



Life stress, sense of belonging and sleep in American Indian college students



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ABSTRACT

Objectives: In a sample of 90 American Indian (AI) college students (Age M(SD) = 21.47(3.02), 61.1% female), we investigated relationships between stress (perceived psychological stress and recent negative life events), sense of belonging to the university community and tribal community and sleep. We hypothesized that belonging and stress would associate with sleep.

Methods: Participants wore a wrist accelerometer for 7 nights and answered surveys during an in-lab visit. **Results:** Sense of belonging to the university community associated with actigraphy-measured wake after sleep onset (WASO) ($\beta = -.45$, $t(80) = -3.98$, $P < .001$, R^2 change = 0.16), total sleep time ($\beta = .30$, $t(80) = 2.49$, $P = .02$, R^2 change = .07), sleep efficiency ($\beta = .38$, $t(80) = 3.29$, $P = .001$, R^2 change = .11) and subjective global sleep quality ($\beta = -.44$, $t(75) = -4.82$, $P < .001$, R^2 change = .15). Sense of belonging to the tribal community predicted average wake after sleep onset ($\beta = -.29$, $t(80) = -2.64$, $P = .01$, R^2 change = 0.08). Total negative life events in the preceding year associated with WASO ($\beta = .24$, $t(80) = 2.19$, $P = .03$, R^2 change = 0.05), while perceived psychological stress associated with actigraphy-measured sleep efficiency ($\beta = -.28$, $t(80) = -2.25$, $P = .03$, R^2 change = 0.06) and subjective global sleep quality ($\beta = .40$, $t(78) = 3.94$, $P < .001$, R^2 change = 0.16).

Conclusions: Stress and sense of belonging associate with sleep in AI college students. Future research should investigate whether life stress and belonging may affect health in this population by affecting patterns of sleep and investigate psychosocial resources that may moderate the relationships between stress, belonging and sleep.

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For American Indians (AIs), exposure to trauma and adversity often begins early in the lifespan and can persist into adulthood with high rates of traumatic or negative life events and higher levels of perceived psychological stress.^{1–3} These stress exposures have implications for mental and physical health.^{4–5} Given the documented associations between stress and health, high levels of stress likely contribute to the persisting disparities in health observed in AI communities. Life events and psychological stress may impact health by impacting health behaviors. For example, a large body of research indicates associations between stress (life events and psychological stress) and sleep quality.^{6–9}

While several investigations have focused on stress and sleep in other racial and ethnic groups,^{10–12} very little is known about sleep quality in AI populations. Previous research does indicate that AI adults are less likely to have healthy sleep (>7 hours) compared to other racial/ethnic groups,¹³ and adults with higher degrees of AI An-

cestry report shorter sleep duration.¹⁴ However, the limited literature on sleep in AI adults is based on one-time self-report measures and to date, no research has focused on the relationships between stress and sleep quality in AI college students. AI college students have significantly lower college enrollment rates than other ethnic groups and their dropout rates continue to rise.^{15–17} Previous studies have identified challenges that AI students face during their pursuit of higher education. These challenges include feeling underprepared, difficulties in adjusting to the academic community, family problems, cultural differences, and financial stress.¹⁷

In addition to impacting academic outcomes, graduation rates and retention, psychological stress and stressful life events may affect health behaviors, such as sleep, and could affect future physical health. For example, poor sleep patterns are linked to many adverse health outcomes including metabolic and cardiovascular disease as well as premature mortality.^{18–19} In adulthood, AI communities have disproportionately high rates of cardiovascular disease and have a reduced life expectancy compared to other ethnic groups. As such, sleep is a behavioral pathway which could contribute to AI

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health disparities. In line with this, previous research focused on AI children found that longer sleep duration associated with lower Body Mass Index.²⁰ As a first step, it is important to understand relationships between psychosocial and cultural factors, stress, and sleep quality, in AI college students. For example, across racial groups, loneliness in college students associates with sleep quality.^{21–22} To our knowledge, this is the first investigation to examine factors that associate with subjective and objective indicators of sleep quality in AI college students.

Method

AI students were recruited through advertisements placed across the campus of a large state university and all procedures were approved by the Institutional Review Board. Participants were paid \$30.00 for participation in this research. The study was advertised as research focused on understanding the college experience for AI students. Interested participants were invited to the lab for a one-hour session. They completed a screening questionnaire after providing informed consent to determine eligibility. Students with self-reported chronic health or sleep conditions were excluded from this research. During this session, participants completed a series of questionnaires, including demographics, measures of current depressive symptoms, perceived social stress, life events in the past 12 months, and their sleep quality over the past month. Finally, research assistants placed a wrist accelerometer (Actigraph GT9X link, Pensacola, FL) on the participants' non-dominant hand. Accelerometers were initialized using ActiLife (version 6, Pensacola, FL) in 60 second epochs. The Actigraph GT9X link is a device that detects and records movement through the use of an accelerometer. Participants wore the watch continuously for 7 nights, after which they returned to the lab to return the device and received compensation for their participation. During the monitoring period participants also completed nighttime and morning diaries on their phones. The survey was administered using Illumivu MEMA software.²³ Each morning participants recorded sleep variables from the previous night including the time they tried to fall asleep and the time they woke up, number of awakenings during the night, and the number of naps they took during the day.

Measures

Socioeconomic status

We collected a measure of subjective socioeconomic status using the MacArthur's scale of subjective socioeconomic status.²⁴ Participants were asked to place an "X" on a nine-rung ladder to indicate their perception of their Socioeconomic Status (SES) relative to the rest of the United States. Participants were told that those at the top of the ladder had the most money, the most education, and the most respected jobs, whereas those at the bottom were the worst off, with the least money, the least education, and the least respected job or no job ($M(SD) = 5.75[1.83]$).

Sense of belonging measure

We measured students' sense of belonging to the university community and their tribal community using an adaptation of the Inclusion of Other in the Self (IOS) scale.²⁵ This measure has been used previously to measure an individual's identification with their university,²⁶ and with other social groups.²⁷ The original IOS scale consists of 7 pairs of circles. The overlap between each pair of circles progressively increases, while the total surface area remains constant. In this research, one circle of each pair represented the self, while the other symbolized the university community or the tribal community. A higher score on this measure reflects greater overlap between the self and the described community (possible range = 0–7).

Current depressive symptoms

We used Beck's Depression Inventory (BDI-II) as a measure of current depressive symptoms. The BDI-II is a 21-item questionnaire widely used to assess subclinical and clinical depression.²⁸ Each item includes 4 response options. As an example, participants are asked to select which of the following 4 statements most accurately reflects how they have been feeling in the last 2 weeks, including today: (0) I am not particularly discouraged about the future, (2) I feel I have nothing to look forward to, and (3) I feel the future is hopeless and that things cannot improve. A total score is derived by summing all of the responses, and higher scores reflect more depressive symptoms (possible range = 0–63).

Perceived stress scale

We used the 4-item perceived stress scale as a measure of participants' perceived stress levels over the past month.²⁹ As an example, participants are asked: In the last month, how often have you felt that you were unable to control the important things in your life? Participants answered four questions and were given the following response options (0) never, (1) almost never, (2) sometimes, (3) fairly often, and (4) very often. Responses to each of the 4 questions were summed, with higher totals representing more perceived stress (possible range = 0–16).

Negative life events

Participants are asked to indicate whether they experienced each of 21 specific life events during the past 12 months.³⁰ The scale includes events that are normatively negative (e.g. deaths, crime) as well as life events that are more ambiguous (eg. moving, change in finances). For each event they had experienced, participants were asked to indicate how they would rate their feelings about the event (1 = very good, 2 = moderately good, 3 = slightly good, 4 = slightly bad, 5 = moderately bad, and 6 = very bad). As a measure of negative life events, we summed the number of events rated as having a moderately bad to very bad impact (possible range = 0–18).

Sleep measures

Objective measures of sleep were assessed using 7 nights of wrist-worn accelerometry (Actigraph GT9X link; Actigraph, LLC, Pensacola, FL). Actigraphy devices are widely used in research studies and have been validated against polysomnography.³¹ Only participants with 5 nights of valid data were included in the analyses, as prior research indicates that a period of 5 days is ideal to provide an adequate reflection of an individual's sleep-wake patterns.^{32–33} Nighttime sleep periods were determined using self-reported sleep onset and offset times from the sleep diaries in combination with visual inspection of activity levels. Nights where the actigraph was not worn (as detected by the wear time sensor on the GT9X link) were excluded from analyses. Data were collected using the zero crossing mode in one minute epochs and sleep parameters were estimated using a medium detection threshold and the Cole-Kripke algorithm.³⁴ Total sleep time was the sum of the number of sleep minutes during the night-time sleep period. Wake after sleep onset (WASO) was calculated as the number of minutes spent awake within the total night-time sleeping period. Sleep efficiency (SE) was calculated as the number of sleep minutes divided by the total duration of time between sleep onset and sleep offset, multiplied by 100.

The Pittsburgh Sleep Quality Index (PSQI) was used as measure of participants' sleep quality. The 19-item PSQI assesses sleep quality during the previous month.³⁵ The scale consists of 19 items which are used to derive a total of 7 component scores: sleep quality, sleep latency, sleep duration, Habitual sleep efficiency, sleep disturbances, sleep medication and daytime dysfunction. The 7 component scores can be looked at independently and can be summed to

produce a global PSQI score. Global PSQI scores (with a possible range of 0–21; higher scores represent more severe sleep complaints) were calculated for each participant. We also examined each of the PSQI component scores independently. Internal consistency in this sample between the 7 component scores high $\alpha = 0.8$.

Smoking status

As a measure of smoking status, we asked participants if they were currently smoking. Responses were coded as 0 = nonsmoker, 1 = current smoker).

Statistical analyses

Analyses were conducted using SPSS (IBM: Version 24). Linear regression models were used to conduct the main analyses. Continuous covariates were centered prior to use in statistical models. In linear regressions examining the relationship between sleep, belonging and stress, we included age, gender, subjective SES, depressive symptoms, and smoking status as covariates. In linear regressions examining relationships between stress and depressive symptoms we included age, gender and subjective SES as covariates.

Results

Descriptive statistics are listed in Table 1 and correlations between primary variables of interest are listed in Table 2. Five participants took naps during the monitoring period, and none of these participants took more than 4 naps during the period. Given low rates of daytime naps, these sleep periods were not included in sleep analyses. We did not observe any circadian dysrhythmias in our sample.

Based on previous research indicating that sleep data over 5 nights have adequate reliability estimates,^{32–33} we excluded 1 participant who did not have 5 or more complete nights of actigraphy data. Our reported regression analyses include participants with data for all of the predictors. Three of our participants were missing age data, 5 participants were missing data for the PSQI sleep disturbances subscale, 2 participants were missing data for the PSQI sleep duration subscale. As a result of missing data for PSQI subscales, we were unable to calculate a PSQI global sleep quality score for 5 participants. For our central linear regression analyses, the total sample size (ie,

participants who had all of the included variables) is listed in Tables 3a–3c.

Sleep and current depressive symptoms

Actigraphy measures of sleep and current depressive symptoms

In a linear regression, controlling for age, gender and subjective SES, and smoking status, current depressive symptoms, did not associate with average WASO ($\beta = -.03$, $t(81) = -0.28$, $P = .77$) or average total sleep time ($\beta = -.13$, $t(81) = -1.16$, $P = .25$). Current depressive symptoms was marginally associated with average sleep efficiency ($\beta = -.22$, $t(81) = -2.01$, $P = .05$),

Subjective measures of sleep and current depressive symptoms

Current depressive symptoms did associate with self-reported sleep disturbances ($\beta = .24$, $t(76) = 2.34$, $P = .02$, R^2 change = .06), daytime dysfunction ($\beta = .60$, $t(81) = 7.14$, $P < .001$, R^2 change = .36), sleep latency ($\beta = .29$, $t(81) = 2.74$, $P = .01$, R^2 change = .08) and the PSQI measure of global sleep quality ($\beta = .57$, $t(76) = 6.10$, $P < .001$, R^2 change = .31).

It did not associate with the PSQI measure of sleep efficiency ($\beta = .15$, $t(81) = 1.30$, $P = .19$), sleep duration ($\beta = .04$, $t(78) = .32$, $P = .75$), sleep medication use ($\beta = -.05$, $t(81) = -0.40$, $P = .68$), or subjective sleep quality ($\beta = .16$, $t(81) = 1.46$, $P = .15$).

Stress and current depressive symptoms

Separately, we examined associations between stress and depressive symptoms using linear regressions controlling for age, gender, subjective SES and smoking status. Total negative events in the preceding 12 months did not associate with current depressive symptoms ($\beta = -.01$, $t(81) = -.11$, $P = .91$).

However, as expected, current perceived I stress did associate with current depressive symptoms ($\beta = .54$, $t(81) = 5.92$, $P < .001$, R^2 change = .29).

Sleep and sense of belonging

Actigraphy measures of sleep and sense of belonging to the university community

Utilizing linear regression, controlling for age, gender, subjective SES, smoking status and depressive symptoms, we found that

Table 1
Descriptive statistics

Measure	n	M (SD)	% (n)	Possible range
Age	87	21.47 (3.92)		
Sex	89		62.2% Female	
Subjective socioeconomic status	88	5.03 (2.56)		1–10
Depressive symptoms (BDI-II)	89	26.31 (13.27)		
Current smoking status	90		15.6% current smokers	
Total sleep time (minutes)	89	409 (75.54)		
Sleep efficiency (%)	89	83.5 (9.6)		
Wake after sleep onset (minutes)	89	53.25 (16.97)		
Average in bed time (hh:mm ± min)	89	1:01 ± 57		
Average out of bed time (hh:mm ± min)	89	8:31 ± 61		
PSQI global sleep quality	84	6.46 (2.83)		0–21
PSQI sleep disturbances	84	.94 (.55)		0–3
PSQI sleep efficiency	89	.54 (.84)		0–3
PSQI sleep medication use	89	.34 (.81)		0–3
PSQI daytime dysfunction	89	1.28 (.87)		0–3
PSQI sleep latency	89	1.67 (1.07)		0–3
PSQI sleep duration	89	.47 (.76)		0–3
PSQI sleep quality	89	1.43 (.60)		0–3
Total negative life events	89	2.43 (2.46)		
Perceived psychological stress	89	6.04 (2.22)		0–16
Sense of belonging to university community	89	3.70 (1.78)		1–7
Sense of belonging to tribal community	89	3.43 (2.06)		1–7

Note: BDI-II = Beck's Depressive Inventory-II, PSQI = Pittsburgh Sleep Quality Index.

Table 2
Correlation matrix for key variables

Variable	1	2	3	4	5	6	7	8
1. PSQI global sleep quality	-	.29**	.20	-.34**	.19	.36**	.53**	.07
2. Average WASO		-	-.09*	-.65**	.22*	.06	-.43**	-.28**
3. Average total sleep time			-	.70**	.09	.03	.30**	.01
4. Average sleep efficiency				-	.05	-.31**	.38**	.04
5. Negative life events					-	.20	-.01	-.07
6. Perceived stress						-	.07	.22*
7. Sense of belonging to university community							-	.01
8. Sense of belonging to tribal community								-

Note: * $P < .05$ (two-tailed). ** $P < .01$ (two-tailed).

students' sense of belonging to the university community was associated with average wake after sleep onset ($\beta = -.45, t(80) = -3.98, P < .001, R^2$ change = 0.16), total sleep time ($\beta = .30, t(80) = 2.49, P = .02, R^2$ change = .07), and sleep efficiency ($\beta = .38, t(80) = 3.29, P = .001, R^2$ change = .11).

Subjective measures of sleep and sense of belonging to the university community

Separately, we examined the relationship between sense of belonging to the university community and the subjective measures of sleep. Belonging to the university community associated with the PSQI global measure of sleep quality ($\beta = -.44, t(75) = -4.82, P < .001, R^2$ change = .15), sleep latency ($\beta = -.31, t(80) = -2.74, P = .01, R^2$ change = .08), sleep medication use ($\beta = -.26, t(80) = -2.10, P = .04, R^2$ change = .05) and daytime dysfunction ($\beta = -.30, t(80) = -3.38, P = .001, R^2$ change = .10). Sense of belonging to the university community did not associate with sleep duration ($\beta = .02, t(77) = 0.16, P = .88$), sleep disturbances ($\beta = -.05, t(75) = -0.44, P = .66$), or sleep efficiency ($\beta = -.11, t(80) = -.90, P = .37$) or subjective sleep quality ($\beta = -.22, t(80) = -1.91, P = .06$).

Actigraphy measures of sleep and sense of belonging to the tribal community

In a separate linear regression, with the same covariates, we found that sense of belonging to the tribal community was also a significant predictor of average wake after sleep onset ($\beta = -.29, t(80) = -2.64, P = .01, R^2$ change = 0.08). However, unlike belonging to the university community, belonging to students' tribal community did not associate with total sleep time ($\beta = .01, t(80) = .08, P = .93$), or measured sleep efficiency ($\beta = .02, t(80) = .20, P = .84$).

Subjective measures of sleep and sense of belonging to the tribal community

Separately, we examined the relationship between sense of belonging to the tribal community and the subjective measures of sleep. Belonging to the tribal community did not associate with the subjective measures of sleep including global sleep quality ($\beta = .07, t(76) = .76, P = .44$), subjective sleep quality ($\beta = -.19, t(80) = -1.67, P = .09$), sleep duration ($\beta = .05, t(80) = -.46, P = .65$), sleep latency ($\beta = .05, t(80) = -.51, P = .61$), daytime dysfunction ($\beta = -.03, t(80) = .28, P = .78$), sleep medication use ($\beta =$

Table 3a
Linear regression models with sense of belonging to the university community predicting sleep outcomes

	WASO (N = 86)		Sleep efficiency (N = 86)		Total sleep time (N = 86)		PSQI global sleep quality (N = 81)	
	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>
Age	.03	.25	-.10	-.84	.04*	.43	.04	.49
Gender	-.03	.76	.00	.001	.16*	-.01	-.07	-.80
Subjective SES	-.05	-.54	-.02	-.14	-.06	-.49	-.08	-.97
Depressive symptoms (BDI-II)	.05	.48	.15	1.43	-.03	-1.56	.51**	6.06
Smoking status	-.03	-.23	.05	.40	.01	-.04	.03	.36
Belonging to university community	-.45*	-3.98	.38*	3.30	.30*	2.49	-.44**	4.82
R^2	.15		.11		.05		.27	

Notes: * $P < .05$, ** $P < .001$. Unstandardized estimates are displayed. Gender is coded as 1 = Male and 2 = Female. Smoking status was coded as 0 = not current smoker, 1 = current smoker. WASO = wake after sleep onset, PSQI = Pittsburgh Sleep Quality Index, SES = socioeconomic Status, BDI-II = Beck's Depressive Inventory-II.

Table 3b
Linear regression models with negative life events predicting sleep outcomes

	WASO (N = 86)		Sleep efficiency (N = 86)		Total sleep time (N = 86)		PSQI global sleep quality (N = 81)	
	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>
Age	-.13	-1.22	.01	.01	.12	1.04	.12	1.23
Gender	-.06	-.55	.05	.45	.04	.35	.002	.02
Subjective SES	-.03	-.27	-.02	-.22	-.06	-.54	-.09	-.95
Depressive symptoms (BDI-II)	-.03	-.27	-.22*	-2.00	-.12	-1.04	.58**	6.25
Smoking status	-.13	-1.18	.05	.49	.07	.58	.15	1.55
Negative life events	.24*	2.19	-.14	1.18	.05	.43	.16	1.67
R^2	.03		-.01		-.03		.01	

Notes: * $P < .05$. Unstandardized estimates are displayed. Gender is coded as 1 = Male and 2 = Female. Smoking status was coded as 0 = not current smoker, 1 = current smoker. WASO = wake after sleep onset, PSQI = Pittsburgh Sleep Quality Index, SES = Socioeconomic status, BDI-II = Beck's Depressive Inventory-II.

Table 3c
Linear regression models with current perceived stress predicting sleep outcomes

	WASO (N = 86)		Sleep efficiency (N = 86)		Total sleep time (N = 86)		PSQI global sleep quality (N = 81)	
	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>	β	<i>t</i>
Age	-.10	-.82	.01	.11	.12	1.15	.14	1.48
Gender	-.07	-.65	.07	.65	.05	.43	-.01	-.04
Subjective SES	-.03	-.30	-.01	-.10	-.05	-.48	-.10	-.95
Depressive symptoms (BDI-II)	-.10	-.78	.06	.63	-.20	-1.53	.50**	4.46
Smoking status	-.15	-1.26	.11	.96	.05	.44	.14	.15
Perceived stress	.13	.98	-.28*	-2.25	.16	1.19	.13	1.14
R ²	-.01		.05		-.01		.32	

Notes: * $P < .05$. Unstandardized estimates are displayed. Gender is coded as 1 = Male and 2 = Female. Smoking status was coded as 0 = not current smoker, 1 = current smoker. WASO = wake after sleep onset, PSQI = Pittsburgh Sleep Quality Index, SES = socioeconomic status, BDI-II = Beck's Depressive Inventory-II.

-.15, $t(80) = -1.31$, $P = .19$), sleep disturbances ($\beta = .06$, $t(80) = .61$, $P = .55$), and sleep efficiency ($\beta = .001$, $t(80) = .01$, $P = .99$).

Sleep and measures of stress

Actigraphy measures of sleep and stress

In a linear regression model, controlling for age, gender, subjective SES and depressive symptoms, we found that number of negative life events in the preceding 12 months associated with average wake after sleep onset ($\beta = .24$, $t(80) = 2.19$, $P = .03$, R^2 change = 0.05). Number of negative life events did not associate with average total sleep time ($\beta = .05$, $t(80) = 0.43$, $P = .66$) or sleep efficiency ($\beta = -.14$, $t(80) = -1.18$, $P = .24$).

Separately, current perceived stress was associated with sleep efficiency ($\beta = -.28$, $t(80) = -2.25$, $P = .03$, R^2 change = 0.06), but was not associated with average wake after sleep onset ($\beta = .13$, $t(80) = 0.98$, $P = .32$), or with average total sleep time ($\beta = .16$, $t(80) = 1.19$, $P = .32$).

Subjective measures of sleep and stress

Number of negative life events in the preceding 12 months did not associate with the PSQI measure of sleep efficiency ($\beta = .01$, $t(81) = .11$, $P = .90$), sleep medication use ($\beta = -.05$, $t(82) = -.44$, $P = .66$), daytime dysfunction ($\beta = -.15$, $t(82) = -1.36$, $P = .18$), subjective sleep quality ($\beta = -.02$, $t(82) = -.14$, $P = .89$), sleep latency ($\beta = .07$, $t(82) = .62$, $P = .54$) or global sleep quality ($\beta = .13$, $t(78) = 1.13$, $P = .26$). However it did associate with the PSQI measure of sleep disturbances ($\beta = .52$, $t(77) = 6.01$, $P < .001$, R^2 change = 0.27).

Current perceived stress was associated with the PSQI measures of sleep duration ($\beta = .32$, $t(79) = 3.16$, $p = < .01$, R^2 change = 0.10), sleep efficiency ($\beta = .35$, $t(82) = 3.42$, $P = .001$, R^2 change = 0.12), sleep latency ($\beta = .23$, $t(82) = 2.16$, $P = .03$, R^2 change = 0.05), sleep disturbances ($\beta = .46$, $t(77) = 5.06$, $P < .001$, R^2 change = 0.21), daytime dysfunction ($\beta = .24$, $t(82) = 2.31$, $P = .02$, R^2 change = 0.06), and the PSQI global measure of sleep quality ($\beta = .40$, $t(78) = 3.94$, $P < .001$, R^2 change = 0.16). Current stress was not associated with the PSQI measure of sleep medication use ($\beta = .20$, $t(82) = 1.87$, $P = .07$) or subjective sleep quality ($\beta = -.17$, $t(82) = -1.58$, $P = .12$).

Discussion

This is the first study, to our knowledge, to utilize both objective and subjective measures of sleep in a sample of American Indian college students. We present initial evidence that in AI college students, measures of stress (i.e. recent life stress and current psychological stress) associate with important sleep outcomes.

Separately, we found that measures of belonging were also associated with sleep outcomes in this population. We measured two

dimensions of belonging: belonging to the university institution and belonging to students' tribal community. The data indicates that sense of belonging to the university was more consistently related to the measured sleep outcomes. It is interesting to note that students' sense of belonging to their tribal community did not associate with any of the subjective measures of sleep quality, but did associate with actigraphy-measured WASO. Based on this, more work is needed to understand how these different dimensions of belonging may affect sleep in different ways. Future research is also needed to understand the relationships between these distinct measures of belonging. The current research is unable to speak to the types of experiences and feelings that may contribute to one's sense of belonging to each of these communities.

Overall, these findings indicate that stress and belonging may be two factors that could shape the quality of sleep in AI college students. More information is needed to understand the pathways that may lead to these associations. For example, it is unknown how daily life experiences may vary as a function of stress, negative life events, and sense of belonging. Future investigations could utilize Ecological Momentary Assessment (EMA) to capture daily affect, experiences, behaviors and social interaction in real time to better understand how these factors may contribute to the relationships observed in this investigation.

The findings may have implications for the well-being of AI college students. First, since life stress and current perceived psychological stress associated with compromised sleep quality in this sample, these students may benefit from counseling services or interventions that aim to help these students cope with the stressors they face. Further, the data suggest that higher levels of belonging to the university may improve sleep quality in AI college students. As such, initiatives and programs that work to foster belonging to the larger university and promote inclusiveness may improve sleep quality for these students. While we did not measure physical health outcomes here, given the large body of literature documenting associations between sleep quality and physical health, the sleep outcomes measured here could have implications for physical health and could contribute to existing AI health disparities. Further, it will be important to investigate whether sleep disturbances associated with stress and a lack of sense of belonging in AI college students associates with academic outcomes including grades, retention and dropout rates.

The relationships between measures of sleep and stress observed in this investigation are consistent with documented associations in college students from other racial/ethnic groups.^{36–38} While this is the first investigation to our knowledge to investigate associations between stress, belonging and sleep in American Indian college students, previous work in American Indian communities have found relationships between sleep and diabetes risk and obesity incidence in children.^{20,39} While it is possible that stress and belonging were involved in these relationships, these investigations did not provide measures of stress or belonging. Subsequent investigations should

focus on whether stress and belonging are psychosocial factors that may contribute to observed relationships between sleep and physical health in AI college students.

This research also has important limitations. First, the work is cross-sectional, so causality cannot be inferred. It is possible that sleep quality affects the rate of life events for students or that sleep quality affects sense of belonging to the university. However, previous research indicates that chronic stress is prospectively associated with sleep disturbance.⁴⁰ Further, in previous work we have found that levels of psychological stress during a time of transition associates with changes in sleep quality from the time before the transition.⁷ Separately, a previous investigation found evidence of bidirectionality in the relationship between stress and sleep, perhaps reflecting a vicious cycle in which stress and sleep mutually influence each other over time.⁴¹

While we did have a measure of number of negative life events, we did not ask students about how they manage or cope with these stressful events. It is also possible that coping styles may explain the relationships between life stress and sleep quality. For example, in a previous investigation using a community sample, three coping behaviors acted as mediators in the relationship between stress and sleep quality.⁴²

In this investigation we did not ask about substance use, including hypnotic use, both of which are known to affect sleep.⁴³ Future work should include measures of these behaviors to determine if they would affect the observed pattern of findings.

Prior research in South American Indians found that psychological distress associates with restless legs syndrome.⁴⁴ While we did not ask specifically about restless legs syndrome in this research, we did exclude any participants who indicated that they had been diagnosed with a chronic health or sleep condition. Future work is needed to investigate rates of sleep disorders in this population. Given our recruitment methods (i.e. advertising across campus), the sample reported on in this manuscript may not represent the larger American Indian student population due to potential selection bias.

Future work should examine these relationships using a longitudinal design and should explore mediating roles of coping and stress management styles. This research is needed to better inform efforts to help AI college students cope with life stress in ways that may result in improved sleep quality. The findings reported here are novel in that this is the first investigation to examine the associations between stress, sense of belonging and sleep quality in a sample of AI college students. In future investigations, it will be important to examine whether stress, sense of belonging and sleep quality in AI college students associate with physical health outcomes.

Conflict of interest

The authors have no conflicts of interest to disclose.

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