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Understanding Correlates of Physical Activity in American Indian Families: The Healthy Children Strong Families-2 Study

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Abstract

BACKGROUND: Little is known about factors contributing to physical activity (PA) in American Indian (AI) populations. Addressing this gap is paramount as sedentary activity and obesity continue to increase in this population. The purpose of this study was to determine factors associated with PA among AI families with young children.

METHODS: Adult (n=423) and child (n=390) height and weight were measured, and surveys assessed demographics, PA, stress (adult only), sleep, and screen time. Separate multivariate logistic regression models were constructed for adults and children (reported as adjusted odds ratios, aORs).

RESULTS: For adults, age (aOR=0.952; $p \leq 0.0001$), TV viewing (aOR=0.997; $p=0.01$), and computer use (aOR=0.996; $p=0.003$) decreased odds of being active. For children, high adult activity (aOR=1.795; $p \leq 0.01$), longer weekday sleep (aOR=1.004; $p=0.01$), and family income > $35,000 (aOR=2.772; $p=0.006$) increased odds of being active. We found no association between adult PA with stress or adult sleep or between child PA with BMI and screen time.

CONCLUSIONS: Given the complexity of the factors contributing to obesity among AI families, multigenerational interventions focused on healthy lifestyle change such as decreasing adult screen time and increasing child sleep time may be needed to increase PA within AI families.

BACKGROUND

Obesity is a major public health concern in American Indian (AI) communities. From 1998 to 2011, AI obesity prevalence increased 4.79% with an average annual increase of 1.4%.[1]

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Trial Registration
This study is registered at www.clinicaltrials.gov (NCT01776255; Healthy Children, Strong Families: American Indian Communities Preventing Obesity).

Moreover, Indian Health Service national data indicates that AI adults have higher obesity prevalence than their White counterparts (34.7% vs 22.1%), respectively.[2]

In non-AI populations, sedentary activity is consistently associated with obesity.[3–9] It is estimated that only approximately 20–27%[10,11] of AI adults engage in regular physical activity (PA). AI child data shows similar trends, with only 30% meeting the 2008 PA Guidelines for Americans.[12]

Sleep has been identified as a PA predictor for both children and adults. Children with later bed times engage in less moderate-to-vigorous physical activity (MVPA) compared to children with earlier bed times,[8,13,14] even when sleeping later in the day.[15] Children late to bed and late to rise have 48 minutes more screen time per day compared to those early in bed and early to rise.[16] In adults, high sleep quality contributes to less fatigue[17] and is a significant PA predictor.[17,18] Low PA has been linked to daytime sleepiness and chronic fatigue in adults.[19–21] While these relationships have been examined in the general population, no studies exist that examine the association between sleep and PA in AI children or adults.

Another poorly understood adult PA predictor is stress. To our knowledge, interventions in AI communities to increase PA have not assessed stress. One cross-sectional study with Yup'ik Eskimos assessed correlates of PA with stress as a predictor variable, reporting an association between higher PA and lower stress.[22] Two PA interventions have assessed the impact of stress. Dougal et al.[23] randomized college students to an intervention designed to encourage fitness center use and found that those with low stress engaged in higher PA, while another intervention used e-counseling to increase PA and reported an inverse association between high stress and low PA.[24] Although these interventions report similar findings, cross-sectional research reports conflicting findings that appear to be dependent on the population. For instance, plant workers were found to have an inverse association between PA and stress[25] while no association was found between these variables for Diabetes Prevention Program participants[26]. Moreover, studies suggest an interaction between stress and low PA that is dependent on race,[27] which has implications for this work with AI populations. To our knowledge, no studies have examined how stress impacts PA in AI adults.

Few cross-sectional studies have assessed correlates of PA in AIs. PA has been used as a predictor, but most AI studies target obesity as the primary outcome.[28–34] The majority of studies assessing PA were conducted in First Nations communities in Canada,[35–38] and the few available studies examining AI PA have been exclusive to either children or adults, but not both.[3,28,39,40] One exception was a study that included AI children, parents, and grandparents that was limited to bivariate associations between PA, body composition, and screen time variables.[40]

The objective of this study was to examine factors that contribute to PA in a sample of AI family dyads (one child and one adult) using a model that considered the novel covariates sleep and stress to better inform obesity and chronic disease prevention. Healthy Children Strong Families 2 (HCSF2) is a novel healthy lifestyles and obesity prevention randomized trial that was conducted in five tribal communities nationwide. Participants included 450 adult and child (ages 2–5 years) dyads from rural and urban communities. The study sample is noteworthy as few studies have included both urban- and rural-based families concurrently. Moreover, the included communities spanned five states and ranged in population density from 3.5 to 3,000 people per square mile, indicating the diversity of the study sites. Communities with whom the researchers were currently working or where they had close relationships with community members or the wellness staff were approached to participate. Variables associated with PA in AI children and adults were examined, including the novel obesity risk factors stress and sleep. We hypothesized an inverse relationship between BMI, adult age, screen time, and stress (adults only) with PA in adults and children. We also hypothesized that sleep would have a positive association with PA in all participants.

METHODS

Participants

This cross-sectional study was based on adult and child data collected at baseline in the HCSF2 families. HCSF2 has been described in detail elsewhere.[41] Adult and child (2–5 years) dyads were recruited by community coordinators in five tribal communities (4 rural and 1 urban) across the country. Institutional review board (IRB) approvals were obtained from the University of Wisconsin, participating tribal councils, and where applicable, tribal IRBs.

Physical activity

Adults.—Adult PA was assessed with the Godin-Shepard Leisure-time Physical Activity Questionnaire (GSLTPAQ).[42] Respondents indicated the number of times per week they engaged for more than 15 minutes in the following activity categories: strenuous, moderate, and mild exercise. MVPA was calculated by equation: (9 * strenuous exercise times/week) + (5 * mild exercise times/week).[42] A binary variable was created and coded as follows: 0=low PA (≤23 units; n=233), and 1=high PA (≥24 units; n=190).[43]

Children.—Child PA was assessed with the Netherlands Physical Activity Questionnaire (NPAQ).[44] The NPAQ contains 7 questions in which caregivers choose between options that best describe their child in relation to activity and play scenarios (e.g., prefers vigorous games vs. prefers quiet games). A higher score on this measure represents higher PA. A binary variable was created and coded as follows: 0 = low PA (≤21 units; n=105), and 1=high PA (≥22 units; n=345).[44]

Body composition

Adults and children were measured in light clothing without shoes. Height was measured twice with a SECA stadiometer to the nearest 0.1 cm and averaged. Weight was measured twice with a digital scale to nearest 0.1 kg and averaged. BMI was calculated as kg/m^2. Child BMI was converted to percentiles using age- and sex-specific parameters.[45]

Additional survey measures

Adult and child demographics (e.g., race, age, income) were collected via questionnaire. Screen time was assessed with a survey developed by the HCSF2 research team to determine from the previous day (1) total minutes spent watching television, (2) total minutes spent using a computer, and (3) total minutes spent playing video games. Separate questionnaires were used to assess adult and child screen time. Child computer and video game use was not asked because they were under 5 years old and logged minimal time with these devices. A 6-item sleep questionnaire was developed by the HCSF2 research team based on the Child Sleep Habits Questionnaire[46,47] for children and the Pittsburg Sleep Quality Index[48] for adults. Questions were asked for both children and adults about weekday and weekend bed time, wake time, time it takes to fall asleep, and if participants slept longer on the weekends. Adult stress was assessed with the 10-item Perceived Stress Scale.[49]

Data analysis

The adult data contained 423 observations (28 cases that were excluded due to pregnancy). Ten observations were missing for income and 1 observation for physical activity and weekday and weekend sleep. The child data was missing 1 observation for BMI percentile and 2 observations for weekday and weekend sleep.

Descriptive statistics (mean±SD) were used to summarize all variables. Separate regression models were constructed for both children and adults with PA as the dependent variable. Predictors included TV viewing, computer use, and video game use (adult only), BMI, weekday and weekend sleep, income, education, adult age, PA, and adult stress. Physical activity, income and education were treated as categorical variables. All others were treated as continuous variables. Separate predictors were adjusted in each adult and child model (Tables 2 and 3). Gender was not used as a predictor in the adult model because 94% of the sample was female.

Bivariate logistic regression models were fit to determine inclusion of each predictor into the multivariate model. All predictors significant at $p \leq 0.10$ were included in the multivariate model(s). Significance for the multivariate logistic regression models was set at $p \leq 0.05$. Results are reported separately for adults and children using adjusted odds ratios (aOR). R 3.3.0 was used for all analysis (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Demographics

Table 1 shows descriptive results for adults and children. The baseline sample included 423 adult participants. Out of 423 adults, 344 (81.3%) self-reported as AI and 398 (94.0%) as female with a mean age of 31.6±8.5 years. Mean adult BMI was 32.0 kg/m^2 (obese), with 74 (17.4%) participants classified as normal weight, 99 (23.4%) as overweight, and 247 (58.3%) as obese. Self-reported adult PA indicates 190 (44.9%) were active, 68 (16.0%) moderately active, and 165 (39.0%) sedentary.[42] Overall, adults in this sample reported that 55% were engaged in insufficient or moderate activity, spent an average of 3.2 hours engaged in screen time, and slept an average of 8.2 hours per night (data not shown).

The baseline sample included 450 children. Out of 450 children, 390 (86.6%) were identified as AI and 226 (50.2%) as female with a mean age of 3.3±1.1 years. Mean child BMI percentile was 70.7% (normal weight), with 8 (1.8%) classified as underweight, 263 (58.6%) as normal weight, 80 (17.8%) as overweight, and 98 (21.8%) as obese. Adults reported that 202 (44.9%) children had high activity and 247 (50.0%) had low activity.[44]

Adult PA correlates

The bivariate and multivariate adult models are reported in Table 2. After adjusting for all variables in the model, the results show a one-year increase in age decreased odds of being active by 4.7% (aOR=0.952; 95% CI=0.928–0.976; $p \leq 0.0001$), every one-minute increase in TV viewing decreased odds of being active by 0.22% (aOR=0.997; 95% CI=0.995–0.999; $p=0.01$), and every minute of computer use decreased odds of being active by 0.35% (aOR=0.996; 95% CI=0.993–0.998; $p=0.003$).

Children's PA correlates

The bivariate and multivariate child models are reported in Table 3. After adjusting for all variables in the model, the results show that high adult activity increased odds of being active by 79.5% (aOR=1.795; 95% CI=1.133–2.882; $p \leq 0.01$), every one minute of sleep during the weekday increased odds of being active by 0.46% (aOR=1.004; 95% CI=1.001–1.008; $p=0.01$), and children that have a caregiver with an income >$35,000 had increased odds of being active by 177.2% (aOR=2.772; 95% CI=1.353–6.010; $p=0.006$).

DISCUSSION

Our results from a sample of AI adults and children from multiple communities across 5 states show that child PA levels in 2–5 year old children are highly correlated with adult PA, income, and the child's sleep habits. Adult PA was correlated with screen time (TV and computer use) and age. However, we did not find an association of adult PA with stress or adult sleep as hypothesized. This finding may be due to a lack of sensitivity of the self-report surveys used or related to the finding that adults were obtaining adequate amounts of sleep per national recommendations (Ingram et al, *in press*). This paper is the first to report PA correlates in AI children and their adult caregivers that included the covariates sleep and stress, which are understudied risk factors for obesity. Moreover, the inclusion of adult/child dyads allows a unique perspective on family-level predictors of PA.

The multivariate adult model revealed that age and screen time was inversely associated with PA, supporting the study hypothesis. A systematic review reported negative associations between PA and age in AIs,[7] while other studies report that steps per day decreases as age increases.[9] In general, younger AI adults have higher PA levels compared to older AI adults,[4,9,50] similar to our study. Screen time is inversely associated with the attainment of 10,000 steps per day,[51] and each additional hour of TV viewing is associated with 8.6 less PA minutes per week.[52] Thus, our adults spend the majority of time engaged in sedentary activity, which may partially explain why 81.3% of our adult study participants were overweight or obese.

Our data support the study hypothesis that sleep and PA are positively associated in children. The literature in this area show mixed results. Aligning with our study, Khan et al.,[53] found that longer sleep duration was associated with higher self-report PA. Other studies report that later bed times, later rise times, and sleeping 60 minutes more than the average is associated with less MVPA.[8,13–15] The conflicting results in these studies may be attributed to the study locations (e.g., Estonia, Sweden, U.S., Australia, etc.), protocol (cross-sectional vs intervention), and the variation in the age of children. To our knowledge, this is the first study to report sleep patterns in AI children age 2–5 years from multiple tribal communities across the United States. It appears that sleep may play a significant role in PA with AI children in this age group, but more work is needed to understand other dimensions of sleep (sleep quality, sleep disorders, etc.) and interventions to enhance sleep quality.

Parents (and other caregivers) have the greatest influence on instilling healthy behaviors, which may explain the association between adult PA and child PA in our study. Physically active parents influence the amount of MVPA bouts in their children,[54] and parental support for PA may help children be more physically active.[37]

In addition, our study found that adult income was significantly associated with PA. In other studies, results are mixed with income showing no association[55] and others a positive association with PA.[56] The three significant factors in the child model (sleep, active adult, and high income) are all factors related to the home-environment, reinforcing the notion that PA opportunities stem from the family. Children who observe their parents being physically active may be encouraged to live a similar lifestyle. Accordingly, parents who put their children to bed at an early hour ensure they get sufficient rest and are energized the next day. Collectively, these findings support the rationale to increase caregiver PA and encourage families to ensure their children are getting adequate rest.

BMI and screen time were not associated with child PA, which did not support our hypotheses. Surprisingly, studies assessing correlates of PA in First Nations children (none exist in AI children) have not examined BMI or screen time as a covariate in regression models.[35,36,38] Early childhood is a vulnerable period for the development of diet- and activity-related behaviors,[57,58] but these children may still be too young for screen time and weight to significantly impact daily PA. In fact, a recent study demonstrated no effect of adherence to screen time, sleep, or physical activity guidelines on weight status among preschool children.[59] Moreover, the use of parent-report survey data to assess screen time and physical activity in our sample may have contributed to the lack of relationship, as the screen time levels reported in our study were relatively low compared to other reports of Indigenous children.[60] More longitudinal research is needed to understand the relationships among these variables for young AI children and the contribution of other factors, such as current or historical trauma.

In adults, sleep, BMI, and stress did not have any association with PA. In other studies, high sleep quality (suggestive of sufficient sleep) is predictive of high PA,[17,18] whereas daytime sleepiness (suggestive of insufficient sleep) is predictive of low PA.[19,20] Determining the effect that sleep has on PA may involve assessing both sleep quality and sleep quantity, and may explain our non-significant findings as we only analyzed one aspect of sleep (i.e., sleep quantity).

Stress has never been assessed as a PA covariate in AI adults. However, stress and historical trauma have been shown to have significant negative impacts causing a wide range of current problems in AI communities, such as high rates of chronic disease and suicide, which further compound trauma.[61–65] In the general United States population, studies report an inverse association between stress and PA,[24,25] others report a positive association,[23] and others report no association.[26] The conflicting findings may be attributed to different measurement techniques and the inclusion of non-AI participants, which demonstrate the need for more research with AIs in this area and a closer examination of the role of current stress and historical trauma on physical activity levels and other obesity risk factors. Moreover, future research may benefit from objective measures of sleep and stress to better understand the effect these factors have on PA in AI adults.

Strengths and Limitations

There are two major strengths of our study. First, we recruited a diverse sample of 450 adult and child family dyads from five rural and urban AI communities in five different states. The adults and children were recruited concurrently, and child participants were in an age group typically excluded from the PA literature. Second, we collected data on novel covariates related to PA and obesity, namely, sleep and stress. We were limited in our data collection to self-report measures; this method of data collection presents risk of self-report bias, but the use of self-report measures over direct measurement (e.g., accelerometry) was appropriate to alleviate the burden on the participants as these data were collected as part of a larger RCT (Healthy Children, Strong Families 2). Although the adult and child sleep surveys used in this study were based on validated surveys, neither the adapted sleep surveys nor the screen time questionnaires used in our study were validated in this population. This represents another potential limitation, and the use of the self-report surveys may partially explain the lack of relationship between these variables and adult and child PA in our sample.

Conclusion

This study assessed PA correlates in adult/child dyads from five AI communities across the nation. Low adult PA was associated with one unit increases in age (years), TV viewing (minutes), and computer use (minutes). High child PA was associated with high caregiver activity, increased weekday sleep (minutes), and having a caregiver that earned >$35,000. These cross-sectional findings contribute to a greater understanding of PA correlates in this population and may contribute to intervention design in future studies. Collectively, these results suggest family-based interventions focused on healthy lifestyle change may be important in AI communities.

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Table 1.

Baseline characteristics of American Indian adults and children participating in the Healthy Children Strong Families 2 study (n = 423).

	Number	Percent
Adults		
Race		
American Indian	344	81.3
Other*	79	18.6
Gender		
Female	398	94.0
Male	25	5.9
Mean Age (sd)	31.6 (8.5)	
Income		
< $5,000	125	29.5
$5,000 to $19999	117	27.6
$20,000 to $34,999	98	23.1
> $35,000	83	19.6
Education		
High School Equivalent or Less	155	36.6
Some college or Associate Degree	227	53.6
College or Post Graduate Degree	41	9.6
Body Mass Index (BMI)		
Underweight	3	0.7
Normal Weight	74	17.4
Overweight	99	23.4
Obese	247	58.3
Mean BMI (sd)	32.0 (7.8)	
Mean Body Weight (kg) (sd)	85.4 (22.4)	
Physical Activity (PA)		
Insufficient Activity (<14 units)	165	39.0
Moderately Active (≥14 & ≤24 units)	68	16.0
Active (>24 units)	190	44.9
Mean PA Score (sd)	24.8 (25.6)	
Children		
Race		
American Indian	390	86.6
Other*	60	13.3
Gender		
Female	226	50.22
Male	224	49.78

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	Number	Percent
Mean Age (sd)	3.3 (1.1)	
BMI Percentile		
Underweight	8	1.8
Normal Weight	263	58.6
Overweight	80	17.8
Obese	98	21.8
Mean BMI Percentile (sd)	70.7 (27.0)	
Mean Body Weight (kg) (sd)	17.4 (4.2)	
Physical Activity		
Insufficient Activity (≤14 units)	6	1.3
Moderately Active (>14 - ≤21 units)	99	22.0
Active (>21 units)	345	76.7
Mean PA Score (sd)	24.0 (3.7)	

*Hispanic/Latino, Native Hawaiian/Pacific Islander, White, and Asian

Table 2.

Correlates of physical activity in American Indian adults participating in Health Children Strong Families study.

Adult Physical Activity	Unadjusted OR*	95% Confidence Interval			*p*-value	Adjusted OR**	95% Confidence Interval			*p*-value
Age										
	0.958	**(0.935**	**-**	**0.982)**	**<0.001**	**0.952**	**(0.928**	**-**	**0.976)**	**0.0001**
Race										
Other[1]	1 (referent)					N/A				
American Indian	0.751	(0.452	-	1.232)	0.26					
Body mass index										
	0.975	**(0.950**	**-**	**1.000)**	**0.05**	0.983	(0.957	-	1.009)	0.22
Television viewing										
	0.997	**(0.996**	**-**	**0.999)**	**0.01**	**0.997**	**(0.995**	**-**	**0.999)**	**0.01**
Computer use										
	0.996	**(0.993**	**-**	**0.998)**	**0.004**	**0.996**	**(0.993**	**-**	**0.998)**	**0.003**
Video games										
	1.001	(0.998	-	1.004)	0.26	N/A				
Weekday Sleep										
	0.998	(0.996	-	1.000)	0.23	N/A				
Weekend Sleep										
	0.999	(0.997	-	1.001)	0.56	N/A				
Perceived Stress										
	1.019	(0.989	-	1.051)	0.21	N/A				
Yearly income										
< $5,000	1 (referent)					N/A				
$5,000 to $19999	1.170	(0.706	-	1.943)	0.54					
$20,000 to $34,999	0.886	(0.518	-	1.511)	0.65					
> $35,000	0.943	(0.538		1.649)	0.83					
Education										
High school equivalent or less	1 (referent)									
Some College or Associate Degree	**0.682**	**(0.451**	**-**	**1.030)**	**0.06**	0.668	(0.430	-	1.036)	0.07
College Degree or post-graduate	1.467	(0.735	-	2.982)	0.28	1.608	(0.768	-	3.444)	0.21

* Unadjusted odds ratio (*p*-value significant at α ≤0.10 to be included in the full model; **Bold** indicates a significant odds ratio)

** Adjusted odds ratio (*p*-value significant at α ≤0.05; **Bold** indicates a significant odds ratio)

N/A = not applicable as variable not included in the final model

[1] Other = Hispanic/Latino, Native Hawaiian/Pacific Islander, White, and Asian

Table 3.

Correlates of physical activity in American Indian children participating in the Healthy Children Strong Families study.

Children Physical Activity	Unadjusted OR*	95% Confidence Interval			p-value	Adjusted OR**	95% Confidence Interval			p-value
Adult Physical Activity										
Low Physical Activity	1 (referent)									
High Physical Activity	**1.787**	**(1.140**	**-**	**2.839)**	**0.01**	**1.795**	**(1.133**	**-**	**2.882)**	**0.01**
Race										
Other[1]	1 (referent)									
American Indian	1.111	(0.575	-	2.044)	0.74					
Gender										
Females	1 (referent)									
Males	1.437	(0.927	-	2.241)	0.11					
Body Mass Index										
	0.999	(0.991	-	1.007)	0.94					
Weekday Sleep										
	1.003	**(1.000**	**-**	**1.007)**	**0.03**	**1.004**	**(1.001**	**-**	**1.008)**	**0.01**
Adult Age										
	0.984	(0.960	-	1.010)	0.23					
Yearly Income										
< $5,000	1 (referent)									
$5,000 to $19999	0.882	(0.506	-	1.534)	0.65	0.952	(0.540	-	1.678)	0.86
$20,000 to $34,999	1.070	(0.583	-	1.989)	0.82	1.273	(0.680	-	2.418)	0.45
> $35,000	**2.255**	**(1.121**	**-**	**4.804)**	**0.02**	**2.772**	**(1.353**	**-**	**6.010)**	**0.006**
Adult Education										
High school equivalent or less	1 (referent)									
Some College or Associate Degree	0.977	(0.614	-	1.545)	0.92					
College Degree or post-graduate	2.135	(0.899	-	5.925)	0.11					

*Unadjusted odds ratio (*p*-value significant at alpha ≤0.20 to be included in the full model; **Bold** indicates a significant odds ratio)

Adjusted odds ratio (*p*-value significant at alpha ≤0.05; **Bold indicates a significant odds ratio)

N/A = not applicable as variable not included in the final model

[1]Other = Hispanic/Latino, Native Hawaiian/Pacific Islander, White, and Asian