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Sleep and Physical Activity Patterns in Urban American Indian Children

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Abstract

Objectives: The purpose of this study was to examine patterns of obesity, physical activity (PA), sleep, and screen time in urban American Indian (AI) youth in the 6^{th}-8^{th} grade.

Methods: A youth sample (N = 36) from 3 middle schools was recruited to participate in this observational sample of convenience. Youth completed a demographic and screen time survey, measurements of height and weight, and wore a wrist accelerometer continuously for 7 days to objectively assess PA and sleep.

Results: Approximately 42% of participants were overweight or obese. Average weekday screen time was 254.7±98.1 minutes. Compared to weekdays, weekend sedentary activity increased (weekday, 159.2±81.1 minutes vs weekend, 204.3±91.7 minutes; p = .03) and vigorous PA (weekday, 20.9±19.1 minutes vs weekend, 5.7±8.1 minutes; p = .0001) and moderate-to-vigorous PA (weekday, 192.65±62.3 minutes vs weekend, 141±71.7 minutes; p = .002) decreased. Compared to weekdays, weekend total sleep time (weekday, 512.8±48.6 minutes vs weekend, 555.3±84.3 minutes; p = .007) and time in bed (weekday, 487.3±49.6 minutes vs weekend, 528.6±71.2 minutes; p = .01) increased.

Conclusions: Weekday to weekend shifts in PA and sleep must be considered when designing targeted obesity prevention interventions.

Keywords

urban American Indian; obesity; physical activity; sleep

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Human Subjects Statement
This study was approved by the University of Montana Institutional Review Board, the school district superintendent, Indian Education Department (IED), and each middle school principal.

Conflict of Interest Statement
All authors of this article declare they have no conflicts of interest.

There is abundant evidence that overweight and obesity (OWOB) in American Indian (AI) youth is a major public health concern. In the general US population, 35.1% of youth are OWOB.[1] By comparison, 56% of AI children ages 5-17 years were reported to be OWOB in Montana and Wyoming tribal communities.[2] Another large survey of 11,538 Northern Plains tribal youth ages 5-17 reported 75% OWOB.[3]

Although rural AI youth demonstrate high OWOB prevalence, OWOB is relatively unknown in urban AI youth. Current research on urban AI youth is predominately focused on the Midwest region, where the OWOB burden ranges from 45.2% to 63%.[4–9] Accordingly, OWOB differs between girls and boys. For instance, studies of urban AI youth show OWOB ranges between 54%-66% in boys and 36.5%-60.6% in girls.[4,7] The high OWOB prevalence in urban AI youth underscores the need to further understand this high-risk, understudied population.

Systematic reviews show that physical inactivity and high screen time use are strong contributors to OWOB.[10–14] Research in Indigenous children shows that boys engage in 3.27 hours and girls in 2.65 hours of daily screen time.[10] NHANES data reports that 41.3% of children in the general population spend at least 2 hours engaged in daily screen time.[11] Accordingly, screen time is a major contributor to sedentary activity and consequently, contributes to rising OWOB rates.

Studies assessing PA patterns in AI youth are limited to tribal communities. A systematic review reports that only 26.5% of AI youth reported meeting PA recommendations, whereas 37.2% are inactive.[12] Self-report PA by AI youth in rural and urban Oklahoma indicates they spent 4.4±3.8 hours per week in moderate-to-vigorous PA (MVPA), and approximately 32% met PA recommendations.[4] Most studies with objective PA measures were done in Southwest rural communities with pedometers, which only measure step counts. Pima children (age 8-12 years) reported 4139.5 steps per day,[13] far below the recommended 12,000 steps/day for girls and 15,000 steps/day for boys.[14] Another study in the Southwest reported 11,891 steps/day for 11-year-old youth.[15] Objective PA measures in urban AI youth are not available.

Several studies report overall PA patterns[12] and PA comparisons between sex in the general population.[16–18] However, objective PA between AI boys and girls is limited to one pedometer study. Southwestern AI youth in the 6th grade (mean age 11.2 years) reported 12,621 and 11,640 average daily steps for boys and girls, respectively (981 step difference);[15] this difference aligns with reports from the general population suggesting boys are more active than girls.[16–18]

Another literature gap relates to weekday to weekend sleep and PA differences. Studies in the general population show that youth that go to bed later are less active and have higher odds of OWOB.[19–25] The only study of Indigenous youth on these variables assessed PA but not sleep. Tomlin et al[26] conducted a study with First Nations youth in British Columbia in grades 4-12 (mean age 12.4 years) and measured PA with accelerometer and found that youth engaged in 46.3 min less MVPA on weekend days compared to weekdays. Other studies in non-AI populations show this same trend.[17]

The Canadian Physical Activity and 24-Hour Movement guidelines characterize movement across a 24-hour period to include sedentary time, activity, and sleep in recognition of the continuum of movement-related behaviors.[27] Accelerometry is a valid method to objectively measure energy expenditure in youth[28,29] that recently has been utilized to capture sleep time and sleep efficiency.[30] Objective measures of both sleep and PA concurrently are unknown in urban AI youth, and no studies exist that report on these important obesity risk factors. Moreover, no studies have examined weekday to weekend sleep in AI youth. Therefore, the purpose of this study was to objectively measure PA, sleep, and obesity and to assess self-report screen time in urban AI youth in Montana; we aimed to compare PA, sleep, and screen time behaviors between weekday and weekend and between boys and girls.

METHODS

Study Design

This observational study with a sample of convenience assessed body composition, screen time, PA, and sleep in 6th – 8th grade urban AI youth attending 3 local middle schools in a Montana city (Table 1). In this community, it is a requirement for parents and/or families to register with the Urban Indian Center to utilize their services. Accordingly, youth had to be registered with the Urban Indian Center to be enrolled in the study and to ensure AI identity.

Procedure

The research team collaborated with the Indian Education Department (IED) to conduct this study. The IED had dedicated time(s) when they met with every AI student in each of the 3 middle schools; the research team used this time to introduce the study and provide a parental consent form to participate. Students who returned a signed parental consent form were enrolled in the study.

Data were collected in dedicated areas in each school over the course of 6 weeks during lunch hour in Fall 2016. Youth completed a child assent form before participating. All instructions were explained to each participant; if they needed help, a research team member read the assent form and surveys to the participant(s). Youth were then given a demographic and screen time survey, and height and weight were measured. Before they left, children were fit with an Actical accelerometer (Philips Respironics, Bend, OR) attached by a waterproof wristband to wear for 7 days. If they removed it, they were asked to return it to the IED coordinator. The accelerometers were collected the following week, and a $20 incentive was provided to each participant.

Physical Activity and Sleep

Physical activity and sleep were collected with Actical for 7 days consecutively. Epochs were set for one minute. Actical discriminates among different PA intensities (eg, sedentary, light, moderate, and vigorous) using built in cut-points that were used to calculate mean overall, weekday, and weekend PA. Sleep measures were calculated by hand: time in bed (TIB), defined as the time from the first minute of uninterrupted lying down in the evening ("in bed") to the last minute scored as lying down the next morning ("out of bed"); total

sleep time (TST), computed as the sum of all epochs scored as sedentary during TIB; and sleep efficiency, calculated as TST divided by TIB.[30]

Demographics

Demographics were collected with a basic survey that asked students their age, grade, and sex. Height was measured with a portable stadiometer to the nearest 0.1 cm (Seca Model 217, Seca, Inc, Hanover, MD). An electronic scale was used to measure weight (Tanita Model BWB-800S, Tanita, Inc., Chicago, IL) without shoes to the nearest 0.1 kg. Height and weight were converted to age- and sex-specific BMI percentiles according to CDC algorithms.[31]

Screen Time

Screen time was assessed with a 7-item survey developed by the Healthy Children Strong Families research team that assessed weekday and weekend minutes.[32] Weekday questions assessed total minutes any television was on in the home, total minutes spent watching television, total minutes spent using the computer, and total minutes spent playing video games. Three questions assessed weekend screen time behaviors (total minutes spent watching TV and eating occasions coinciding with screen time use).

Data Analysis

Data were downloaded from each Actical via Actical software and exported to an Excel spreadsheet that contained all 7-day raw data points. Excel spreadsheets were then transferred into R 3.3.0 (R Foundation for Statistical Computing, Vienna, Austria) to format PA and sleep variables. A total of 36 out of 37 Acticals contained useable data (one participant removed the device). A moderate-to-vigorous PA (MVPA) category was created by summing moderate and vigorous PA. The mean value for overall, weekday, and weekend activity was calculated for each participant.

For sleep, time in bed was calculated as the first 10 minutes of uninterrupted epochs to the last 10 minutes of uninterrupted epochs. TST was calculated as all epochs recorded as sedentary during time in bed. Bed time and wake time were determined from the first and last TST values. Sleep efficiency was calculated as total sleep time/time in bed. The mean value for each sleep category was calculated for overall, weekday, and weekend sleep for each participant.

All demographic, screen time, PA, and sleep data were analyzed in R. The assumptions of linear regression were fit to the data with MVPA and TST as dependent variables. Separate bivariate linear regression models were fit with MVPA and all other covariates and TST and all other covariates. Bivariate models significant at $p \leq .05$ were included in a multivariate model. Assessment of both MVPA and TST multivariate models revealed gross violations of the linear model assumptions, which disqualified this approach. The data were then fit with multivariate logistic regression using the same dependent variables, but the binary groupings of the dependent variables were too small and inflated the confidence intervals. Therefore, we chose to describe patterns and trends in the data. Descriptive data were analyzed as mean

± standard deviation. Independent 2-tailed *t*-tests were used to compare differences between sex and between weekday vs weekend variables.

RESULTS

Demographics

A total of 36 participants were included in the study (Table 1). The sample consisted of 15 (41.6%) boys and 21 (58.3%) girls. Grade breakdown included 16 (44.4%) 6th graders, 8 (22.2 %) 7th graders, and 12 (33.3%) 8th graders. According to BMI percentile, 15 (41.6%) participants were overweight or obese (OWOB). There was no difference in OWOB between sex.

Screen Time

During the weekday, children indicated that the TV was on in their home 347.7±376.6 minutes/day, watched TV 98.4±100.6 total minutes/day, computer time 109.8±113.9 minutes/day, and played video games 46.5±79.8 minutes/day. During the weekend, 188.3±161.1 minutes were spent watching TV (Table 2). A total of 21 (58.3%) children reported eating a meal “some of the time” and 17 (47.2%) eat snacks “some of the time” while engaged in screen time (TV, computer, or video games). There was no difference between sex with any of the screen time behaviors.

Physical Activity: Sex Differences and Weekday vs Weekend Differences

PA trends were similar overall and for both sex weekday to weekend (Tables 3 and 4). Sedentary activity (SA) significantly increased overall (weekday=159.2±81.1 minutes vs weekend=204.3±91.7 minutes; p = .03). Vigorous physical activity (VPA) decreased from weekday to weekend overall (weekday=20.9±19.1 minutes vs weekend=5.7±8.1 minutes; p = .0001), in girls (weekday=18.5±13.3 minutes vs weekend=5.7±7.2 minutes; p = .001), and in boys (weekday=23.8±24.7 minutes vs weekend=5.7±9.3 minutes; p = .016). MVPA decreased overall (weekday=192.65±62.3 minutes vs weekend=141±71.7 minutes; p = .002) and in boys (weekday=192.6±61.6 minutes vs weekend MVPA=134.2±51.7 minutes; p = .009), but not in girls. There were no differences between sex in overall, weekday, or weekend PA.

Sleep: Sex Differences and Weekday vs Weekend Differences

There were no sleep differences between sex except for weekday TIB (TIB; boys=494.2±49.5 minutes vs girls=527.6±43.6 minutes; p = .04). Trends indicated increased sleep overall and for each sex weekday to weekend (Tables 3 and 4). TST increased overall (weekday=512.8±48.6 minutes vs weekend=555.3±84.3 minutes; p = .007) and in boys (weekday=494.2±49.5 minutes vs weekend=563.5±110.1 minutes; p = .01). TIB increased overall (weekday=487.3±49.6 minutes vs weekend=528.6±71.2 minutes; p = .01) and in boys (weekday=468.8±50.0 minutes vs weekend TIB=535.2±86.3 minutes; p = .03), but not in girls. Later bedtimes were observed on the weekend overall (weekday=22:45±00:12 vs weekend=00:01±00:23; p = .0005) and in girls (weekday=22:37±00:11 vs weekend=00:10±00:22; p = .003), but not for boys. In addition, significantly later wake times were observed on weekends overall (weekday=07:27±00:16 vs

weekend=08:55±00:17; p = .0001), in girls (weekday=07:23±00:14 vs weekend=09:13±00:19; p = .0001), and in boys (weekday=07:31±00:19 vs weekend=08:34±00:13; p = .01).

DISCUSSION

The purpose of this study was to understand obesity risk for urban AI youth as it relates to physical activity, sleep, and screen time. Notably, approximately 42% of the sample was OWOB, and children spent over 4 hours engaged in daily screen time. Moreover, our study is the first to report objective sleep and activity data in urban AI youth this age. We observed key differences between weekday and weekend sleep and activity behaviors: compared to weekdays, weekend SA increased, MVPA and VPA decreased, and all sleep measures increased. Understanding these obesity risk factors is of particular importance for the approximately 60% of AI youth who live in urban areas[33] and are often not accounted for in reservation-based studies.

Sleep

Sleep has received increasing attention as an obesity risk factor and is of particular relevance to youth during a time of rapid growth and development. This is the first study to report objective sleep measures in urban AI youth and to compare weekday to weekend sleep patterns during this critical age (6^{th} – 8^{th} grade). Patterns show that girls get more TST (insignificant difference) and spend more TIB (significant difference) on the weekday and the weekend compared to boys. Additionally, TST, TIB, bed time, and wake times shifted from the weekday to the weekend for the overall sample. Compared to the weekday, average weekend day TST was 42.5 minutes longer, TIB 41.3 minutes longer, bed time one hour and 16 minutes later, and wake time one hour and 28 minutes later for all youth in our study. Studies using self-report and accelerometer in other populations report similar patterns in youth engaging in less weekday sleep and more weekend sleep.[24,34] Maintaining a consistent sleep pattern from weekday to weekend has many important implications for diet,[35–37] PA,[38] and stress.[39,40] Children who slept <9 weekday hours and maintained this amount of weekend sleep engaged in more MVPA and less sedentary activity compared to children that attained <9 hours of weekday sleep and subsequently increased weekend sleep >9 hours.[24] Another study showed that greater weekday-to-weekend variability in sleep timing, in combination with shorter sleep duration, was associated with obesity and poorer metabolic health throughout childhood.[41] The implications of sex differences are unclear, and understanding if shifting sleep patterns impact metabolic mechanisms differently between sex may help researchers tailor interventions aiming to improve sleep and activity patterns among youth.

Physical Activity

We observed no differences in activity between sex. Compared to weekdays, weekend sedentary activity significantly increased overall and in boys but not girls. Specifically, boys' sedentary activity increased on average 64 minutes and girls 30.2 minutes from weekday to weekend. VPA and MVPA decreased from weekday to weekend overall and for each sex. According to self-report questionnaire from another study, rural and urban AI children in

Oklahoma ages 7–13 years spent 4.4 hours per week in MVPA,[4] but weekday to weekend comparisons were not reported. A study done with rural and urban First Nations children age 10-15 in Canada reported similar findings, with a significant MVPA decline from weekday to weekend.[17] Studies done in the general population report variable findings. Fuemmeler et al[42] assessed PA in children (mean age 10.6 years) with accelerometer and reported a SA decrease and MVPA increase from weekday to weekend, which conflicts with our study. However, most other general population studies show patterns similar to our study, with VPA and MVPA declining and SA increasing from weekday to weekend.[16,34,43–45] A longitudinal analysis reports that children age 9 engaged in approximately 3 hours of MVPA during each day on both weekdays and weekend days, but at age 15, daily weekday MVPA decreased to 50 minutes and daily weekend MVPA decreased to 36 minutes per day.[46]

Physical activity discrepancies between our study and others may be attributed to device and epoch length. Studies that also used accelerometry have different epoch lengths that ranged from 2 seconds,[45] 5 seconds,[44] 10 seconds,[16,34] and 15 seconds.[17] Our study and that of Feummeler et al[42] set epoch lengths at 1 minute intervals. A systematic review of accelerometer measurement by Migueles et al[47] (published after we began data collection) determined that one minute epochs may be too long to capture vigorous bouts of activity and suggest that the optimal range is 3-15 seconds, which will inform our future work.

Studies using accelerometry have been done in AI and First Nations children living in tribal communities to collect PA but did not assess sleep.[26,48–51] The 2 studies of PA in urban AI children used self-report survey, with one of those studies not providing comparable PA variables.[4,5] Further, these studies do not report sex-specific data. Other studies in AI youth used pedometers, but step counts are not comparable to accelerometer values.[13,15] This is the first study to assess objectively-measured PA and sleep concurrently in urban AI children complete with sex-specific PA. However, more work is needed to understand the relationship between sex and the spectrum of daily movement, including sleep, sedentary activity, light activity, and moderate-to-vigorous activity.

Body Composition

Approximately 42% of this sample was OWOB. This high prevalence is similar to other studies of urban[5,7,52] and combined urban/rural AI populations[4,9] ranging from 45-65% OWOB. OWOB differences may be related to differences in included age ranges and in sample sizes. However, our study confirms the high OWOB rates in urban AI youth and underscores the need for research that addresses obesity in this high risk, understudied population.

Screen Time

Sedentary activity is a strong OWOB contributor,[53] and screen time represents a significant portion of sedentary activity that is more available than ever before.[54] AI youth in our sample reported 254.7 minutes (4.24 hours) average screen time per weekday. General population data (NHANES) found that the majority of children engage in screen time >2 hours per day.[11,55] A systematic review of North American Indigenous youth found that they engage in 3.65 hours of screen time per day on average, with the highest rates among boys.

[10] One study with urban AI youth age 9-12 reported 3.13 hours average screen time per day.[5] This results is similar to the screen time amount that the urban AI youth in our sample reported and demonstrates the need for research to develop interventions that hinder screen time usage. As mobile devices and other electronics continue to gain popularity and affordability, it is critical to address the deleterious effects of screen time on health and the importance of living a healthy lifestyle, particularly during adolescence when children are allowed more autonomy over how they spend their time.

Strengths and Limitations

This study contributes to the literature by describing objectively measured obesity prevalence, sleep, and PA patterns and self-reported screen time in an urban AI youth sample, with a particular focus on weekday to weekend differences. However, we note several limitations. First, we recruited and retained a small sample (N = 36), although this represents a significant proportion of AI youth in this community. Second, inference cannot be drawn from this observational study that utilized a convenience sample, one of the weakest of study designs. Third, 1-minute epochs have the potential to miss intense PA bouts, and in future studies, we intend to use epoch lengths of 3-15 seconds.[47] Fourth, we collected data in the fall and winter. The cold weather coupled with the holiday season may have influenced PA and sleep patterns. More work is needed to understand how PA and sleep patterns shift with seasonal changes in addition to the weekend and weekday differences described here. Fifth, we did not collect any dietary information. Diet plays an important role in overall health, and future studies should include this important energy-related component. Finally, screen time was limited to self-report, and we do not know if youth are responding accurately to daily screen time recall.

Conclusion

This observational study of a convenience sample assessed body composition, screen time, PA, and sleep in 6th – 8th grade urban AI youth. Compared to weekdays, weekend sleep and SA increased and PA decreased, and high OWOB rates were observed. Our data contribute significantly to the paucity of literature regarding health behaviors in urban AI youth, as the majority of work is done in rural or reservation-based tribal communities. In order to design appropriate public health interventions for AI youth in urban areas, this work needs to be replicated on a larger scale in future studies. Additionally, sleep, PA, obesity, and screen time have important public health implications for AI youth, and consideration should be given to both weekday- and weekend-specific behaviors when designing youth interventions.

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Table 1

Demographic Data (N = 36)

	N	Percent
Grade		
6th	16	44.4
7th	8	22.2
8th	12	33.3
Sex		
Boys	15	41.6
Girls	21	58.3
BMI Percentile		
Underweight	0	0
Normal Weight	21	58.3
Overweight	6	16.6
Obese	9	25

Table 2

Screen Time Minutes TV Watching, Using Computer, and Playing Video Games

	Mean Minutes (sd)
Total weekday minutes TV is on in home	347.7 (376.6)
Total weekday minutes spent watching TV	98.4 (100.6)
Total weekday minutes spent using computer[a]	109.8 (113.9)
Total weekday minutes playing video games	46.5 (79.8)
Total minutes spent watching TV on the weekend	188.3 (161.1)

Note.

[a:] includes tablet, cell-phone, or iPad

Table 3

Overall Weekday and Weekend Differences in Physical Activity and Sleep.

	Weekday minutes (sd)	**Weekend minutes (sd)**	**p-value**
Physical Activity			
Sedentary	159.2 (81.1)	204.3 (91.7)	**.03** *
Light	567.2 (70.2)	504.9 (68.4)	**.0004** *
Moderate	171.7 (51.7)	135.2 (69.2)	**.016** *
Vigorous	20.9 (19.06)	5.7 (8.1)	**.0001** *
MVPA[a]	192.65 (62.3)	141 (71.7)	**.002** *
Sleep			
Total Sleep Time	512.8 (48.6)	555.3 (84.3)	**.007** *
Time in Bed	487.3 (49.6)	528.6 (71.2)	**.01** *
Sleep Efficiency[b] (%)	0.94 (0.03)	0.95 (0.03)	.60
Bedtime	22:45 (00:12)	00:01 (00:23)	**.0005** *
Wake time	07:27 (00:16)	08:55 (00:17)	**.0001** *

Note.

a: moderate-to-vigorous physical activity

b: total sleep time/time in bed

* $p \leq .05$

Table 4

Weekday vs Weekend Differences in Girls and Boys Physical Activity and Sleep

	Girls weekday minutes (sd)	Girls weekend minutes (sd)	p-value	Boys weekday minutes (sd)	Boys weekend minutes (sd)	p-value
Physical Activity						
Sedentary	154.4 (70.5)	184.6 (87.8)	.25	165.3 (95.0)	229.3 (93.3)	.07
Light	568.6 (58.4)	500.8 (80.2)	**.005** *	565.5 (85.0)	510.1 (52.2)	**.04** *
Moderate	174.1 (57.1)	140.5 (82.7)	.15	168.7 (45.9)	128.4 (49.0)	**.027** *
Vigorous	18.5 (13.3)	5.7 (7.2)	**.001** *	23.8 (24.7)	5.7 (9.3)	**.016** *
MVPA[a]	192.6 (64.5)	146.3 (85.4)	.068	192.6 (61.6)	134.2 (51.7)	**.009** *
Sleep						
Total Sleep Time	527.6 (43.6)	548.9 (59.0)	.21	494.2 (49.5)	563.5 (110.1)	**.01** *
Time in Bed	501.9 (45.4)	523.4 (58.7)	.21	468.8 (50.0)	535.2 (86.3)	**.03** *
Sleep Efficiency[b] (%)	0.95 (0.03)	0.95 (0.02)	.83	0.94 (0.03)	0.95 (0.03)	.61
Bedtime	22:37 (00:11)	00:10 (00:22)	**.003** *	22:54 (00:12)	23:48 (00:24)	.09
Wake time	07:23 (00:14)	09:13 (00:19)	**.0001** *	07:31 (00:19)	08:34 (00:13)	**.01** *

Note.

a: moderate-to-vigorous physical activity

b: total sleep time/time in bed

* $p \leq .05$