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Associations Between Mental Health Status and Sleep and Physical Activity Among Adolescents in Hawai'i

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Abstract

This study examined associations between mental health status, physical activity, and sleep among Hawai'i adolescents using data from the 2017-2021 Hawai'i State High School Youth Risk Behavior Survey (YRBS). Mental health outcomes included feelings of sadness/hopelessness and suicidality. Logistic regression models assessed associations between physical activity, sleep, and mental health outcomes, adjusting for covariates including race, bullying, and the COVID-19 pandemic. Sleep duration, sleep location, and physical activity were significantly associated with mental health outcomes. Adolescents who slept longer were less likely to report sadness/hopelessness (6-7 vs. 0-5 hours: adjusted odds ratio [aOR]=0.59, 95% confidence interval [CI]=0.52-0.67; 8+ vs. 0-5 hours: aOR=0.36, 95% CI=0.32-0.41) and suicidality (6-7 vs. 0-5 hours: aOR=0.64, 95% CI=0.54-0.76; 8+ vs. 0-5 hours: aOR=0.38, 95% CI=0.31-0.46). Adolescents without a stable place to sleep had higher odds of suicidality (aOR=1.69, 95% CI=1.29-2.21). Physical activity was also protective; adolescents active for 6-7 days per week had lower odds of sadness/hopelessness (aOR=0.75, 95% CI=0.65-0.87) and suicidality (aOR=0.71, 95% CI=0.61-0.83) compared with those active 0-2 days. Boys had lower odds of both outcomes than girls. Compared with Whites, Filipinos, other Asians, and Pacific Islanders had lower odds of suicidality. Adolescents surveyed during the COVID-19 pandemic had increased odds of sadness/hopelessness. These findings underscore the importance of adequate sleep and physical activity for adolescent mental health, highlight the unique experiences of Hawai'i adolescents, and underscore the need to identify disparities among major adolescent groups to inform mental health prevention and intervention strategies.

List of Abbreviations

aOR = adjusted odds ratio
AUC = area under the receiver operating characteristic curve
BMI = body mass index
CDC = Centers for Disease Control and Prevention
MAR = missing at random
OR = crude odds ratio
YRBS = Youth Risk Behavior Survey

Introduction

In recent years, mental health problems and suicidality among adolescents have increased rapidly.[1-3] The percentage of adolescents reporting various mental health issues has steadily risen, reaching unprecedented levels. In 2021, over 40% of high school students in the United States reported experiencing persistent feelings of sadness or hopelessness.[4] Numerous factors have been investigated as potential intervention and prevention measures for adolescent mental health.

Research indicates that inadequate sleep is a significant factor affecting the mental health of individuals across all age groups.[5-7] This relationship is especially evident among adolescents,[8] with the majority of high school students (72.7%) reporting less sleep than the nationally recommended amount of 8 hours.[9] As adolescents transition to adulthood, various changes such as earlier school start times, increased late-night activities, and delayed sleep phases-contribute to sleep deprivation.[6] These changes significantly affect the quality and quantity of sleep adolescents receive each night.

Another known factor contributing to negative mental health outcomes is physical inactivity and a sedentary lifestyle.[10] Numerous studies have demonstrated the association between sedentary behaviors, including physical inactivity and excessive screen usage, and mental health issues such as anxiety, depression, and suicidality.[11,12] This is particularly relevant for adolescents, as 81% of those aged 11-17 globally are insufficiently active.[13]

Previous studies have analyzed adolescent mental health using the Youth Risk Behavior Surveillance System.[14] However, Hawai'i adolescents, characterized by a high percentage of minorities and diverse racial backgrounds, have not been extensively studied. In 2023, Joseph et al found significant associations between lack of sleep and suicide risk among minority adolescents, particularly among Black and Hispanic youth.[15] However, the National Youth Risk Behavior Survey (YRBS) combines all Asians into one racial category and does not disaggregate Asian ethnicities important to Hawai'i (eg Filipinos), limiting detailed comparisons and obscuring health disparities among the state's diverse youth population. Consequently, national statistics may not accurately reflect the mental health patterns of adolescents in Hawai'i.

Additionally, the negative effects of the COVID-19 pandemic exacerbated mental and physical health issues among adolescents due to lockdowns, distance-learning, and reduced social interaction.[16,17] Adolescents in Hawai'i may have experienced heightened feelings of isolation due to the state's geographic remoteness, despite its mild tropical climate, which allows for year-round outdoor physical activity. The pandemic may have impacted their physical

activity levels, and in turn, mental health. Analyzing post-COVID-19 data at the state level could help fill this research gap and provide deeper insight into the unique experiences of adolescents in Hawai'i.

In the current study, Hawai'i State YRBS data were utilized to evaluate the associations between mental health status, physical activity, and sleep among Hawai'i adolescents, as well as to compare mental health status before and after the COVID-19 pandemic. The findings of the study will help identify disparities among various major racial groups and illuminate the unique experiences of adolescents in Hawai'i.

Methods

Data Source

Hawai'i State-Level High School YRBS data from 2017, 2019, and 2021 were utilized. The Hawai'i YRBS is a joint effort of the Hawai'i State Department of Education, Department of Health, and University of Hawai'i Curriculum Research & Development Group, in collaboration with the Centers for Disease Control and Prevention (CDC). The YRBS collects information on health-risk behaviors that contribute to the leading causes of death and disability among youth and young adults. Traditionally, it has been a paper-pencil survey administered to Hawai'i public school students every other year. In 2021, the survey transitioned to a hybrid format, allowing schools to choose between pencil-and-paper or online administration.

The Hawai'i YRBS sample is selected using a two-stage, stratified random sampling method, considering the overall analysis weight, sampling strata, and primary sampling unit. Detailed information about the survey design and sampling method can be found on the YRBS website.[4] Deidentified Hawai'i data with disaggregated racial information was obtained from the Hawai'i Health Data Warehouse under a data use agreement. This study was approved by the University of Hawai'i Institutional Review Board under the "non-human subjects" category (#2024-00657).

Variables

Dependent variables. Two primary mental health indicators, both binary, representing a "yes" or "no" were included. The first question asked whether the respondent had ever felt "so sad or hopeless almost every day for 2 weeks or more in a row that [they] stopped doing some usual activities" in the past 12 months. The second question inquired if the respondent had "ever seriously consider[ed] attempting suicide" in the past 12 months.

Independent variables. Sleep variables included the number of hours of sleep on an average school night and the usual location of sleep in the past 30 days. The amount of sleep was categorized into 3 groups: 0-5 hours (sleep-deprived), 6-7 hours (insufficient), and ⩾8 hours (optimal), based on the recommendation that high school students should get 8-10 hours of sleep.[18,19] The sleep location question asked where respondents had slept during the past 30 days. It was categorized into 2 groups: a parent or guardian's house vs. other locations. Other locations included the home of a friend, family member, or others; shelter or emergency housing; motel or hotel; car, park, campground; or having no usual place to sleep. This variable served as a proxy for homelessness and family instability.

Physical activity was categorized into 3 groups: 0-2 days (low activity), 3-5 days (moderate activity), and 6-7 days (high activity). These categories were defined to approximate adherence to the US Physical Activity Guidelines for Americans, which recommend at least 60 minutes of moderate-to-vigorous physical activity daily for adolescents.[20]

The timeframe for before and after COVID-19 was determined by the year of the data: 2017 and 2019 data were considered pre-COVID-19, while 2021 data was classified as post-COVID-19. The YRBS is normally conducted every odd year during the spring (January-June). However, due to the COVID-19 pandemic, including the transition to virtual and hybrid learning and ongoing school closures in spring 2021, the 2021 YRBS was postponed and administered in fall (September-December) of that year.

Covariates. Demographic variables included sex, grade level, body mass index (BMI), and race. Sex was a binary variable, with values "boy" and "girl." Grade level had 4 categories, corresponding to each grade from 9th to 12th grade. BMI percentile was calculated based on sex, height, and age and categorized into 3 groups: underweight (<5th percentile), healthy weight (5th to <85th percentile), and overweight (⩾85th percentile).[4] Race data from the Hawai'i Department of Health included American Indian/Alaska Native, Black, White, Filipino, Japanese, Native Hawaiian/Part Hawaiian, Pacific Islander, Other Asian, and other racial groups. Based on observed similarity in mental health associations in the present study and prior literature on mental health disparities,[21,22] categories were collapsed into White, Filipino, Other Asians, Native Hawaiian, Pacific Islander, and Other.

Additional variables included bullying[23] and eating breakfast.[24,25] Bullying was assessed by whether the respondents experienced school-based or electronic bullying in the past 12 months and coded as yes/no. Eating breakfast in the past 7 days was coded as "none of the days" versus "at least some days."

A total of 17 547 surveys were completed across 2017 (n=6031), 2019 (n=5879), and 2021 (n=5637). After excluding cases with missing data, 12 892 high school students were included in the final analytic sample (see Figure 1).

Statistical Analyses

Descriptive statistics were generated, including weighted percentages and 95% confidence interval (CI). Rao-Scott's Chi-squared tests identified variables associated with mental health outcomes (ie, sadness/hopelessness, suicidality). Univariate and multivariable logistic regression models assessed the associations between mental health status and factors such as exercise and sleep, with model fit evaluated using area under the receiver operating characteristic curve (AUC). Multivariable models were adjusted for sex, race,

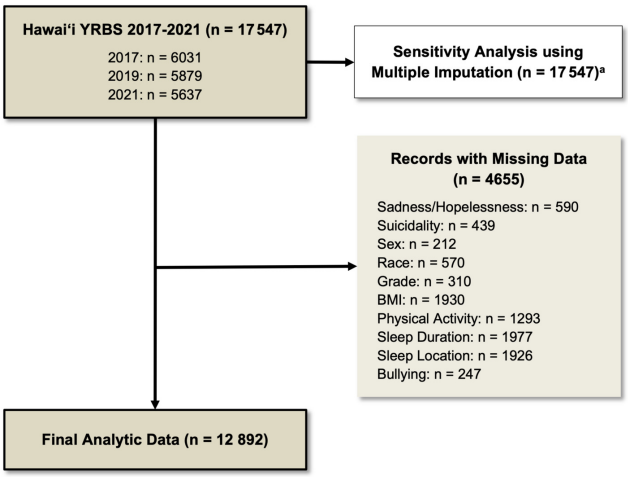

Figure 1. Flow Diagram of Study Sample Selection, Missing Data, and Sensitivity Analysis Using Multiple Imputation, Hawai'i Youth Risk Behavior Survey (YRBS), 2017-2021

[a]Sensitivity analysis was conducted using multiple imputation (20 imputed datasets) to assess the robustness of findings to missing data.

grade, BMI category, breakfast consumption, sleep duration, sleep location, physical activity, bullying, and time frame. A sensitivity analysis using multiple imputation (20 imputed datasets) was conducted to address missing data in the original 17 547 responses under the assumption of missing at random (MAR). Results were compared with complete-case analyses to assess the robustness of the findings. All analyses accounted for the YRBS sampling design. A 2-tailed *P*-value of .05 was considered statistically significant, and statistical analyses were conducted using R version 4.5.2 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Table 1 presents the descriptive analysis. Approximately half of the adolescents were boys (50.1%), and the sample was evenly distributed across grades 9-12. About one-quarter of adolescents identified as Native Hawaiian and one-quarter as Filipino. Most adolescents had a healthy BMI (66.7%), while 28.4% were classified as overweight. Only 23.2% achieved the recommended ⩾8 hours of sleep on school nights, and 19.9% reported bullying. The data primarily consisted observations from 2017-2019 (63.4%).

Sadness/Hopelessness

Overall, 32.5% of students reported feeling sad or hopeless for at least two weeks in the past 12 months (Table 1). Grade and BMI percentile were not significantly associated with sadness/hopelessness. The prevalence of sadness/hopelessness decreased with longer sleep duration (46.3% for 0-5 hours, 30.7% for 6-7 hours, and 20.3% for ⩾8 hours on school nights) and greater physical activity (38.3% for 0-2 days, 31.5% for 3-5 days, and 26.1% for 6-7 days).

In multivariable analyses, sadness/hopelessness was significantly associated with hours of sleep, physical activity, race, sex, eating breakfast, bullying, and the COVID-19 pandemic (Table 2). Adolescents 6-7 hours or 8 or more hours of sleep on a school night had 41% and 64% lower odds, respectively, of feeling sad or hopeless compared to those getting 0-5 hours of sleep (6-7 hours: adjusted odds ratio [aOR]=0.59, 95% CI=0.52-0.67; 8+ hours: aOR=0.36, 95% CI=0.32-0.41). Adolescents physically active 6-7 days per week had lower odds of sadness/hopelessness than those active 0-2 days (aOR=0.75, 95% CI=0.65-0.87). Boys were less prone to feelings of sadness or hopelessness than girls (aOR=0.45, 95% CI=0.40-0.51). Among racial groups, other Asians were significantly less likely to report sadness or hopelessness compared to Whites (aOR=0.65, 95% CI=0.48-0.86). Furthermore, individuals who were bullied were more likely to experience sadness or hopelessness (aOR=3.33, 95% CI=2.91-3.82). After COVID-19, individuals had 27% higher odds of reporting feelings of sadness or hopelessness (aOR=1.27, 95% CI=1.11-1.46). The model fit was acceptable, with an AUC of .72 (95% CI=.71-.73).

Suicidality

Overall, 15.7% of students reported considering attempting suicide in the last 12 months (Table 1). Chi-squared tests revealed that variables race, sex, breakfast consumption, amount of sleep, sleep location, physical activity, and experience of bullying/cyberbullying were significantly associated with suicidality. Specifically, the prevalence of suicidality decreased with increasing sleep duration, from 24.2% among students sleeping 0-5 hours to 14.2% among those sleeping 6-7 hours and 8.8% among those sleeping 8 or more hours on school nights. Physical activity showed a similar trend, with prevalence declining from 19.6% among students active for 0-2 days to 14.3% for 3-5 days and 12.0% among those active for 6-7 days.

The multivariable analysis indicated that suicidality was significantly associated with physical activity, hours of sleep, sleep location, sex, race, eating breakfast, and bullying (Table 2). Adolescents who averaged 6-7 hours or 8 or more hours of sleep on a school night were also less likely to report suicidality compared with those who averaged 0-5 hours of sleep (6-7 hours: aOR=0.64, 95% CI=0.54-0.76; ⩾8 hours: aOR=0.38, 95% CI=0.31-0.46). Students without stable housing were more likely to report suicidality (aOR=1.69, 95% CI=1.29-2.21). Students who were physically active 3-5 days or 6-7 days were less likely to report suicidality compared with those active 0-2 days per week (3-5 days: aOR=0.81, 95% CI=0.67-0.97; 6-7 days: aOR=0.71, 95% CI=0.61-0.83). Boys were less likely to report suicidality than girls (aOR=0.55, 95% CI =0.46-0.65). Adolescents from certain racial groups were less likely to report suicidality than White adolescents, including Filipino (aOR=0.73, 95% CI=0.54-0.98), Other Asians (aOR=0.63, 95% CI=0.45-0.88), and Pacific Islanders (aOR=0.55, 95% CI=0.33-0.92). Those who experienced bullying were more likely to report suicidal ideation compared with those who did not report such experiences (aOR=3.48,

Table 1. Summary of Students Hawai'i High School Student Characteristics Stratified by Mental Health Status, Youth Risk Behavior Survey, 2017, 2019 and 2021

Variable	Total[a]		Sadness/Hopelessness (*Sad or feel hopeless almost every day for 2+ weeks in a row*)		Suicidality (*Seriously considered attempting suicide in the last 12 months*)	
	Unweighted n	Weighted % (95% CI)	Weighted % (95% CI)	***P* value[a]**	Weighted % (95% CI)	***P* value[a]**
All Students	12892	100	32.5 (31.4-33.8)		15.7 (14.8-16.6)	
Sex				**<.001**		**<.001**
Girl	6533	49.9 (48.4-51.4)	41.9 (40.4-43.4)		20.1 (18.7-21.7)	
Boy	6359	50.1 (48.6-51.6)	23.3 (21.5-25.1)		11.2 (10.2-12.3)	
Race/Ethnicity				**<.001**		**.001**
White	10631	16.4 (13.0-20.3)	31.7 (29.0-34.6)		17.0 (14.5-19.9)	
Filipino	2377	27.1 (25.1-29.2)	36.1 (33.9-38.4)		14.4 (12.5-16.5)	
Other Asian	883	10.5 (8.8-12.6)	23.3 (19.7-27.4)		11.3 (8.6-14.6)	
Native Hawaiian	3322	23.6 (21.1-26.4)	30.9 (28.6-33.3)		16.1 (14.3-17.9)	
Pacific Islander	533	3.6 (2.9-4.3)	29.3 (23.2-36.3)		12.1 (8.1-17.6)	
Other	4716	18.8 (18.0-19.7)	36.0 (34.0-38.0)		19.0 (17.7-20.3)	
Grade				.064		.37
9	3126	27.2 (23.8-30.9)	29.8 (27.4-32.3)		15.9 (14.5-17.4)	
10	3477	25.5 (22.8-28.5)	32.6 (30.2-35.1)		16.9 (15.0-18.9)	
11	3379	24.1 (21.5-27.0)	35.8 (33.5-38.1)		15.0 (13.1-17.2)	
12	2910	23.1 (20.8-25.6)	32.4 (28.4-36.6)		14.7 (12.7-16.8)	
Body Mass Index Percentile				.064		.27
Healthy Weight (5^{th}-85^{th})	8449	66.7 (64.9-68.5)	33.2 (31.5-35.0)		15.3 (14.3-16.4)	
Underweight (<5^{th})	540	4.8 (4.2-5.6)	35.9 (31.4-40.8)		18.7 (14.5-23.7)	
Overweight (≥85^{th})	3903	28.4 (26.9-30.0)	30.3 (28.2-32.5)		15.9 (14.4-17.5)	
How many times eat breakfast per week				**<.001**		**<.001**
0	2104	15.9 (14.8-17.1)	46.0 (42.3-49.6)		26.2 (23.9-28.5)	
1-7	10788	84.1 (82.9-85.2)	30.0 (28.7-31.4)		13.7 (12.7-14.7)	
Hours of sleep on school night				**<.001**		**<.001**
0-5	3511	27.5 (26.3-28.7)	46.3 (43.9-48.7)		24.2 (21.8-26.7)	
6-7	6298	49.3 (48.0-50.6)	30.7 (29.0-32.4)		14.2 (13.3-15.1)	
≥8	3083	23.2 (21.6-24.9)	20.3 (18.3-22.4)		8.8 (7.4-10.3)	
Usually slept in parent's or guardian's home				**.029**		**<.001**
Yes	12105	94.7 (93.8-95.4)	32.2 (30.9-33.5)		15.0 (14.2-15.9)	
No	787	5.3 (4.6-6.2)	39.1 (33.2-45.3)		27.0 (22.5-32.0)	
Physically active per week (days)				**<.001**		**<.001**
0-2	4680	37.6 (35.4-39.7)	38.3 (36.5-40.2)		19.6 (18.1-21.3)	
3-5	4393	34.5 (33.1-35.9)	31.5 (29.3-33.7)		14.3 (12.8-16.0)	
6-7	3819	28.0 (26.5-29.5)	26.1 (23.9-28.5)		12.0 (10.9-13.2)	
Bullied/E-bullied in the last 12 months				**<.001**		**<.001**
Yes	2799	19.9 (18.7-21.1)	56.2 (53.5-58.8)		33.3 (31.0-35.7)	
No	10093	80.1 (78.9-81.3)	26.7 (25.4-28.0)		11.3 (10.3-12.3)	
Time frame				**.016**		.30
2017-2019 (Before COVID)	8617	63.4 (60.2-66.5)	31.3 (30.0-32.7)		15.3 (14.1-16.6)	
2021 (After COVID)	4275	36.6 (33.5-39.8)	34.6 (32.3-37.1)		16.2 (15.1-17.3)	

Unweighted N = 12 892. CI = Confidence Interval. Weighted percentages and 95% CIs were estimated using methods accounting for the complex sampling design of the Youth Risk Behavior Survey.

[a] *P*-values were obtained using the Rao-Scott's Chi-squared test

Table 2. Associations between Mental Health Status and Student Characteristics based on Logistic Regression Analyses, Youth Risk Behavior Survey, 2017, 2019 and 2021

Variable	Sadness/Hopelessness (*Sad or feel hopeless almost every day for 2+ weeks in a row*)		Suicidality (*Seriously considered attempting suicide in the last 12 months*)	
	OR (95% CI)	aOR (95% CI)	OR (95% CI)	aOR (95% CI)
Sex				
Girl		Reference	Reference	Reference
Boy	**0.42 (0.37-0.48)**	**0.45 (0.40-0.51)**	**0.50 (0.43-0.58)**	**0.55 (0.46-0.65)**
Race				
White	Reference	Reference	Reference	Reference
Filipino	**1.22 (1.04-1.43)**	1.15 (0.97-1.37)	0.82 (0.61-1.10)	**0.73 (0.54-0.98)**
Other Asian	**0.66 (0.52-0.84)**	**0.65 (0.48-0.86)**	**0.62 (0.44-0.88)**	**0.63 (0.45-0.88)**
Native Hawaiian	0.96 (0.83-1.11)	0.96 (0.81-1.14)	0.93 (0.77-1.14)	0.86 (0.68-1.08)
Pacific Islander	0.89 (0.65-1.24)	0.90 (0.66-1.24)	0.67 (0.42-1.08)	**0.55 (0.33-0.92)**
Other	**1.21 (1.04-1.41)**	1.11 (0.93-1.33)	1.14 (0.93-1.40)	1.01 (0.83-1.24)
Grade				
9	Reference	Reference	Reference	Reference
10	1.14 (0.98-1.33)	1.15 (0.99-1.34)	1.07 (0.90-1.28)	1.09 (0.87-1.35)
11	**1.31 (1.12-1.53)**	**1.26 (1.09-1.47)**	0.93 (0.76-1.14)	0.87 (0.72-1.06)
12	1.13 (0.89-1.43)	1.09 (0.89-1.33)	0.91 (0.73-1.12)	0.88 (0.72-1.07)
Body Mass Index Percentile				
Healthy Weight (5^{th}-85^{th})	Reference	Reference	Reference	Reference
Underweight (<5^{th})	1.13 (0.90-1.42)	1.07 (0.84-1.35)	1.27 (0.92-1.74)	1.17 (0.86-1.60)
Overweight (≥85^{th})	0.87 (0.76-1.01)	0.86 (0.73-1.02)	1.05 (0.92-1.19)	1.07 (0.93-1.23)
How many times eat breakfast per week				
0	Reference	Reference	Reference	Reference
1-7	**0.51 (0.43-0.59)**	**0.60 (0.52-0.70)**	**0.45 (0.38-0.52)**	**0.56 (0.47-0.67)**
Hours of sleep on school night				
0-5	Reference	Reference	Reference	Reference
6-7	**0.51 (0.45-0.59)**	**0.59 (0.52-0.67)**	**0.52 (0.44-0.61)**	**0.64 (0.54-0.76)**
≥8	**0.30 (0.26-0.34)**	**0.36 (0.32-0.41)**	**0.30 (0.25-0.36)**	**0.38 (0.31-0.46)**
Usually slept in parent's or guardian's home				
Yes	Reference	Reference	Reference	Reference
No	**1.35 (1.03-1.78)**	1.11 (0.85-1.44)	**2.09 (1.65-2.66)**	**1.69 (1.29-2.21)**
Physically active per week (days)				
0-2	Reference	Reference	Reference	Reference
3-5	**0.74 (0.65-0.84)**	0.89 (0.77-1.02)	**0.68 (0.58-0.81)**	**0.81 (0.67-0.97)**
6-7	**0.57 (0.50-0.65)**	**0.75 (0.65-0.87)**	**0.56 (0.49-0.64)**	**0.71 (0.61-0.83)**
Bullied/E-bullied in the last 12 months				
Yes	**3.52 (3.10-4.01)**	**3.33 (2.91-3.82)**	**3.93 (3.38-4.58)**	**3.48 (3.01-4.04)**
No	Reference	Reference	Reference	Reference
Time frame				
2017-2019 (Before COVID)	Reference	Reference	Reference	Reference
2021 (After COVID)	**1.16 (1.03-1.31)**	**1.27 (1.11-1.46)**	1.07 (0.94-1.21)	1.15 (0.99-1.34)

OR = Crude Odds Ratio. CI = Confidence Interval. aOR = Adjusted Odds Ratio. ORs (aORs) and 95% CIs were estimated using logistic regression models accounting for the complex sampling design of the Youth Risk Behavior Survey. All covariates included in the adjusted analyses are shown in the aOR column.

95% CI=3.01-4.04). Model discrimination was acceptable (AUC=.72, 95% CI=.71-.74).

To address the impact of missingness, a sensitivity analysis using multiple imputation was conducted (Table 3). Results were consistent with those from the complete-case multivariable analysis in terms of both magnitude and statistical significance. Differences in ORs between the multiple imputation and complete-case analyses were generally small (maximum absolute difference ⩽0.31), indicating consistent results across methods.

Table 3. Multivariable Logistic Regression Results Based on Five Imputed Datasets Using Multiple Imputation, Youth Risk Behavior Survey, 2017, 2019 and 2021

Variable	**Sadness/Hopelessness (*Sad or feel hopeless almost every day for 2+ weeks in a row*)**	**Suicidality (*Seriously considered attempting suicide in the last 12 months*)**
	aOR (95% CI)	**aOR (95% CI)**
Sex		
Girl	Reference	Reference
Boy	**0.48 (0.43-0.54)**	**0.60 (0.52-0.68)**
Race		
White	Reference	Reference
Filipino	1.29 (1.00-1.44)	**0.73 (0.55-0.98)**
Other Asian	**0.66 (0.50-0.87)**	**0.59 (0.42-0.82)**
Native Hawaiian	1.00 (0.86-1.16)	0.87 (0.71-1.07)
Pacific Islander	0.98 (0.68-1.41)	**0.57 (0.34-0.94)**
Other	1.14 (0.96-1.34)	0.97 (0.81-1.18)
Grade		
9	Reference	Reference
10	1.19 (1.00-1.42)	1.11 (0.91-1.36)
11	**1.26 (1.10-1.45)**	0.92 (0.75-1.12)
12	1.09 (0.90-1.32)	0.85 (0.70-1.04)
Body Mass Index Percentile		
Healthy Weight (5^{th}-85^{th})	Reference	Reference
Underweight (<5^{th})	1.04 (0.82-1.32)	1.18 (0.84-1.67)
Overweight (≥85^{th})	0.88 (0.76-1.03)	1.08 (0.92-1.26)
How many times eat breakfast per week		
0	Reference	Reference
1-7	**0.61 (0.52-0.71)**	**0.56 (0.48-0.66)**
Hours of sleep on school night		
0-5	Reference	Reference
6-7	**0.62 (0.55-0.71)**	**0.67 (0.57-0.79)**
≥8	**0.39 (0.35-0.44)**	**0.42 (0.34-0.52)**
Usually slept in parent's or guardian's home		
Yes	Reference	Reference
No	**1.28 (1.02-1.61)**	**2.00 (1.59-2.52)**
Physically active per week (days)		
0-2	Reference	Reference
3-5	0.90 (0.79-1.02)	**0.83 (0.71-0.97)**
6-7	**0.78 (0.68-0.90)**	**0.70 (0.60-0.80)**
Bullied/E-bullied in the last 12 months		
Yes	**3.38 (2.97-3.85)**	**3.51 (3.09-3.99)**
No	Reference	Reference
Time frame		
2017-2019 (Before COVID)	Reference	Reference
2021 (After COVID)	**1.28 (1.12-1.46)**	1.14 (0.99-1.32)

aOR = Adjusted Odds Ratio. CI = Confidence Interval.
Sensitivity analysis using multiple imputation (20 imputed datasets). aORs and 95% CIs were estimated using multivariable logistic regression models accounting for the complex sampling design of the Youth Risk Behavior Survey. All covariates included in the adjusted analyses are shown in the aOR column.

Discussion

This study examined the association between mental health, sleep, physical activity, and the COVID-19 pandemic among adolescents in Hawai‘i. Furthermore, factors such as subjection to bullying, as well as demographic variables, were considered.

Findings revealed that sleep during significantly impacts suicidality and depressive symptoms. Students sleeping 0-5 hours reported higher rates of sadness/hopelessness and suicidal thoughts than those sleeping 6 or more hours. While these findings highlight sleep duration as a key risk factor, the study did not assess sleep quality, which is a limitation. Prior research indicates that sleep quality may be a significant predictor of psychological distress than duration alone.[26,27] Meta-analyses and longitudinal studies indicate that poor sleep quality and insomnia symptoms are more strongly associated with mental health and suicidality.[28-30] Future research should incorporate multidimensional sleep assessments to capture both duration and quality.

While location of sleep is significantly associated with suicidality, it does not appear to affect feelings of sadness/hopelessness. This association likely reflects broader risk factors such as housing instability or family disruption, rather than sleep context alone. Adolescents experiencing unstable housing or family homelessness are at higher risk for suicidal ideation and attempts.[31,32] Sleep location in this study may therefore serve as a marker of acute environmental stressors, highlighting the need for future research to include direct measures of housing stability and family context.

Consistent with previous studies,[10,12,33,34] this study also demonstrated the importance of physical activity in maintaining adolescent mental health. Although the magnitude of its association was attenuated after adjusting for other covariates, physical activity remained a significant and meaningful factor. This suggests that engagement in regular physical activity may exert both direct and indirect effects on psychological well-being, potentially through mechanisms such as stress reduction, improved sleep quality, enhanced self-esteem, and increased social interaction. This underscores its continued relevance as a target for prevention and health promotion efforts.

Racial disparities in mental health were observed in this study, supporting prior research finding.[35] Compared with White youth, other Asian youth had lower odds of both suicidality and sadness/hopelessness and Filipino and Pacific Islander youth had lower odds of suicidality. Although national data often indicate elevated risk for depressive symptoms and suicidality among certain minority groups,[36] these findings may reflect unique protective factors in Hawai‘i. Prior research suggests that Asian and Pacific Islander youth benefit from strong family support, cultural connectedness, and community cohesion, which are associated with greater resilience and psychological well-being.[22,37] Connections to family, community, and cultural practices have also been linked to lower perceived stress and reduced suicidal risk among Asian and Pacific Islander youth more broadly.[22,37] In addition, these patterns may reflect differences in psychosocial risk and protective factors between non-White versus White youth. The collectivistic nature in communities of color could serve may offer protection adverse mental health consequences, particularly internalizing disorders such as depression and suicidality. In contrast, the individualistic nature prevalent in Western culture and more commonly endorsed by White youth may increase vulnerability to social isolation and related internalizing symptoms.

This study has several limitations. First, it is unclear whether some independent variables, such as physical activity and sleep, were unaffected by mental health outcomes. Individuals with depression may neglect physical well-being, raising concerns about reverse causation and suggesting a potential bidirectional relationship between mental health and health behaviors, whereby poor mental health adversely affects health behaviors, while disrupted sleep and reduced physical activity may in turn exacerbate psychological distress. Clarifying these dynamics would require longitudinal data. Second, suicidal ideation was selected rather than suicide plans or attempts, because suicidal ideation represents an earlier stage along the suicidal continuum, is a critical target for prevention and early intervention efforts, and is more commonly and reliably reported in survey-based data. Future studies are encouraged to examine these associations across multiple stages of suicidal behavior. Third, this study did not account for all variables potentially linked with mental health. Specifically, screen-use metrics such as time spent TV or gaming were excluded to prevent issues with confounding and multicollinearity. Further research should investigate these factors alongside socioeconomic background and parental data to better understand their collective impact on health risk and sleep patterns.[38] Fourth, the YRBS measures overall physical activity, failing to distinguish between moderate and vigorous intensities. This is a notable limitation, as the neurological and mental health benefits of exercise often follow a dose-response relationship tied specifically to intensity levels.[39,40] Future studies should investigate distinct modalities such as strength training, cardiovascular exercise, competitive sports while exploring barriers to participation to better understand their unique impacts on mental health.[41] Fifth, certain racial categories were collapsed to ensure statistical robustness; however, this have obscured specific trends. Future research should utilize more disaggregated data to provide a more nuanced analysis of these demographics. Sixth, a substantial proportion of missing data was present in the dataset. Although multiple imputation was used under the assumption that data were MAR, the possibility of non-random missingness cannot be excluded. Therefore, residual bias may still be present if the missingness mechanism deviated from the MAR assumption. Furthermore, due to the nature of the YRBS survey procedures, the accuracy of the self-reported data may introduce bias. Although the sample size was relatively large, the inclusion of only public schools in the Hawai‘i YRBS dataset could introduce selection bias.

Despite these limitations, this study has several notable strengths. To the authors' knowledge, it is the first to ex-

amine the association between Hawai'i adolescents' mental health status and both sleep and physical activity while adjusting for multiple covariates. By combining Hawai'i State High School YRBS data from 3 survey years, a relatively large and representative sample of adolescents in Hawai'i was analyzed. This approach also allowed for the inclusion of more diverse and detailed racial groups than would not have been possible using the national YRBS dataset. The findings highlight important opportunities for intervention: to better support student mental health, high school administrations and teachers should emphasize the importance of adequate sleep and remain attentive to chronic sleep deprivation and drowsiness among students.[42] Furthermore, public health policies should more widely consider racial- and sex-tailored mental health prevention strategies, especially for adolescents.

Conclusion

Adequate sleep and physical activity are crucial for adolescents' mental health and should be central to public health promotion. The racial differences observed in this study underscore the unique mental health challenges faced by adolescents in Hawai'i. Future interventions should address these inequities through targeted, culturally responsive prevention and support strategies that reflect the state's diverse demographic profile.

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Conflicts of interest

No authors have conflicts of interest to report; nor competing financial interests.

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References

1. Joseph VA, Martínez-Alés G, Olfson M, Shaman J, Gould MS, Keyes KM. Temporal trends in suicide methods among adolescents in the US. *JAMA Netw Open*. 2022;5(10):e2236049. doi:10.1001/jamanetworkopen.2022.36049

2. Martínez-Alés G, Pamplin JR 2nd, Rutherford C, et al. Age, period, and cohort effects on suicide death in the United States from 1999 to 2018: moderation by sex, race, and firearm involvement. *Mol Psychiatry*. 2021;26(7):3374-3382. doi:10.1038/s41380-021-01078-1

3. Ramchand R, Gordon JA, Pearson JL. Trends in suicide rates by race and ethnicity in the United States. *JAMA Netw Open*. 2021;4(5):e2111563. doi:10.1001/jamanetworkopen.2021.11563

4. National Center for HIV/AIDS, Viral Hepatitis, STD, and TB Prevention. *Youth Risk Behavior Survey: Data Summary & Trends Report 2011-2021*. Centers for Disease Control and Prevention; 2023. Accessed January 28, 2026. https://stacks.cdc.gov/view/cdc/124928

5. McKnight-Eily LR, Eaton DK, Lowry R, et al. Relationships between hours of sleep and health-risk behaviors in US adolescent students. *Prev Med*. 2011;53(4-5):271-273. doi:10.1016/j.ypmed.2011.06.020

6. Roberts RE, Duong HT. The prospective association between sleep deprivation and depression among adolescents. *Sleep*. 2014;37(2):239-244. doi:10.5665/sleep.3388

7. Flores JP, Stuart EA, Swartz KL, et al. Risk and protective factors associated with suicidal thoughts and behaviors among Maryland middle school students. *School Ment Health*. 2022;14(4):1024-1043. doi:10.1007/s12310-022-09521-6

8. Baiden P, Tadeo SK, Tonui BC, et al. Association between insufficient sleep and suicidal ideation among adolescents. *Psychiatry Res*. 2020;287:112579. doi:10.1016/j.psychres.2019.112579

9. Wheaton AG, Jones SE, Cooper AC, et al. Short sleep duration among middle school and high school students - United States, 2015. *MMWR Morb Mortal Wkly Rep*. 2018;67(3):85-90. doi:10.15585/mmwr.mm6703a1

10. Pfledderer CD, Burns RD, Brusseau TA. School environment, physical activity, and sleep as predictors of suicidal ideation in adolescents: Evidence from a national survey. *J Adolesc*. 2019;74:83-90. doi:10.1016/j.adolescence.2019.05.008

11. Pengpid S, Peltzer K. High sedentary behaviour and low physical activity are associated with anxiety and depression in Myanmar and Vietnam. *Int J Environ Res Public Health*. 2019;16(7):1251. doi:10.3390/ijerph16071251

12. Wen X, Zhu F, Yuan Z, Mao Z. Relationship between physical activity, screen-related sedentary behaviors and anxiety among adolescents in less developed areas of China. *Medicine (Baltimore)*. 2022;101(39):e30848. doi:10.1097/md.0000000000030848

13. Guthold R, Stevens GA, Riley LM, et al. Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 1·6 million participants. *Lancet Child Adolesc Health*. 2020;4(1):23-35. doi:10.1016/s2352-4642(19)30323-2

14. Laurson KR, Lee JA, Eisenmann JC. The cumulative impact of physical activity, sleep duration, and television time on adolescent obesity: 2011 Youth Risk Behavior Survey. *J Phys Act Health*. 2015;12(3):355-360. doi:10.1123/jpah.2013-0402

15. Joseph VA, Kreski NT, Keyes KM. Sleep deprivation and suicide risk among minoritized US adolescents. *BMC Psychiatry*. 2023;23(1):638. doi:10.1186/s12888-023-05074-3

16. Uccella S, Cordani R, Salfi F, et al. Sleep deprivation and insomnia in adolescence: implications for mental health. *Brain Sci*. 2023;13(4):569. doi:10.3390/brainsci13040569

17. Iacopetta D, Catalano A, Ceramella J, et al. The ongoing impact of COVID-19 on pediatric obesity. *Pediatr Rep*. 2024;16(1):135-150. doi:10.3390/pediatric16010013

18. Paruthi S, Brooks LJ, D'Ambrosio C, et al. Consensus statement of the American Academy of Sleep Medicine on the recommended amount of sleep for healthy children: methodology and discussion. *J Clin Sleep Med*. 2016;12(11):1549-1561. doi:10.5664/jcsm.6288

19. Dinges DF, Pack F, Williams K, et al. Cumulative sleepiness, mood disturbance, and psychomotor vigilance performance decrements during a week of sleep restricted to 4-5 hours per night. *Sleep*. 1997;20(4):267-277. doi:10.1093/sleep/20.4.267

20. Piercy KL, Troiano RP, Ballard RM, et al. The physical activity guidelines for Americans. *JAMA*. 2018;320(19):2020-2028. doi:10.1001/jama.2018.14854

21. Johnson DL, Okamoto SK, Rosario MH, Pokhrel P. Tobacco product use and cultural connectedness among Native Hawaiian/Pacific Islander, Asian American, and Filipino American young adults in Hawai'i. *J Ethn Subst Abuse*. 2024;23(4):967-981. doi:10.1080/15332640.2022.2161082

22. Wills TA, Okamoto SK, Knight R, Pagano I. Parental Support, Parent-Adolescent Conflict, and Substance Use of Native Hawaiian and Other Pacific Islander Youth: Ethnic Differences in Stress-Buffering and Vulnerability Effects. *Asian Am J Psychol*. 2019;10(3):218-226. doi:10.1037/aap0000139

23. Sampasa-Kanyinga H, Willmore J. Relationships between bullying victimization psychological distress and breakfast skipping among boys and girls. *Appetite*. 2015;89:41-46. doi:10.1016/j.appet.2015.01.020

24. Liu BP, Fang HJ, Jia CX. The Serial Mediation of the Association between Breakfast Skipping and Suicidality by Weight Status and Depressive Symptoms: Findings from the National Youth Risk Behavior Surveys of the United States. *Nutrients*. 2022;14(5). doi:10.3390/nu14050956

25. Kim JS, Seo Y. Breakfast habits, sedentary behavior, and suicide among Korean adolescents: A cross-sectional national study. *PLoS One*. 2023;18(5):e0285312. doi:10.1371/journal.pone.0285312

26. Seaton VA, Narcisse MR, Subica AM, Long CR, Matthews EE, McElfish PA. Sleep quality partially mediates the association between type 2 diabetes and psychological distress in Native Hawaiian and Pacific Islander adults in the United States: Analysis of the 2014 National Health Interview Survey. *Asian Am J Psychol*. 2019;10(3):258-267. doi:10.1037/aap0000147

27. Castiglione-Fontanellaz CEG, Schaufler S, Wild S, et al. Sleep regularity in healthy adolescents: associations with sleep duration, sleep quality, and mental health. *J Sleep Res*. 2023;32(4):e13865. doi:10.1111/jsr.13865

28. O'Callaghan VS, Couvy-Duchesne B, Strike LT, et al. A meta-analysis of the relationship between subjective sleep and depressive symptoms in adolescence. *Sleep Med*. 2021;79:134-144. doi:10.1016/j.sleep.2021.01.011

29. Zhang X, Dou Z, Yang F, et al. Exploring the relationship between sleep patterns and depression among Chinese middle school students: a focus on sleep quality vs. sleep duration. *Front Public Health*. 2024;12:1383884. doi:10.3389/fpubh.2024.1383884

30. Stepan ME, Franzen PL, Teresi GI, et al. Sleep quality predicts future mood symptoms in adolescents with bipolar disorder. *J Affect Disord*. 2024;361:664-673. doi:10.1016/j.jad.2024.06.069

31. Chavez LJ, Kelleher KJ, Bunger A, et al. Youth experiencing homelessness at risk for suicide: psychosocial risk factors and service use patterns. *BMC Public Health*. 2025;25(1):444. doi:10.1186/s12889-024-21212-2

32. Baiden P, LaBrenz CA, Broni MN, et al. Prevalence of youth experiencing homelessness and its association with suicidal thoughts and behaviors: Findings from a population-based study. *Psychiatry Res*. 2024;334:115823. doi:10.1016/j.psychres.2024.115823

33. Samji H, Wu J, Ladak A, et al. Review: Mental health impacts of the COVID-19 pandemic on children and youth - a systematic review. *Child Adolesc Ment Health*. 2022;27(2):173-189. doi:10.1111/camh.12501

34. Redig L, Feter N, Dumith SC, et al. Physical inactivity from childhood to adolescence and incident depression. *Am J Prev Med*. 2022;62(2):211-218. doi:10.1016/j.amepre.2021.09.001

35. Bridge JA, Horowitz LM, Fontanella CA, et al. Age-related racial disparity in suicide rates among US youths from 2001 through 2015. *JAMA Pediatr*. 2018;172(7):697-699. doi:10.1001/jamapediatrics.2018.0399

36. Xiao Y, Cerel J, Mann JJ. Temporal trends in suicidal ideation and attempts among US adolescents by sex and race/ethnicity, 1991-2019. *JAMA Netw Open*. 2021;4(6):e2113513. doi:10.1001/jamanetworkopen.2021.13513

37. Carlton BS, Goebert DA, Miyamoto RH, et al. Resilience, family adversity and well-being among Hawaiian and non-Hawaiian adolescents. *Int J Soc Psychiatry*. 2006;52(4):291-308. doi:10.1177/0020764006065136

38. Miguez MJ, Bueno D, Perez C. Disparities in sleep health among adolescents: the role of sex, age, and migration. *Sleep Disord*. 2020;2020:5316364. doi:10.1155/2020/5316364

39. Li X, Chen W, Zhang Z, et al. Association between physical activity and risk of anxiety: a dose-response meta-analysis of 11 international cohorts. *EClinicalMedicine*. 2025;84:103285. doi:10.1016/j.eclinm.2025.103285

40. Zhang Y, Wang Z, Zhang R, et al. Non-linear dose-response association between physical activity and mental health in adolescents: a prospective cohort study based on SEARCH. *Int J Behav Nutr Phys Act*. 2025;22(1):146. doi:10.1186/s12966-025-01848-y

41. Ferreira Silva RM, Mendonça CR, Azevedo VD, Raoof Memon A, Noll P, Noll M. Barriers to high school and university students' physical activity: A systematic review. *PLoS One*. 2022;17(4):e0265913. doi:10.1371/journal.pone.0265913

42. Paruthi S, Brooks LJ, D'Ambrosio C, et al. Recommended amount of sleep for pediatric populations: a consensus statement of the American Academy of Sleep Medicine. *J Clin Sleep Med*. 2016;12(6):785-786. doi:10.5664/jcsm.5866