BMI Status and Trends among Native American Family Members Participating in the Growing Resilience Home Garden Study

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ABSTRACT

This research reports the BMI status of 176 adults and 134 children from 96 Native American families who are participating in a randomized controlled trial to assess health impacts of home gardens. Analyses include demographic associations with BMI using a novel approach of analyzing BMI status of children and adults together as one population by using LMS-based z scores generated from NHANES data. Results fit national data, with Native Americans more likely to be overweight/obese than other US demographic groups. This, in turn, makes Indigenous communities more vulnerable to chronic diseases. Ending these health inequities requires substantial public health nutrition investments in, for example, restoration of Indigenous foodways. This trial is registered at clinicaltrials.gov as NCT02672748. *Curr Dev Nutr* 2022;6:nzac100.

Introduction

In the face of high chronic disease rates (1), the Northern Arapaho and Eastern Shoshone Nations who share the Wind River Indian Reservation (WRIR) in Wyoming are reclaiming their health, including through collaborations to restore traditional foodways and increase food sovereignty. However, published baseline data against which to assess progress are scarce. Only very few peer-reviewed studies share WRIR health status data, with 2 reports on child BMI (2, 3) and 1 from this team that summarizes health status among adults participating in this study (1). In this research report, we share BMI data for participating children and adults and analyze it using a novel LMS-based z-score approach that treats adults and children as one population (4, 5). This new method offers several advantages, including allowing direct comparison of BMI status within and among family members of all ages, assessing family responses to intervention as a whole family, and increasing sample sizes for analysis of intervention impacts. We also calculate BMI using conventional methods and compare our child BMI-status results with those reported in a previous study on WRIR child BMI published in 2008 (2).

Methods

Families were eligible to enroll in the Growing Resilience project if they lived in WRIR, had at least 1 participating family member identifying as enrolled in a federally recognized tribe, were willing to participate in 2 y of gardening and health data collection, and were interested in a home food garden but did not have one over 30 ft^2 in the previous year. Overall, 119 families who expressed interest were found to be eligible and were invited to enroll in the study. Of those, 96 families (80%) enrolled in the study immediately before their first health data collection. This report includes BMI results for the 176 adults ($\geq$20 y old, per CDC age cutoffs for BMI calculations) and 134 children in those families.

Data were collected from 3 waves of participants, 2016–2018. Researchers measured height and weight for BMI calculations (Seca 213 Mobile Stadiometer, Tanita SC-331S Body Composition Analyzer). These and other study protocols detailed elsewhere were followed (6). Each adult participant and guardian gave informed consent for themselves and their children with permission to include collective results in publications such as this one. Children aged 5 to 13 y gave verbal assent and those aged 14–17 y gave written assent. Participants chose code names and received ID numbers upon enrollment and consent to

help ensure data confidentiality. The second author, who is the Principal Investigator of this study, is responsible for data security. Results suggesting serious health concerns were flagged. Of these, those who gave permission to share their data with their tribal health agency were contacted by a community health worker and those who did not were urged to seek help from their health agency or the Indian Health Service. Each adult received a report of their personal results and those of their children. Overall results have been shared at public events in WRIR to which participants are invited and 1-page summaries have been circulated in the community and presented to tribal councils. Families participating in the study were later offered support to establish and grow a home food garden.

To analyze participant BMI status, we first used conventional methods. For children, we used the CDC growth charts to identify BMI z scores. For adults, we calculated raw BMI values (weight in kilograms divided by height in meters squared).

However, having 2 conventions prevents assessing BMI trends and intervention impacts across populations, over an individual's life course, or within households. But we wanted to be able to examine relations between BMI and age, gender, income, and education for this entire participant population of children and adults ($n = 310$). We enabled this by calculating BMI z scores for age and gender for both adults and children (using year of birth for adult age and year and month for children). To create the reference dataset to use as the growth standard (7), we used the same NHANES panel rounds that underlie the 2000 CDC Growth Charts for children, NHANES I–III (1971–1994) (8–11).

To create the growth curves, we used a parametric LMS approach ["LMS" refers to the 3 parameters of the BMI distributions to be estimated for each age and sex subgroup, where μ is the median (M), σ is the coefficient of variation (S), and λ is the skewness measure (L)]. This method accounts for skewness in the BMI reference data (12, 13). In particular, we created the BMI growth curves using state-of-the art extensions of the LMS approach. Theses statistical techniques, LMSP and LMST, add a fourth modeling parameter that allowed us to adjust not only for skewness but also for kurtosis (i.e., clustering in the tails of the distribution in the reference population data) (14). The actual LMSP and LMST parameter and the BMI centile curve estimation was implemented using the function lms() in the R package GAMLSS (R Foundation for Statistical Computing) (14). Estimations were run separately for the subsamples of 37,497 females and 32,344 males for those aged 2–90 y. This enabled us to create sex-specific BMI growth curves that we then use to construct BMI-for-age z scores that are consistent for all people aged 2 y and older. [A working paper provides more detail about this approach (5) and it has been applied to analyze BMI outcomes in Tanzania (4).]

We used this method to calculate BMI z scores for all 310 participants, of all ages. Because of the improved statistical methods used to generate these growth curves, which were not available when the CDC child growth curves were developed, the child z scores are similar but not directly comparable to conventional BMI-for-age z scores. However, they are comparable across all of the participants in this study. Thus, we could use the z scores to conduct parametric regression analysis and create nonparametric LOWESS plots to examine relations between BMI and age, gender, income, and education.

The study is registered at clinicaltrials.gov (NCT02672748). The protocol was approved by the University of Wyoming Institutional Review Board (Protocol 20150626CP00852), the Growing Resilience Community Advisory Board (CAB), Northern Arapaho Business Council, and Eastern Shoshone Business Council. The CAB also approved this manuscript.

Results

All of the 176 adults reported their gender, with 63% female and 37% male. Grouped by age by decade, adult ages were relatively evenly distributed (19–25% per category) until the 60–69 and 70+ categories (12% and <3% of participants, respectively). Of the 170 adults who identified their tribal affiliation, 44% identified as Northern Arapaho, 40% as Eastern Shoshone, 3% as both, and 13% as another tribe. The 134 children were aged 2 to 20 y (mean = 11) and 53% were female.

Using conventional BMI calculations, the vast majority of adults were overweight or obese (90%), with over one-third (36%) in obese class II or III. The mean BMI (in kg/m^2) for women was 33.4. This was not statistically different from the men's average (32.6).

Using conventional US CDC BMI-for-age z scores for the children ($\leq$20 y old), we found that less than 1% were underweight, 52% were normal/healthy weight, 14% were overweight, and 33% were obese. Girls, on average, were at a higher percentile (84.9th; mean BMI $z = 1.032$) than boys (74.9th; mean BMI $z = 0.671$).

To facilitate comparison with results of a previous study conducted with WRIR children in 2009 (2), we also calculated conventional BMI z scores for the subset of children aged 7 to 14 ($n = 44$ girls and 38 boys; total $n = 82$). Within this age group, we found lower average BMI z scores than in the total population of 134 child participants. The mean BMI z score for this subset of girls was 1.21. For boys aged 7 to 14 the mean was 0.71.

The remaining results reported below use the BMI z scores that we created for both adults and children in this study as one population ($n = 310$).

BMI z scores increased with participant age until individuals were in their 30s. Then, gender trajectories diverged, with females slightly dropping while men continued to increase (see **Figure 1**). These relations are statistically significant overall and for females ($P < 0.01$) but not quite significant for males ($P < 0.1$). When analyzed separately by gender and adult/child status, this pattern was already apparent among girls, who increasingly exceeded the BMI of their age peers in the US reference population as they reached adulthood ($P < 0.05$).

Also, among women, BMI z scores were statistically significantly inversely correlated with income ($P < 0.05$) (see all columns in **Table 1**) and with education (see column 3). However, men in this study showed no statistically significant association between these socioeconomic status variables and BMI z scores. We also found no significant relations between tribal affiliation and BMI z scores.

Discussion

Study limitations include that the data are cross-sectional, not life course, constraining interpretation of BMI-for-age findings. Also, the data come from a nonrandom sample of families. However, our study
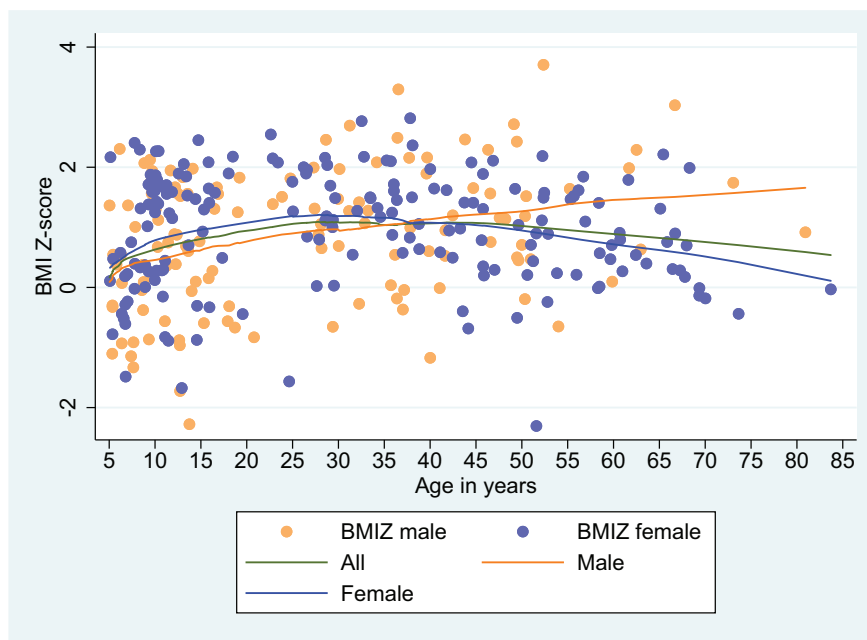
FIGURE 1 BMI *z*-score across age. BMI *z* scores increase with participant age until people are in their late 30s. Then, gender trajectories diverge, with females slightly dropping while men continue to increase. These relations are statistically significant (*P* < 0.01), with the exception of the male trend (*P* < 0.1). When re-analyzed separately by gender and by adult/child status, this pattern is already apparent among girls, who increasingly exceed the BMI of their age peers in the US reference population as they reach adulthood ages (*P* < 0.05). BMIZ, BMI *z* score.

of overall adult health status in these participants was approximately aligned with estimates reported by tribal health affiliates ([1]). Also, even if these findings are not entirely generalizable to the WRIR population at large, the high levels of overweight and obesity indicate serious public health nutrition challenges that require action. Strengths include documenting BMI data from WRIR and assessing trends by age, enabled by the novel LMS *z*-score method.

In comparison with the United States overall, obesity rates were high among adults and children, but in general in keeping with US Native American trends. That said, in contrast to national trends showing Native American boys with a higher obesity prevalence ([15]), in this population girls were heavier for their height and ages. Also, teenage girls, but not teenage boys, had higher CDC BMI *z* scores than younger children of the same sex. This suggests that it may be wise to offer some public health nutrition interventions that are tailored to reach prepubescent and teenaged girls in WRIR.

In the subanalysis of children aged 7–14 y [i.e., the ages assessed in a WRIR study conducted in 2005–2006 ([2])], the average BMI *z* score of 1.21 in girls among Growing Resilience participants (on the CDC growth charts) was identical to the average found in that earlier study. The average for boys in that age group was much lower than what that study found, 0.71 vs. 1.34. No historical BMI data are available for WRIR adults. However, this potential stabilization or even decrease in child obesity is good news.

Trends of lower BMI among higher-income women in this study mirror a general US pattern of wealthier individuals tending to be less overweight or obese, particularly among females ([16]).

Overall, the simple, yet novel, approach of analyzing BMI status of children and adults together as one population opens up enormous additional research opportunities to assess BMI associations between these and many other variables over the life course in Native American and in other communities. In particular, BMI *z*-score trends by age

TABLE 1 Regression results for independent-variable BMI *z* scores: women only[1]

Independent variables	(1)	(2)	(3)	(4)
Household income	−0.115 (0.0495)**	−0.0898 (0.0481)*	−0.381 (0.195)*	−0.352 (0.186)*
Age		−0.000756 (0.0372)		0.00504 (0.0376)
Age squared		−0.000217 (0.000385)		−0.000271 (0.000387)
Education			−0.188 (0.108)*	−0.143 (0.105)
Income × education interaction term			0.0511 (0.0339)	0.0478 (0.0323)
Observations	108	108	108	108
R^2	0.048	0.166	0.075	0.184

[1]SEs are in parentheses. ***P* < 0.01, ***P* < 0.05, **P* < 0.1.

and gender may indicate opportunities for age- and gender-specific interventions for preventing unhealthy weight gain. We plan to also use this approach to analyze intrahousehold dynamics in BMI, and other health indicators are planned with the repeated measures taken over 18 months with each family in this study.

In conclusion, no matter what approach is used to assess nutritional health status in WRIR or any other Native American community, results tend to illustrate the impacts of over 400 y of colonization strategies—including war and massacres, bison slaughter, boarding schools, and internment in reservations—designed to decimate traditional food ways and yielding enormous health disparities between Indigenous and White communities in the United States (1, 6, 15, 17–23). This study adds to the evidence of the ethical imperative and practical need to make significant investments to deepen and expand the wealth of Indigenous-led health, food, and nutrition actions for reclaiming foodways, health, and sovereignty (18, 19, 24–28). The Growing Resilience action-research project aims to help support the health and food sovereignty of WRIR communities by providing families with information for monitoring their individual health and by supporting families in improving their health by growing home food gardens.

Acknowledgments

Data Availability

WRIR data described in the manuscript will not be shared other than by request to the Northern Arapaho and Eastern Shoshone Nations. Methods and data underpinning the BMI z-score approach will be made available upon request.

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