[23,24] and provides important insight into the drivers of, and targets for, interventions addressing overweight and obesity status in AI/AN youth.

Methods

Data

This study was conducted using data extracted from a longitudinal data infrastructure that houses health status, service utilization, and treatment cost data for over 640,000 AI/ANs who live throughout the United States and represent nearly 30% of AI/ANs using services through the Indian Health Service (IHS).[34] The data infrastructure, created as part of the *IHS Improving Health Care Delivery Data Project* (''IHS Data Project''), is a synthesis of existing electronic health data from multiple IHS platforms and includes data for seven fiscal years (FYs; 2007–2013). IHS institutional review board and tribal review board approval was obtained from all relevant parties.

The IHS Data Project data infrastructure includes information for a purposeful sample of AI/ANs living in 15 IHS Service Units (hereafter referred to as project sites), which are IHS geographic classifications located throughout the United States.[35] The IHS Data Project population was selected by geographic area, rather than by random sampling, to allow investigation of important community-level factors that may influence health outcomes (*e.g.*, rural/urban, population counts, etc.). The IHS Data Project sample is comparable to the national IHS service population in terms of age and gender.[36] More information about the data infrastructure may be found in prior reports.[34]

To examine SDOH, we extracted county-level measures from the 2010 to 2014 American Community Survey (ACS),[37] Census Bureau,[38] the United States Department of Agriculture (USDA) Food Environment Atlas,[39] and the National Center for Health Statistics.[40] These data were merged with the IHS Data Project data infrastructure by county.

Study Sample

The study sample includes AI/AN children 2–11 years of age, who were IHS active users at baseline year in FY2010 and had at least one biologically plausible BMI measurement between July 1, 2012, and December 31, 2012, the follow-up period of this study. An IHS active user is a patient who obtained services at least once during the FY or the preceding 2 years (*i.e.*, FYs 2008–2009 for FY2010 active users). The follow-up period for the BMI measurements ranged from 18 to 24 months from baseline (the last day of year in 2010). This window was chosen to maximize the size of the analytic sample and to provide a minimum of 6 months between most SDOH and the follow-up BMI measurement.

We used the SAS program from CDC[41] to calculate the percentiles and z-scores for a child's sex and age-specific BMI, weight, and height based on the CDC growth charts. Extreme or biologically implausible values are flagged by the program. Among 82,065 active users 2–11 years of age in FY2010, 24,351 had at least one BMI measurement during the follow-up period. We subsequently excluded 199 children who only had biologically implausible values of BMI during the follow-up period, and 202 children who had missing data in SDOH. Thus, the study sample for the cross-sectional analysis included 23,950 AI/AN children.

For the longitudinal analysis, after excluding biologically implausible BMI measurements, we included children who had a BMI measurement at baseline and at least one BMI measurement during the follow-up period. If there were multiple BMI measurements in 2010 (baseline year) or the follow-up period, the last BMI of each period was chosen. Among the 23,950 children included in the study sample for the cross-sectional analysis, a total of 17,115 children were included in the longitudinal analysis ($n=409$ excluded due to having underweight status at baseline and $n=6426$ excluded because they had missing or biologically implausible baseline BMI measurement).

Measures

Outcomes: BMI and weight category. We calculated BMI as weight in kilograms divided by height in meters squared[10] and categorized weight category using age- and sex-specific BMI percentiles from the 2000 CDC growth charts.[42,43] Underweight status was defined as BMI <5th percentile and normal-weight status was defined as ≥5th percentile to <85th percentile.[44] For descriptive purposes (Table 1), we included the following categories for overweight and obesity status: (1) overweight status definition 1: BMI ≥85th percentile (includes overweight and obesity status); (2) overweight status definition 2: BMI ≥85th percentile, but <95th percentile; (3) obesity status definition: BMI ≥95th percentile (includes class II and class III obesity status); (4) class II obesity status definition: BMI ≥120% of the 95th percentile (includes class III obesity status); and (5) class III obesity status definition: BMI ≥140% of the 95th percentile.[45,46] Multiple classes of obesity status were used because these BMI ranges are associated with early mortality in adults.[47]

Social determinants of health. As depicted in Figure 1, we examined variables addressing multiple categories of SDOH outlined in the Healthy People 2020 SDOH Conceptual Framework: economic stability, education, health and health care, and neighborhood and built environment. Median values were used to dichotomize all SDOH because this approach provided consistency across SDOH variables, and *a priori* standardized approaches were not found on extensive review of the literature. No available variable aligned with SDOH for social and community context.

Economic stability. County-level measures of AI/AN household income were derived from 2010 to 2014 ACS data from the US Census Bureau.[37] We defined the percentage of households with a low income as the percentage with income below 139% of the federal poverty level. Dichotomous county-level economic stability variables were generated based on the percent of AI/AN households' low incomes (median = 42.5%) and the percent of AI/AN children eligible for free or reduced-price lunch (median = 49.3%).[39] Youth were identified as living in counties with values above or below the median for each measure.

Education. County-level measures of AI/AN educational attainment were derived from 2010 to 2014 ACS data from the US Census Bureau.[37] The educational attainment measure captured the percentage of adults 25 years of age and older, who did not complete high school. A dichotomous county-level variable was generated based on the percent of AI/AN adults who did not complete high school (median = 46.0%). Youth were identified as living in counties with values above or below the median.

Health and health care. All members of the sample were eligible for and received health care through the IHS. Some individuals also had health coverage, in addition to access to IHS services. Two individual-level health insurance coverage variables identified if AI/AN children had Medicaid and if they had private insurance.

Neighborhood and built environment. County-level neighborhood and built environment was approximated using the National Center for Health Statistics urban-rural classification for counties.[40] Individuals were classified as living in an urban or rural county.

Demographic variables. The IHS Data Project data infrastructure included individual-level information on age (generated from month and year of birth) and sex for all IHS users.

Statistical Analyses

Descriptive statistics were generated for participants using mean and standard deviations (SDs) for continuous variables and count and percentage for categorical variables; results were stratified by age groups and BMI category (see measures for definitions). Multivariate generalized linear mixed models were used to examine the cross-sectional and longitudinal associations of SDOH with overweight and obesity status. First, multivariate

Table 1. Sample Characteristics Stratified by Age Group and Overweight/Obesity Status Prevalence in Study Sample

				Overweight/obesity status at the follow-up period				
	Full sample, *N* (%)	Ages 2–5, *N* (%)	Ages 6–11, *N* (%)	Overweight status Definition 1,[a] %	Overweight status Definition 2,[b] %	Obesity Status,[c] %	Class II obesity status,[d] %	Class III obesity status,[e] %
Baseline all	23,950 (100)	10,100 (42.2)	13,850 (57.8)	48.7	18.1	30.6	12.0	3.9
Baseline gender								
Female	11,798 (49.3)	4933 (48.8)	6865 (49.6)	47.3	19.1	28.2	10.2	3.0
Male	12,152 (50.7)	5167 (51.2)	6985 (50.4)	50.0	17.1	32.9	13.7	4.8
Baseline age (mean 6.8 ± 3.0 years)								
2–5 years (mean 3.8 ± 1.1 years)	10,100 (42.2)	—	—	41.6	17.4	24.3	8.0	2.4
6–11 years (mean 9.0 ± 1.7 years)	13,850 (57.8)	—	—	53.9	18.6	35.3	14.9	5.0
6–7 years	4293 (17.9)	—	—	52.0	17.9	34.1	14.6	4.4
8–9 years	4678 (19.5)	—	—	55.4	18.6	36.8	15.5	5.4
10–11 years	4879 (20.4)	—	—	54.1	19.2	34.8	14.7	5.1
Economic stability								
Percent of below 139% poverty level, 2010–2014								
Counties with lower levels of poverty (≤42.5%)	11,975 (50.0)	5156 (51.1)	6819 (49.2)	47.0	17.6	29.4	11.2	3.5
Counties with higher levels of poverty (>42.5%)	11,975 (50.0)	4944 (49.0)	7031 (50.8)	50.4	18.6	31.8	12.8	4.3
Percent eligible for free or reduced-price lunch, 2009								
Counties with fewer eligible children (≤49.3%)	9740 (40.7)	4185 (41.4)	5555 (40.1)	52.8	18.5	34.4	13.8	4.6
Counties with more eligible children (>49.3%)	14,210 (59.3)	5915 (58.6)	8295 (59.9)	45.9	17.8	28.1	10.8	3.4
Educational attainment								
Percent of adults who did not complete high school, 2010–2014								
Counties below median (46.0%)	10,743 (44.9)	4593 (45.5)	6150 (44.4)	48.4	17.7	30.7	11.7	3.8
Counties above median (46.0%)	13,207 (55.1)	5507 (54.5)	7700 (55.6)	48.9	18.4	30.5	12.2	3.9
Insurance coverage at baseline (2010)								
Medicaid								
No Medicaid	10,605 (44.3)	3805 (37.7)	6800 (49.1)	47.7	18.1	29.7	11.7	3.8
Had Medicaid	13,345 (55.7)	6295 (62.3)	7050 (50.9)	49.5	18.1	31.4	12.2	4.0
Private insurance								
No private insurance	19,224 (80.3)	8390 (83.1)	10834 (78.2)	48.9	18.2	30.7	12.0	3.9
Had private insurance	4726 (19.7)	1710 (16.9)	3016 (21.8)	47.9	17.8	30.1	11.9	4.0
Neighborhood/built environment								
Rural/urban status, 2006								
Urban counties	14,955 (62.4)	6488 (64.2)	8467 (61.1)	49.5	18.0	31.5	12.7	4.2
Rural counties	8995 (37.6)	3612 (35.8)	5383 (38.9)	47.3	18.2	29.1	10.9	3.4

[a]Overweight status definition 1: BMI (kg/m^2) ≥ 85th percentile, includes obesity.

[b]Overweight status definition 2: BMI ≥85th, but <95th percentile.

[c]Obesity status: BMI ≥95th percentile, includes class II and class III obesity.

[d]Class II obesity status: BMI ≥120% of the 95th percentile, includes class III obesity.

[e]Class III obesity status: BMI ≥140% of the 95th percentile.

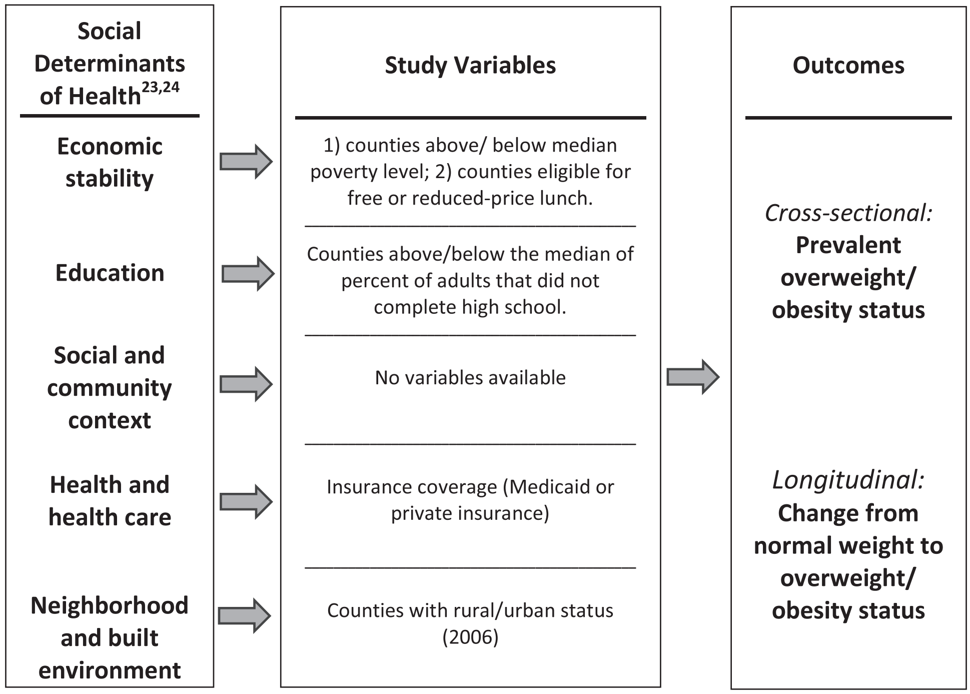

Figure 1. Study conceptual framework, informed by Healthy People 2020 Social Determinants of Health.

generalized linear mixed models were used to examine the cross-sectional association between SDOH and childhood adiposity status with county-level random effects to account for clustering of observations within counties. The primary outcome was a binary variable indicating if the child had overweight or obesity status (overweight status definition 1) during the follow-up period. Second, we used multivariate generalized linear mixed models to examine the association between SDOH and a BMI category over time.

The primary outcome in this analysis was a binary variable indicating if a child changed BMI category, from having normal-weight status at baseline to overweight or obesity status (overweight status definition 1) during the follow-up period. For all regression models, we report age-stratified models (2–5 years; 6–11 years) based on clinically relevant stages of development.[48] Adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were calculated for all regression models after adjusting for age, gender, and months between baseline and follow-up BMI measures. Statistical significance was defined as $p < 0.05$. Data were analyzed using SAS 9.4 (SAS Institute, Cary, NC). All appropriate regulatory approvals were granted (see Acknowledgments section).

Results

Table 1 shows sample characteristics presented separately by age groups and by adiposity status. Mean age at baseline was 6.8 ± 3.0 years. Approximately 48.7% of children had prevalent overweight or obesity status during the follow-up period (BMI ≥85th percentile); 18.1% had overweight status (BMI ≥85th percentile to <95th percentile), and 30.6% had obesity status (BMI ≥95th percentile). Although the prevalence of overweight status was similar across age groups (17.4% 2–5 years; 18.6% 6–11 years), prevalent obesity status was higher as children aged (24.3% in 2–5-year olds to 35.3% in 6–11-year olds).

Severe obesity status was nearly twice as common among 6–11-year olds (19.9%), compared to 2–5-year olds (10.4%). Participants with overweight or obesity status were more likely to be male, older, and reside in a county with higher levels of poverty and fewer children eligible for free or reduced-price lunch. Table 2 confirms that BMI increased from normal status to overweight or obesity status over the course of the follow-up period.

Table 3 presents cross-sectional analyses examining the association of SDOH with overweight or obesity status during the follow-up period. Results showed that female participants had lower odds of overweight or obesity status than males (OR = 0.89; 95% CI = 0.85–0.94), although this association was limited to the 6–11-year age group (OR = 0.85; 95% CI = 0.80–0.91) than the 2–5-year age group (OR = 0.95; 95% CI = 0.88–1.03).

Living in counties with higher levels of poverty was associated with higher odds of overweight or obesity status. Although this association was not statistically significant among the 2- to 5-year-old children (OR = 1.14, 95% CI = 0.84–1.55), it was significant among 6–11-year olds (OR = 1.39; 95% CI = 1.12–1.72). Compared to individuals with no health coverage other than access to IHS services, Medicaid coverage was weakly, but positively associated with prevalent overweight and obesity status (OR = 1.05; 95% CI = 0.99–1.11), particularly in 2- to 5-year-old children (OR = 1.12; 95% CI = 1.02–1.22).

Table 2. Distribution of BMI Categories in Study Population at Baseline and End of Follow-Up in Longitudinal Study (n = 17,115)

	N	BMI change from normal at baseline to overweight or obese status at the end of follow-up (%)	Baseline			End of follow-up		
			Underweight or normal-weight status (row %)[a]	Overweight status (row %)[b]	Obese status (row %)[c]	Underweight or normal-weight status (row %)[a]	Overweight status (row %)[b]	Obese status (row %)[c]
All	17115	9.9	53.0	18.5	28.5	51.6	18.2	31.2
Gender								
Female	8443	9.7	54.3	18.9	26.9	51.7	19.5	28.9
Male	8672	10.2	51.8	18.1	30.1	49.5	17.0	33.5
Age, years								
2–5	7784	11.6	58.4	18.8	22.9	57.2	18.0	24.9
6–11	9331	8.5	48.6	18.2	33.2	45.1	18.5	36.5
6–7	2942	11.2	54.1	17.4	28.5	47.6	17.3	35.1
8–9	3052	8.8	47.9	17.6	34.5	42.8	18.6	38.6
10–11	3337	5.9	44.3	19.5	36.2	45.0	19.3	35.8
Economic stability								
Percent of below 139% poverty level								
Counties below median	8570	10.6	56.0	18.1	25.9	52.1	17.8	30.1
Counties above median	8545	9.3	50.1	18.8	31.1	49.0	18.7	32.3
Percent eligible for free or reduced-price lunch								
Counties below median	6866	10.8	50.8	19.4	29.8	47.3	18.3	34.4
Counties above median	10,249	9.4	54.5	17.8	27.6	52.8	18.2	29.1
Educational attainment								
Percent of adults who did not complete high school								
Counties below median	7658	10.7	54.6	18.4	27.1	50.9	18.0	31.1
Counties above median	9457	9.3	51.8	18.5	29.7	50.3	18.4	31.3
Insurance coverage at baseline								
Medicaid								
No Medicaid	7349	9.8	54.1	17.9	28.0	50.7	18.7	30.6
Had Medicaid	9766	10.1	52.2	18.9	28.9	50.5	17.8	31.7
Private Insurance								
No private insurance	13,642	9.8	52.5	18.6	28.9	50.5	18.2	31.3
Had private insurance	3473	10.6	55.0	17.9	27.1	50.8	18.2	31.0
Neighborhood/built environment								
Rural/urban status, 2006								
Urban counties	10,977	10.4	53.5	18.1	28.4	50.2	18.0	31.7
Rural counties	6138	9.1	52.1	19.2	28.7	51.2	18.6	30.3

[a]Underweight or normal-weight status: BMI <85th percentile.

[b]Overweight status: BMI ≥85th, but <95th percentile.

[c]Obesity status: BMI ≥95th percentile.

Table 3. Cross-Sectional Adjusted Odds Ratios and 95% Confidence Intervals for Prevalent Overweight or Obesity Status (Body Mass Index ≥85th Percentile), Stratified by Age Group

	All sample (n = 23,950), OR and 95% CI	Ages 2–5 years (n = 10,100), OR and 95% CI	Ages 6–11 years (n = 13,850), OR and 95% CI
Follow-up time, months	1.02 (1.002–1.03)*	1.02 (0.99–1.04)	1.02 (0.99–1.04)
Female	0.89 (0.85–0.94)***	0.95 (0.88–1.03)	0.85 (0.80–0.91)***
Age	1.09 (1.08–1.10)***	1.08 (1.04–1.11)***	1.03 (1.01–1.05)**
Economic stability			
Percent of below 139% poverty level			
Counties with higher levels of poverty (% below 139% FPL >42.5%)	1.28 (1.05–1.57)*	1.14 (0.84–1.55)	1.39 (1.12–1.72)**
Percent eligible for free or reduced-price lunch, 2009			
Counties with more eligible children (% eligible >49.3%)	0.89 (0.73–1.09)	0.81 (0.60–1.10)	0.91 (0.74–1.13)
Educational attainment			
Percent of adults who did not complete high school			
Counties above median (46.0%)	1.09 (0.89–1.33)	1.11 (0.83–1.50)	1.11 (0.90–1.36)
Health and health care access			
Insurance coverage at baseline			
Medicaid	1.05 (0.99–1.11)	1.12 (1.02–1.22)*	1.03 (0.95–1.10)
Private coverage	0.98 (0.92–1.05)	1.01 (0.90–1.13)	0.96 (0.88–1.04)
Neighborhood/built environment			
Rural/urban status, 2006			
Rural counties	0.96 (0.78–1.17)	1.10 (0.81–1.49)	0.90 (0.73–1.12)

***$p<0.001$, **$p<0.01$, *$p<0.05$.

95% CI, 95% confidence interval; FPL, federal poverty level; OR, odds ratio.

Table 4 presents longitudinal analyses examining the association of baseline SDOH with change from normal-weight status to overweight status or obesity status over the course of follow-up. Over a mean follow-up of 21.2 months (SD = 1.7), 10% of the sample ($n = 1700$) transitioned from normal weight to having overweight or obesity status. After adjustment for demographics and follow-up time, older baseline age was found to be protective (OR = 0.91; 95% CI = 0.90–0.93). Living in counties with more children eligible for free or reduced-price lunch was protective against change from normal weight to overweight or obesity BMI category (OR = 0.89; 95% CI = 0.78–1.02); the association was stronger among 2–5-year olds (OR = 0.85; 95% CI = 0.72–0.99) than 6–11–year olds (OR = 0.89; 95% CI = 0.75–1.06).

Discussion

This article builds on accelerating work evaluating the influence of SDOH on health in youth. Important additions include addressing a historically marginalized population of AI/AN children and adolescents, a sample that is nationally representative of AI/AN IHS users, including a longitudinal approach, and identifying future areas of focus—such as systematic racism—which are likely important to include in broader SDOH frameworks. Although the negative consequences of poverty on childhood health are emphasized in the broader SDOH literature,[49–52] to the best of our knowledge, this is the first analysis evaluating the longitudinal association between multiple SDOH and overweight and obesity status in a large sample of AI/AN children from multiple sites across the United States.

Our cross-sectional findings are consistent with previously reported risk factors (male sex and older age) and prevalence estimates for overweight and obesity status in AI/AN youth.[9] While not novel in concept, the cross-sectional results were conducted to leverage the larger sample size and because, to the best of our knowledge, the IHS Data Project study sample is the largest and most generalizable for AI/AN children to date. In addition, we

Table 4. Longitudinal Adjusted Odds Ratios and 95% Confidence Intervals for Change in BMI Category from Normal-Weight Status at Baseline to Overweight or Obesity Status (Body Mass Index ≥85th Percentile) at Follow-Up, Stratified by Age Group

	All sample (n = 17,115), OR and 95% CI	Ages 2–5 years (n = 7784), OR and 95% CI	Ages 6–11 years (n = 9331), OR and 95% CI
Follow-up time, months	1.04 (1.01–1.07)*	1.03 (0.98–1.07)	1.05 (1.003–1.10)*
Female	0.95 (0.86–1.05)	0.88 (0.76–1.01)	1.04 (0.90–1.21)
Age at baseline	0.91 (0.90–0.93)***	0.89 (0.84–0.95)***	0.85 (0.81–0.88)***
Economic stability			
Percent of below 139% poverty level			
Counties with higher levels of poverty (% below 139% FPL >42.5%)	0.95 (0.82–1.11)	0.89 (0.74–1.06)	0.97 (0.80–1.17)
Percent eligible for free or reduced-price lunch			
Counties with more eligible children (% eligible >49.3%)	0.89 (0.78–1.02)	0.85 (0.72–0.99)*	0.89 (0.75–1.06)
Educational attainment			
Percent of adults who did not complete high school			
Counties above median (46.0%)	0.94 (0.83–1.06)	0.92 (0.78–1.09)	0.98 (0.82–1.17)
Health and health care access			
Insurance coverage at baseline			
Medicaid	0.98 (0.88–1.09)	0.99 (0.85–1.16)	1.00 (0.86–1.17)
Private coverage	1.12 (0.99–1.27)	1.14 (0.95–1.37)	1.11 (0.93–1.32)
Neighborhood/built environment			
Rural/urban status, 2006			
Rural counties	0.96 (0.84–1.09)	1.06 (0.89–1.27)	0.92 (0.76–1.11)

***$p < 0.001$, *$p < 0.05$.

found that economic instability (measured by county-level poverty) was positively associated with overweight and obesity status in cross-sectional analyses (2–11 years).

It is unclear why a weak positive association was found between Medicaid coverage and prevalent overweight or obesity status, or why it was more pronounced in 2- to 5-year-old children. One possible explanation is that many tribal communities are extremely rural and lack medical facilities for routine medical care. Transportation and travel time barriers may further prohibit accessing and utilizing regular medical care, regardless of Medicaid status. Our cross-sectional results align with previous studies in AI/AN children reporting socioeconomic status as one of the most significant contributors to childhood overweight and obesity status,[20] and another that found AI/AN children experiencing food insecurity were more likely to develop overweight and obesity status.[53,54]

No longitudinal association was present between economic instability (percentage of people living in poverty) and transition from normal-weight status to overweight status or obesity status in longitudinal analyses. Given that AI/ANs using IHS services are a group known to be lower income than other AI/AN populations,[55] a wider distribution of economic stability (*i.e.*, more high income users) may be needed to detect an effect. It is also possible that county-level variables do not adequately capture individual-level effects that contribute to change in adiposity status. Living in a county with more children eligible for free or reduced-priced lunch was protective of change in adiposity status from normal-weight status to overweight status or obesity status in 2- to 5-year-old children and was promising for 6- to 11-year-old children.

Programs such as the Supplementary Nutrition Assistance Program (SNAP)—an eligibility criterion for free and reduced-price lunch programs[56,57]—have been shown to be protective for change in BMI.[58] IHS users in counties with more children eligible for free or reduced-price lunch may be concurrently receiving food assistance from SNAP or other programs that improve diet quality and contribute to overweight and obesity status prevention, although we cannot be certain as the data infrastructure did not include SNAP participation variables. Tribal interventions designed to improve access to SNAP authorized stores have been shown to increase access for healthy food options for youth, especially in rural locations.[59] Thus, future interventions targeting program-level obesity status prevention strategies may be warranted.

The American Academy of Pediatrics' (AAP) policy statement on poverty and health emphasizes that poverty in childhood has lifelong effects on developmental, physical, and mental health.[49] Data from the 2018 US Census Bureau suggest that 25% of AI/ANs live in poverty, the highest poverty rate compared to all other racial and ethnic groups.[60] Although IHS facilities are available to AI/AN communities at no cost, staffing and funding for IHS services are sparse, limiting access to care.[55]

Transportation and travel time barriers may further prohibit access.[61] Because inequities for childhood obesity are pervasive, multifactorial, and exist on individual,[62] community,[52,63] population,[9,20] and built environment levels,[27] it is critical to consider broader sources of health disparities for children in marginalized communities.[64] Systematic racism, "a system of structuring opportunity and assigning value based on the social interpretation of how one looks (page 1),"[65] is a known SDOH[66] that has negative consequences for childhood health.[66–70] Nonetheless, racism is not currently incorporated in conventionally used SDOH frameworks—including the Healthy People 2020 framework.

Although systematic racism is difficult to measure, it is important to consider when evaluating SDOH and should be given careful attention when working with historically marginalized communities. A recent AAP policy statement calls for clinicians and scientists to engage with communities, advocate for policy changes, and optimize research for childhood obesity.[64] The results of this study further support these recommendations, given we found that economic instability was associated with overweight and obesity status in AI/AN children. Broadly speaking, poverty is addressable through policy changes and should be featured in the national policy agenda.[71,72] Increased funding for evidence-based programs such as the Special Diabetes Program for Indians,[73–75] tribal home visiting programs,[76] and other community-based interventions may offer culturally grounded and feasible avenues for overweight and obesity status intervention.[77,78]

This study has notable strengths and limitations. Strengths include a large sample that represents AI/AN children across multiples tribes and geographic regions in the United States, and objectively measured height and weight data from clinical facilities, which provide estimates of BMI that are stable on a population level and align with other nationally representative samples.[79] Some limitations warrant consideration. First, results are only generalizable to AI/AN IHS users, which does not include children who are not members of federally recognized tribes and who do not receive care from IHS facilities.[80]

Second, county-level SDOH variables are prone to variation based on size and diversity of the county and may not represent individual-level characteristics relevant to overweight and obesity status. Third, we lack access to SDOH variables representing social/community context (Fig. 1), which is relevant to minority communities where cultural norms and traditions are prioritized.[81] Fourth, the data infrastructure did not include risk factors or relevant lifestyle variables (*e.g.*, diet, physical activity, pubertal status).[82] Fifth, for the longitudinal analysis, our limited follow-up time (21.2 months; SD = 1.7) may have compromised our ability to detect changes in adiposity status or capture the effects of SDOH that may have longer term consequences. Finally, BMI is an indirect measure of body fat; while a commonly used "field method" and reasonable in most scenarios, it is an imperfect measure.[83]

Conclusions

This work contributes to accumulating knowledge that SDOH play a fundamental role in prevalent and incident overweight and obesity status early in life. Specifically, economic instability appears to play a large role for AI/AN children. Our results build on previously published work by using a nationally representative study sample of AI/AN IHS users, thus improving generalizability of results, including longitudinal results in a historically marginalized population, and identifying areas of future work such as including systematic racism in broader SDOH frameworks. In particular, careful attention is needed to optimize research, clinical practice, and policy decisions to address and eliminate economic instability, and to increase funding for evidence-based approaches to address the consequential health inequities in childhood.

Impact Statement

This work contributes to accumulating knowledge that SDOH play a fundamental role in overweight and obesity early in life. Specifically, economic instability appears to play a large role for AI/AN children. Careful attention is needed to optimize research, clinical practice, and policy decisions to eliminate economic instability in childhood.

Authors' Contributions

All authors approved the final article as submitted and agree to be accountable for all aspects of the work.

Dr. Fyfe-Johnson conceptualized and designed the study, contributed methodological and statistical analysis decisions, drafted the initial manuscript, and reviewed and revised the article.

Ms. Reid, Dr. Jiang, and Ms. Chang contributed methodological and statistical analysis decisions, performed statistical analyses, and reviewed and revised the article.

Dr. Jiang contributed to conceptualizing the study and statistical analysis, performed statistical analyses, and reviewed and revised the article.

Drs. Huyser, Hiratsuka, Johnson-Jennings, Conway, Goins, Sinclair, Brega, Manson, and Steiner contributed to conceptualizing the study, and reviewed and revised the article.

Dr. O'Connell contributed to conceptualizing and designing the study, provided methodological and statistical analysis contributions, drafted the initial manuscript, and reviewed and revised the article.

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Author Disclosure Statement

No competing financial interests exist.

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