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Inequities in adolescent sleep health in Aotearoa New Zealand: Cross-sectional survey findings

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ABSTRACT

Objectives: To investigate ethnic inequities in, and social determinants of, adolescent sleep health in Aotearoa New Zealand.
Methods: Analysis of self-report data from a cross-sectional survey of secondary school students (12- to 18-year-olds). Analyses included weighted prevalence estimates of good and poor sleep health stratified by ethnicity, and multivariable logistic regression models concurrently adjusted for ethnicity, school year, gender, rurality, neighborhood deprivation, school decile, housing deprivation, sleeping elsewhere due to lack of adequate housing, unsafe environment, and racism.
Results: Inequities in social determinants of health were evident for Māori (Indigenous peoples of Aotearoa New Zealand; n = 1528) and minoritized (Pacific n = 1204; Asian n = 1927; Middle Eastern, Latin American, and African [MELAA] n = 210; and 'Other' ethnicity n = 225) adolescents. A greater proportion of Māori, Pacific, Asian, MELAA, and 'Other' adolescents had short sleep, compared to European (n = 3070). Māori, Pacific, Asian, and MELAA adolescents were more likely to report late bedtimes (after midnight), and Māori, Pacific, and 'Other' adolescents were more likely to report early waketimes (5 AM-6 AM or earlier), on school days. Rurality, neighborhood deprivation, school-level deprivation, housing deprivation, sleeping elsewhere due to inadequate housing, unsafe environments, and racism partially, but not fully, explained associations between ethnicity and short sleep, late bedtimes, and early waketimes.
Conclusions: Ethnic inequities exist in adolescent sleep health in Aotearoa New Zealand. Socio-political actions are needed to address racism and colonialism as root causes of ethnic inequities in adolescent sleep, to ensure all young people are afforded the basic human right of good sleep health and associated mental and physical well-being.
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Introduction

Racial/ethnic disparities in adolescent sleep health are evident in the United States of America (US) with marginalized and minoritized racial/ethnic adolescents, particularly Black and Hispanic youth, disproportionately impacted by shorter and poorer quality sleep than White adolescents.[1] This is of significant concern, given that poor sleep health in adolescence is associated with an increased risk of low mood, emotional and behavioral difficulties, poor self-rated health, overweight or obesity, poor school performance, and risk-taking behaviors.[2-4] Thus, marginalized youth are likely to be disadvantaged in multiple ways, through poorer sleep health and poorer associated health outcomes.

Low socioeconomic status and poor neighborhood conditions only partially account for associations between race/ethnicity and

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adolescent sleep health in the US.[1] Further research is needed to continue to identify where adolescent sleep health inequities exist and better understand the range of structural drivers of unjust disparities in young people's sleep. Identifying systemic contributory factors is vital for informing multifaceted, population-level action to achieve sleep health equity, at this developmentally critical life stage.[5]

Internationally, the sleep health of Indigenous peoples has received less attention than other populations and research has largely focused on adults or children rather than adolescents. To date, evidence suggests that in the US the prevalence of poor sleep health is higher for American Indian/Alaska Native and Native Hawaiian/Pacific Island adults compared to White adults[6] and, in Australia, that sleep health inequities exist between Indigenous and non-Indigenous adults and children.[7,8]

In Aotearoa New Zealand (NZ), a comprehensive body of research has provided clear evidence that Indigenous inequities in sleep exist in both adulthood and early childhood and are largely explained by inequities in social determinants of health.[9] Māori (Indigenous peoples of NZ) adults are disproportionately impacted by short and long sleep durations, excessive daytime sleepiness, insomnia symptoms, and disturbed sleep compared to non-Māori.[9,10] A greater proportion of Māori preschoolers (3- to 4-year-olds) are also impacted by poor sleep health, including short sleep durations, disturbed sleep, and inconsistent sleep patterns, compared to non-Māori.[11,12] While less is known about the social patterning of sleep for non-Indigenous minoritized children in NZ, recent research has indicated that as well as Māori (18%), a greater proportion of Pacific (28%), and Asian (23%) toddlers (2-year-olds) have a high likelihood of short sleep durations, compared to European/'Other' toddlers (10%).[13]

Socioeconomic deprivation is consistently associated with poor sleep health and partially explains ethnic sleep inequities in adulthood and early childhood in NZ.[9-13] Racism and low socioeconomic position account for most of the observed inequities in sleep disturbances between Māori and European adults,[10] highlighting that racial discrimination is another significant factor for poor sleep health.[14] Māori and Pacific peoples have continued to be over-represented in neighborhoods with greatest socioeconomic deprivation for decades[15-17] and a disproportionate number of Māori, Pacific, and Asian peoples in NZ experience racism.[18] Thus, it is not ethnicity per se, but rather unjust differential social positioning in NZ society that contributes to sleep inequities in adulthood and early childhood.

However, there has been less of a research focus on adolescent sleep health and the work that has been done has shown somewhat mixed findings in relation to the social patterning of sleep in this age group in NZ.[19-21] Research using survey data collected from secondary school students (13- to 17-years) in 2001 found that approximately one-fifth of adolescents reported not getting enough sleep on a regular basis and that this was more common for Māori and NZ European female students in particular.[19] A more recent study of 13- to 17-year-olds indicated that Asian adolescents had significantly shorter sleep durations, and Māori and Pacific adolescents had later bedtimes, compared to NZ Europeans.[20] Whereas, one-third of secondary school students reported symptoms of disordered sleep in a study conducted by Fernando and colleagues,[21] however this did not differ by ethnicity. Better understanding where ethnic inequities in adolescent sleep health exist, and what the structural determinants of inequitable sleep patterns are, is important for informing evidence-based action to support sleep health equity for young people.

Our research was informed by a social determinants of health lens,[22] which recognizes that the societal conditions in which young people are born and grow up in influence health, including sleep health. The primary aim was to increase knowledge of adolescent sleep health inequities and social determinants of adolescent sleep health by (1) determining the prevalence of good and poor adolescent sleep health by ethnicity and (2) investigating social determinants of good and poor adolescent sleep health, in NZ.

Methods

Participants

We conducted secondary analysis of cross-sectional adolescent self-report survey data from the Youth19 Rangatahi Smart Survey (Youth19).[23] Detailed information about the Youth19 study design, populations, sampling strategy, and data collection is provided elsewhere.[23,24] In brief, Youth19 is the latest in the Youth2000 series of secondary school surveys conducted to investigate the health and well-being of young people in NZ.[23,24] In contrast to previous Youth2000 surveys which used national sampling, for financial and logistical reasons Youth19 had a regional sampling strategy whereby data were collected from adolescents in 49 schools and Kura Kaupapa Māori (Māori-language immersion schools) in three regions of the upper North Island. Combined, these areas comprise 47% of the total youth population and are the most ethnically diverse regions in NZ.[23,24]

Sleep measures

Sleep was measured using the questions "About what time do you go to sleep on a school night?" and "About what time do you wake up on a school day?" A categorical *sleep duration* variable was prepared based on National Sleep Foundation sleep duration recommendations,[25] which inform NZ Ministry of Health sleep guidelines.[26] Sleep duration was categorized as short (≤13-year-olds with < 9 hours; 14- to 17-year-olds with < 8 hours; ≥18-year-olds with < 7 hours), recommended (≤13-year-olds with 9-11 hours; 14- to 17-year-olds with 8-10 hours; ≥18-year-olds with 7-9 hours), or long (≤13-year-olds with > 11 hours; 14- to 17-year-olds with > 10 hours; ≥18-year-olds with > 9 hours). Derived variables were also prepared for *later bedtimes* (after midnight vs. midnight or earlier) and *earlier or later waketimes* (before 6 AM/between 6 AM-8 AM/after 8 AM).

Sociodemographic measures

The social construct of *ethnicity* was measured using the question "Which ethnic group do you belong to? (You may choose as many as you need)." Recognizing that ethnic classification methods can influence the reporting of adolescent mental health outcomes[27] "prioritized" and "total response" output variables were utilized in analyses, in keeping with standardized protocols for reporting ethnicity data in NZ.[28] For prioritized ethnicity, participants were classified into one of five ethnic groupings in prioritized order of Māori, Pacific, Asian, 'Other' (including Middle Eastern, Latin American, African, and other ethnic groups not included in the previous categories but excluding participants who identified solely with the European ethnic group), and European (sole European; incorporating adolescents who identified solely as New Zealand European or another European ethnicity such as German). Thus, each participant was counted in only one ethnic grouping when prioritized output was used.

In contrast, total response output entailed participants being categorized into each of the Māori, Pacific, Asian, Middle Eastern/Latin American/African (MELAA), and 'Other' ethnic groups they identified with, resulting in those who selected multiple ethnicities being counted in multiple ethnic groupings, that is, more than once. Using this classification system is advantageous for maximizing responses for smaller populations groups in NZ, such as Pacific

peoples. However, as this approach produces ethnic groupings that are not mutually exclusive it limits the ability to compare prevalence estimates by ethnicity. Therefore, sole European was used as the comparator group in these analyses, which included adolescents who only identified as European, to reflect the dominant social positioning of this ethnic grouping in NZ.

Other variables included *age* (years) and *school year* (year 9 to year 13). Year 9 is the first year of secondary school in NZ, when most students are 12- or 13-years-old, and year 13 is the final year of secondary school, when students are typically 17- or 18-years-old. Data on *gender* were collected using the question "How do you describe yourself?" (I am a boy or man/I am a girl or woman/I identify in another way). Due to the small number of participants who selected "I identify in another way," a dichotomous *gender* variable was prepared (girl/woman versus boy/man) for use in analyses to ensure participant confidentiality and sufficient statistical power. Based on residential address, *rurality* was classified as rural, small town, or major urban center.

Socioeconomic position was measured using neighborhood- and school-based indicators. *Neighborhood socioeconomic deprivation* was measured using NZDep2018[29] quintiles ranging from 1 (20% of areas with least deprivation) to 5 (20% of areas with greatest deprivation). NZDep2018 is a composite, area-level indicator of relative socioeconomic deprivation comprising eight dimensions measured as part of the NZ Census (communication, income, employment, qualifications, owned home, support, living space, and living condition).[29] NZDep2018 values were provided with the Youth19 dataset, based on student home address. A *school decile* variable was utilized as a school-level measure of deprivation. School deciles reflect the proportion of students in a school living in low socioeconomic communities (decile 1 = 10% of schools with the greatest proportion of students living in low socioeconomic communities; decile 10 = 10% of schools with the smallest proportion).[30]

A composite *housing deprivation* variable (yes/no) incorporated four housing deprivation indicators, that is, serious housing deprivation, housing financial stress, families splitting up because of inadequate housing, and frequently moving house, which are reported in more detail elsewhere.[31] Experience of at least one of these aspects of housing deprivation was categorized as "yes." An additional *sleep elsewhere due to lack of adequate housing* (yes/no) variable was prepared based on responses to the question "In the last 12 months, have you had to sleep in any of the following because it was hard for your family to afford or get a home, or there was not enough space?"[31]

A composite *unsafe environment* (yes/no) variable was prepared based on responses to the questions "Do you feel safe in your neighborhood?," "Do you feel safe in your school/course?," and "Do you feel safe at home, or the place you live?" Feeling safe either "sometimes," "no, mostly not" or "not at all" in at least one of the contexts was categorized as "yes" whereas feeling safe either "yes, all the time" or "yes, most of the time" in all three contexts was categorized as "no."

A composite *racism* (yes/unsure/no) variable was also prepared. This was based on responses to four discrimination questions: three about ever being treated unfairly because of your ethnic group, that is, by a teacher/tutor, health professional, or police, and one about being bullied in the past 12 months at school because of your ethnic group or culture. At least one "yes" response was coded as "yes" or else at least one "I don't know/unsure" response was coded as "unsure." Participants who did not respond with "yes" or "I don't know/unsure" in any of the questions were coded as "no."

Statistical analyses

Statistical analyses were conducted using SAS (Version 9.4) statistical software (SAS Institute, Cary, NC). Sampling weights and school cluster and strata were applied in all analyses to produce outputs representative of the areas that Youth19 data were collected from. However, we were unable to apply calibrated weightings to provide nationally adjusted estimates[24] due to coding for these being available for use with R statistical software only. Planned analyses included calculating weighted prevalence estimates and 95% confidence intervals for sociodemographic and sleep variables, stratified by ethnicity (total Māori, Pacific, Asian, MELAA, 'Other', and sole European as the comparator group).

Social determinants of sleep health were investigated using multivariable logistic regression models concurrently adjusted for prioritized ethnicity, neighborhood socioeconomic deprivation, school decile, housing deprivation, sleep elsewhere due to financial hardship, unsafe environment, and racism, and covariates of school year, gender, and rurality. Independent variables were identified a priori, based on social determinants of health literature and available Youth19 variables. Potential multicollinearity was checked using the PROC REG procedure. Each model had one sleep measure as the outcome variable, and model outputs were adjusted odds ratios and 95% confidence intervals.

Ethics

For each school that participated in Youth19, consent was provided by the principal or head of the board of trustees for students to be invited to take part in the study. Information sheets were distributed by the school to parents/caregivers who could opt-out of their child participating. Randomly selected eligible students were then provided with study information and could choose to decline to participate. Those who took part provided written consent via an online survey screen page.[23] Ethics approval for Youth19 was granted by The University of Auckland Human Subjects Ethics Committee (ref: 022244). Ethics approval to undertake this secondary analysis was granted by the Massey University Human Ethics Southern A Committee (SOA 21/13). Data access for Youth19 data was approved by the Adolescent Health Research Group on February 14, 2022.

Results

The sample consisted of 7721 adolescents (aged 12- to 18-years), with an even distribution of junior and senior students and adolescents who identified as a girl/woman or a boy/man (Table 1). One percent of participants identified as transgender or nonbinary and a further 0.6% reported being unsure of their gender.[32] A similar proportion of Māori and European adolescents lived in major urban, small-town, and rural areas. A larger proportion (> 90%) of Pacific, Asian, and MELAA adolescents lived in a major urban center and a smaller proportion (≤5%) lived rurally, compared to European adolescents (69% and 21%, respectively).

Māori and Pacific adolescents were over-represented in neighborhoods with the greatest socioeconomic deprivation (NZDep2018 quintiles 4 and 5) and in low decile schools (Table 1). A higher percentage of Māori, Pacific, Asian, MELAA, and 'Other' adolescents experienced housing deprivation or slept elsewhere due to a lack of adequate housing, compared to European students. A greater proportion of Māori, Pacific, and 'Other' adolescents reported feeling unsafe, and experiences of racism were more prevalent for Māori, Pacific, Asian, MELAA, and 'Other' young people, compared to European adolescents.

In relation to sleep, a significantly greater proportion of Māori, Pacific, Asian, MELAA, and 'Other' adolescents had short sleep durations, compared to European adolescents (Table 2). A greater proportion of Māori, Pacific, Asian, and MELAA students reported going to bed after midnight on school nights, and a larger percentage of Māori, Pacific, and 'Other' adolescents woke early on school days.

Table 1
Weighted prevalence estimates of sociodemographic characteristics of the sample, stratified by child ethnicity[a]

	Māori (n = 1528)	Pacific (n = 1204)	Asian (n = 1927)	MELAA (n = 210)	'Other' (n = 225)	European (n = 3070)
Sociodemographic variable	Weighted % (95% CI)	Weighted % (95% CI)	Weighted % (95% CI)	Weighted % (95% CI)	Weighted % (95% CI)	Weighted % (95% CI)
School year						
Years 9-10 (junior)	52.0 (49.3-54.6)	46.3 (41.6-51.1)	40.9 (35.5-46.2)	35.6 (28.6-42.6)	68.6 (63.5-73.6)	45.3 (42.5-48.1)
Years 11-13 (senior)	48.0 (45.4-50.7)	53.7 (48.9-58.4)	59.1 (53.8-64.5)	64.4 (57.4-71.4)	31.4 (26.4-36.5)	54.7 (51.9-57.5)
Gender						
Girl/woman	55.1 (47.4-62.8)	58.1 (44.8-71.3)	56.4 (37.7-75.1)	58.9 (45.8-71.9)	45.5 (34.5-56.6)	57.3 (45.2-69.3)
Boy/man	44.9 (37.2-52.6)	41.9 (28.7-55.2)	43.6 (24.9-62.3)	41.1 (28.1-54.2)	54.5 (43.4-65.5)	42.7 (30.7-54.8)
Rurality						
Major urban center	66.6 (54.9-78.2)	92.4 (88.4-96.5)	94.4 (91.3-97.6)	91.2 (85.0-97.3)	78.0 (65.8-90.2)	68.5 (56.4-80.5)
Small town	13.9 (7.8-20.1)	2.6 (1.2-5.0)	2.4 (1.0-5.0)	3.8 (1.0-9.7)	8.2 (3.2-13.3)	10.4 (3.9-17.0)
Rural	19.5 (12.7-26.3)	5.0 (2.6-8.5)	3.1 (1.7-5.2)	5.0 (1.4-8.7)	13.8 (4.9-22.6)	21.1 (13.9-28.4)
Neighborhood socioeconomic deprivation[b]						
1 (least deprived)	11.0 (6.8-15.3)	5.3 (2.3-8.3)	13.6 (9.7-17.5)	17.7 (7.5-28.0)	15.0 (8.1-21.9)	32.4 (26.1-38.7)
2	12.6 (9.0-16.2)	8.3 (4.8-11.7)	22.3 (17.4-27.2)	17.8 (12.4-23.2)	23.0 (14.0-31.9)	25.5 (22.4-28.6)
3	17.8 (12.5-23.2)	12.4 (7.0-17.7)	27.3 (22.2-32.4)	25.7 (17.0-34.5)	17.8 (11.0-24.5)	21.6 (18.7-24.5)
4	20.3 (15.6-24.9)	23.2 (19.7-26.7)	21.0 (16.7-25.3)	15.4 (9.1-21.7)	19.6 (12.9-26.3)	13.4 (10.1-16.8)
5 (most deprived)	38.3 (27.2-49.3)	50.9 (38.9-62.8)	15.8 (7.7-23.9)	23.3 (10.0-36.7)	24.6 (14.6-34.7)	7.1 (4.0-10.2)
School decile						
1 and 2 (most deprived)	27.0 (9.7-44.2)	38.5 (11.4-65.6)	8.6 (0-20.0)	9.4 (0-20.8)	12.9 (1.5-24.3)	2.1 (0.5-5.7)
3 and 4	26.0 (9.1-42.9)	25.0 (2.3-47.7)	16.7 (0-36.9)	23.9 (0.7-47.2)	28.0 (5.9-50.2)	11.7 (1.6-21.8)
5 and 6	16.3 (2.7-29.9)	5.6 (0-14.1)	5.1 (0-12.5)	5.0 (0-11.7)	12.8 (0.2-25.4)	14.4 (1.6-27.2)
7 and 8	15.6 (2.4-28.9)	18.9 (0.4-37.4)	27.9 (5.3-50.5)	29.6 (7.2-52.0)	21.4 (5.3-37.5)	27.4 (8.1-46.8)
9 and 10 (least deprived)	15.1 (4.2-26.0)	12.0 (1.2-22.9)	41.7 (14.9-68.6)	32.0 (10.6-53.4)	24.9 (6.9-42.8)	44.4 (22.1-66.6)
Housing deprivation[c]						
No	65.7 (61.0-70.4)	67.9 (63.5-72.2)	80.7 (78.6-82.7)	72.4 (64.6-80.2)	68.3 (57.8-78.8)	85.5 (83.8-87.3)
Yes	34.3 (29.6-39.0)	32.1 (27.8-36.5)	19.3 (17.3-21.4)	27.6 (19.8-35.4)	31.7 (21.2-42.2)	14.5 (12.7-16.2)
Sleep elsewhere due to lack of adequate housing						
No	82.3 (78.5-86.1)	79.6 (77.1-82.1)	90.4 (89.1-91.7)	88.1 (82.9-93.4)	83.2 (76.7-89.6)	94.7 (93.8-95.5)
Yes	17.7 (13.9-21.5)	20.4 (17.9-22.9)	9.6 (8.3-10.9)	11.9 (6.6-17.1)	16.8 (10.4-23.3)	5.3 (4.5-6.2)
Unsafe environment						
No	46.3 (41.9-50.7)	43.2 (39.3-47.0)	48.8 (44.8-52.8)	48.7 (40.4-57.0)	42.7 (36.3-49.0)	56.1 (52.8-59.3)
Yes	53.7 (49.3-58.1)	56.8 (53.0-60.6)	51.2 (47.2-55.2)	51.3 (43.0-59.6)	57.3 (51.0-63.7)	56.1 (52.8-59.3)
Racism						
No	42.6 (39.3-45.9)	38.7 (34.8-42.7)	41.7 (39.4-44.0)	43.6 (32.3-54.9)	38.7 (30.6-46.8)	69.8 (66.9-72.6)
Unsure	22.2 (19.8-24.5)	25.1 (22.1-28.1)	26.3 (23.1-29.4)	17.6 (12.5-22.8)	29.6 (22.9-36.3)	14.1 (12.7-15.6)
Yes	35.2 (32.2-39.3)	36.1 (30.7-41.6)	32.0 (29.1-34.9)	38.8 (30.1-47.5)	31.7 (21.8-41.7)	16.1 (14.0-18.2)

Abbreviations: CI, confidence interval; MELAA, Middle Eastern/Latin American/African.
[a] Reported by total Māori, Pacific, Asian, MELAA, 'Other', and sole European child ethnicity.
[b] Neighborhood socioeconomic deprivation based on NZDep2018 quintiles.
[c] At least one of four indicators of housing deprivation including serious housing deprivation, housing financial stress, families splitting up because of inadequate housing, and frequently moving house.

Results of multivariable logistic regression models (Table 3) indicated that ethnicity was independently associated with sleep duration and sleep timing on school days, after adjusting for social determinants, school year, gender, and rurality. Māori adolescents had 1.4 times higher odds of short sleep and 1.5 times higher odds of early waketimes, compared to European adolescents. In addition, Pacific adolescents had twice the odds of short sleep or early waketimes and approximately 1.6 times higher odds of late bedtimes, Asian adolescents had 1.7 times and 1.6 times higher odds of short sleep and late bedtimes respectively, and 'Other' adolescents (including MELAA) had 1.9 times higher odds of short sleep durations and 1.8 times higher odds of early waketimes, compared to European adolescents.

Independent associations were identified between social determinants and sleep (Table 3). Adolescents living in neighborhoods with the greatest socioeconomic deprivation had over one and a half times greater odds of short sleep durations and early waketimes than those living in least deprived areas. Whereas adolescents attending lower decile schools (deciles 1-4, indicative of greater deprivation) had three times higher odds of late waketimes on school days compared to students attending highest decile schools. Adolescents who experienced housing deprivation in the past 12 months had approximately one and a half times greater odds of having short sleep, late bedtimes, and/or late waketimes on school days. Having to sleep elsewhere due to a lack of adequate housing was associated with one and a half times higher odds of short sleep durations and early waketimes. Unsafe environments were associated with 1.2 greater odds of early waketimes. Exposure to racism was associated with higher odds of short sleep, late bedtimes, and early waketimes.

Discussion

To the best of our knowledge, this is the first study specifically designed to investigate ethnic inequities in, and social determinants of, adolescent sleep health in NZ. Indigenous and ethnically minoritized adolescents reported a higher prevalence of poor sleep and multivariable modeling suggests that ethnicity, a marker for unmeasured social determinants, was independently associated with short sleep duration, later bedtimes, and earlier waketimes. We provide some of the first data worldwide on sleep durations, sleep timing, and sleep inequities experienced by Indigenous youth, who are under-represented in sleep research.[8,33] Our findings indicate that the racialized ways in which resources and power are allocated across society, that is, social determinants of health, are shaping sleep health for Indigenous and other minoritized young people.[34]

A significantly larger proportion of Māori adolescents had short sleep (26%), bedtimes after midnight on school nights (10%), and

Table 2
Weighted prevalence estimates of sleep health variables, stratified by child ethnicity[a]

	Māori (n = 1528)	Pacific (n = 1204)	Asian (n = 1927)	MELAA (n = 210)	'Other' (n = 225)	European (n = 3070)
Sleep variable	Weighted % (95% CI)	Weighted % (95% CI)	Weighted % (95% CI)	Weighted % (95% CI)	Weighted % (95% CI)	Weighted % (95% CI)
Sleep duration[b]						
Short	25.8 (22.9-28.8)	32.3 (28.3-36.3)	25.7 (23.2-28.3)	29.9 (21.5-38.3)	26.5 (20.5-32.5)	15.6 (14.0-17.1)
Recommended	73.4 (70.5-76.3)	66.7 (62.8-70.5)	73.8 (71.3-76.3)	68.9 (60.5-77.3)	73.5 (67.5-79.5)	84.1 (82.5-85.6)
Long	0.8 (0.3-1.6)	1.0 (0.2-2.8)	0.5 (0.2-1.0)	1.2 (0.2-4.1)	0	0.4 (0.2-0.7)
Bedtime school night						
Before 9 PM	10.7 (8.7-12.7)	9.5 (7.3-11.6)	3.9 (2.7-5.5)	4.4 (1.1-11.2)	12.6 (7.7-17.6)	10.2 (8.6-11.8)
Between 9 PM-10 PM	34.7 (31.2-38.3)	27.5 (24.7-30.3)	24.0 (21.4-26.6)	24.0 (17.2-30.8)	37.2 (30.4-44.0)	37.7 (35.0-40.4)
Between 10 PM-11 PM	29.2 (25.7-32.7)	28.7 (26.4-31.0)	34.6 (31.7-37.4)	36.0 (29.0-43.1)	28.7 (20.8-36.6)	32.1 (29.9-34.4)
Between 11 PM-12 AM	15.6 (13.0-18.3)	20.4 (17.9-22.9)	26.4 (23.6-29.1)	22.2 (16.4-28.0)	12.8 (8.7-16.9)	14.2 (12.3-16.1)
After midnight	9.7 (7.1-12.4)	14.0 (10.8-17.2)	11.2 (9.6-12.7)	13.4 (8.3-18.4)	8.6 (4.4-12.8)	5.7 (4.6-6.8)
Waketime school day						
Before 5 AM	2.1 (1.3-3.3)	3.6 (2.2-5.5)	1.6 (1.0-2.5)	1.7 (0.2-5.5)	2.4 (0.5-6.9)	1.4 (1.0-2.0)
Between 5 AM-6 AM	13.9 (11.7-16.0)	15.8 (12.3-19.3)	10.8 (8.9-12.6)	12.6 (8.0-17.2)	20.3 (13.2-27.5)	9.1 (7.6-10.6)
Between 6 AM-7 AM	45.1 (41.4-48.9)	42.3 (37.2-47.4)	38.3 (34.7-41.9)	38.9 (31.8-45.9)	41.2 (32.5-49.8)	47.5 (44.4-50.7)
Between 7 AM-8 AM	33.3 (29.2-37.3)	31.9 (26.0-37.9)	45.3 (41.0-49.7)	40.9 (32.6-49.3)	31.2 (22.1-40.3)	39.8 (36.2-43.3)
Between 8 AM-9 AM	3.8 (2.5-5.4)	4.1 (2.3-6.8)	3.4 (1.6-6.3)	4.8 (1.4-11.5)	4.9 (2.1-9.4)	1.9 (1.1-3.0)
After 9 AM	1.8 (0.9-3.2)	2.3 (1.3-3.5)	0.6 (0.2-1.1)	1.1 (0.1-4.4)	0	0.3 (0.1-0.6)

Abbreviations: CI, confidence interval; MELAA, Middle Eastern/Latin American/African.
[a] Reported by total Māori, Pacific, Asian, MELAA, 'Other', and sole European ethnicity.
[b] Short sleep duration: 12- to 13-years < 9 h, 14- to 17-years < 8 h, 18-years < 7 h/recommended sleep duration: 12- to 13-years 9-11 h, 14- to 17-years 8-10 h, 18-years 7-9 h/long sleep duration: 12- to 13-years > 11 h, 14- to 17-years > 10 h, 18-years > 9 h.

early waketimes on school days (14%), compared to European adolescents (16%, 6%, and 9%, respectively). Findings compare with a systematic review of sleep health in Aboriginal and Torres Strait Island children and adolescents (0- to 17-year-olds) which indicated that Indigenous youth in Australia are also more likely to have short sleep than non-Indigenous young people.[35] However, in contrast to our research, the estimated prevalence of short sleep was lower (≤10%) and was based largely on studies of preadolescent children thus inhibiting direct comparisons of findings. Due to the current paucity of literature on Indigenous adolescent sleep, it is unclear how the inequitable patterns of late bedtimes and early waketimes that we identified for Māori compare to Indigenous youth elsewhere, highlighting the need for future research in this area.

Māori adolescents in our study were impacted by stark inequities in a wide range of social determinants of poor sleep health, with approximately one-third living in neighborhoods with the greatest socioeconomic deprivation, attending schools with the greatest deprivation, or experiencing housing deprivation. Almost one-fifth reported having to sleep elsewhere (e.g., in a garage) due to a lack of adequate housing, approximately half felt unsafe in their local environments, and almost two-thirds were impacted by racism as indicated by being "unsure" or definitely being treated unfairly or bullied because of their ethnic group. Historical and contemporary impacts of colonization have resulted in entrenched social inequities for Māori, including being consistently over-represented in the most socioeconomically deprived neighborhoods[16,17] and being more likely to experience racism[18,36] than Europeans, which has resulted in Māori adolescents being at greater risk of poor health.[37] This is indicative of structural racism[38] and is a breach of the United Nations Declaration on the Rights of Indigenous Peoples.[39] We add to the literature by providing further evidence of myriad unjust, systemic social inequities experienced by Indigenous youth and demonstrate that these are associated with poor sleep health.

In addition, our findings add to international evidence that adolescents from minoritized ethnic groups are disproportionately impacted by poor sleep health compared to young people from dominant ethnic groups. Approximately one-third of Pacific and MELAA and over one-quarter of Asian and 7 'Other' adolescents had short sleep durations, compared to 16% of European adolescents. A significantly greater proportion of Pacific, Asian, and MELAA youth went to bed after midnight on school nights, and a significantly larger proportion of Pacific and 'Other' adolescents woke early on school mornings, compared to European young people. Our results compare with those in the US indicating that Black and Hispanic youth are more likely to have shorter and poorer quality sleep than White youth.[1] They also contribute to the literature by providing evidence of sleep inequities experienced by other minoritized groups for whom little or no research has been previously conducted, that is, Pacific, Asian, MELAA, and 'Other' adolescents residing in NZ.

The patterning of social inequities varied across minoritized ethnic groupings in our study. Pacific adolescents were greatly impacted by deprivation, with over half living in the most deprived neighborhoods, and more than one-third attending low decile schools or experiencing housing deprivation. This is reflective of Pacific peoples in NZ having long been impacted by discriminatory immigration, employment, and social policy[40] resulting in intergenerational trauma and entrenched socioeconomic and housing inequities.[15-17] Considered in conjunction with findings for Māori adolescents outlined above, results suggest that the sleep inequities observed for Māori and Pacific youth were largely explained by systemic differences in deprivation. Findings compare to associations between neighborhood disadvantage and poor adolescent sleep health previously reported[41] and contribute new knowledge on links between school-level deprivation and adolescent sleep health.

Approximately one-third of Māori, Pacific, MELAA, and 'Other' adolescents experienced housing deprivation, and a disproportionate number of these youth had to sleep elsewhere due to a lack of available adequate housing. These aspects of housing deprivation were independently associated with increased odds of shorter sleep, late bedtimes, and/or early waketimes. We contribute to current literature on the negative impacts of poor housing on multiple aspects of health[42] by providing evidence that sleep is also impacted, highlighting the importance of addressing housing inequities as a public health priority.

Over half of Pacific and 'Other' adolescents felt unsafe in one or more of their immediate environments, similar to patterns observed for Māori. The fact that Indigenous and minoritized adolescents in NZ are not being afforded their basic right to feeling safe is in breach of the United Nations Convention on the Rights of the Child.[43] We

Table 3
Results of multivariable logistic regression models (with weighting) investigating social determinants of good and poor adolescent sleep health

	Short sleep duration[a]	Late bedtime (After midnight)[b]	Early waketime (6 AM or earlier)[c]	Late waketime (8 AM or later)[c]
Multivariable model[d]	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)
Ethnicity[e]				
Māori	**1.40 (1.13-1.73)**	1.18 (0.79-1.76)	**1.46 (1.12-1.89)**	1.67 (0.98-2.84)
Pacific	**1.98 (1.57-2.50)**	**1.58 (1.16-2.14)**	**2.10 (1.60-2.77)**	1.40 (0.68-2.89)
Asian	**1.70 (1.43-2.01)**	**1.57 (1.19-2.07)**	1.21 (0.95-1.56)	1.30 (0.70-2.44)
'Other'	**1.89 (1.40-2.56)**	1.55 (0.97-2.48)	**1.76 (1.24-2.48)**	1.45 (0.67-3.13)
European	Ref	Ref	Ref	Ref
School year				
Years 9-10 (junior)	Ref	Ref	Ref	Ref
Years 11-13 (senior)	1.05 (0.91-1.20)	**2.26 (1.75-2.92)**	0.87 (0.72-1.05)	**1.66 (1.17-2.35)**
Gender				
Girl/woman	1.14 (0.98-1.33)	**0.74 (0.60-0.92)**	1.11 (0.91-1.35)	**0.43 (0.28-0.64)**
Boy/man	Ref	Ref	Ref	Ref
Rurality				
Major urban center	Ref	Ref	Ref	Ref
Small town	0.97 (0.74-1.27)	0.89 (0.57-1.40)	1.10 (0.76-1.59)	0.71 (0.36-1.40)
Rural	1.15 (0.86-1.53)	0.67 (0.40-1.10)	**1.72 (1.23-2.39)**	**0.45 (0.26-0.77)**
Neighborhood socioeconomic deprivation				
1 (least deprived)	Ref	Ref	Ref	Ref
2	1.09 (0.88-1.37)	1.16 (0.91-1.49)	1.22 (0.92-1.62)	0.79 (0.36-1.71)
3	1.16 (0.78-1.72)	1.14 (0.78-1.66)	1.25 (0.84-1.85)	1.58 (0.72-3.44)
4	1.19 (0.82-1.72)	1.14 (0.79-1.65)	1.39 (0.97-2.01)	1.08 (0.54-2.19)
5 (most deprived)	**1.56 (1.08-2.27)**	1.15 (0.76-1.73)	**1.68 (1.08-2.61)**	1.36 (0.66-2.78)
School decile				
1 and 2 (most deprived)	0.89 (0.72-1.10)	1.44 (0.83-2.47)	0.79 (0.46-1.34)	**2.66 (1.45-4.89)**
3 and 4	0.96 (0.74-1.25)	1.08 (0.86-1.35)	0.95 (0.64-1.41)	**3.17 (2.03-4.93)**
5 and 6	1.09 (0.85-1.39)	1.06 (0.80-1.42)	0.96 (0.70-1.31)	0.84 (0.48-1.48)
7 and 8	1.11 (0.85-1.46)	0.89 (0.65-1.22)	0.95 (0.68-1.33)	0.97 (0.60-1.57)
9 and 10 (least deprived)	Ref	Ref	Ref	Ref
Housing deprivation				
No	Ref	Ref	Ref	Ref
Yes	**1.43 (1.19-1.72)**	**1.66 (1.30-2.11)**	0.88 (0.71-1.10)	**1.53 (1.03-2.27)**
Sleep elsewhere due to lack of adequate housing				
No	Ref	Ref	Ref	Ref
Yes	**1.48 (1.08-2.03)**	1.31 (0.91-1.88)	**1.49 (1.11-2.01)**	1.12 (0.65-1.91)
Unsafe environment				
No	Ref	Ref	Ref	Ref
Yes	1.13 (0.93-1.37)	1.15 (0.91-1.45)	**1.21 (1.06-1.39)**	1.15 (0.83-1.59)
Racism				
No	Ref	Ref	Ref	Ref
Unsure	**1.44 (1.11-1.86)**	**1.86 (1.26-2.74)**	1.08 (0.86-1.35)	1.29 (0.87-1.91)
Yes	**1.52 (1.34-1.73)**	**1.70 (1.39-2.08)**	**1.24 (1.04-1.47)**	1.02 (0.60-1.73)

Abbreviations: AOR, adjusted odds ratio; CI, confidence interval.
Bold signifies statistical significance.
[a] Reference = "recommended" sleep duration.
[b] Reference = bedtime at midnight or earlier.
[c] Reference = waketime between 6 AM and 8 AM.
[d] Models were concurrently adjusted for ethnicity, school year, gender, neighborhood socioeconomic deprivation (NZDep2018 quintile), school decile, rurality, housing deprivation, sleep elsewhere due to lack of adequate housing, unsafe environment, and racism.
[e] Ethnicity categorized in prioritized order of Māori, Pacific, Asian, 'Other' (including Middle Eastern/Latin American/African and other ethnic groups not included in the previous categories but excluding participants who identified solely with the European ethnic group), and European (sole European).

add to the literature by demonstrating that this is independently associated with waking at 6 AM or earlier, with one interpretation being that chronic stress caused by feeling unsafe may have impacted sleep continuity resulting in early morning waking. However, in contrast to previous literature reporting increased odds of insufficient sleep duration for adolescents who feel unsafe at school or in their neighborhood,[44] we did not identify independent associations between environmental safety and sleep duration. Further investigation in this area is therefore recommended.

Strikingly, over one-third of Pacific, Asian, MELAA, and 'Other' adolescents reported experiencing racial discrimination and over one-quarter of Pacific, Asian, and Other young people reported being "unsure" about potential exposure to racism. As outlined above, figures were similar for Māori and, considered in combination with other social inequities observed, highlight the magnitude of young people's exposure to racism at multiple levels, including structural and interpersonal.[38] The independent associations we identified between racism and short sleep, late bedtimes and early waketimes also build on those previously reported, whereby racial discrimination was associated with shorter, poorer quality, and more disturbed sleep for young people.[45,46] Thus, we provide further evidence for the importance of tackling systemic racism for, amongst other things, supporting the sleep health of adolescents.

Residual confounding was evident, whereby ethnicity remained independently associated with poor sleep health in several multivariable models after adjusting for a range of social determinant variables, school year, gender, and rurality. While we included a range of measures of deprivation at the neighborhood-, school-, and housing-level, other aspects of deprivation not incorporated in these metrics may have contributed to sleep inequities, as well as prejudice based on gender, sexuality, or religion. Aspects of housing quality not included in the housing deprivation measure, such as damp, mold, noise, and light,[42,47,48] may also have influenced how well adolescents slept. Nonetheless, we demonstrate that

differential social positioning and conditions of daily living in a racialized society contribute to adolescent sleep health inequities. Urgent sociopolitical action must therefore be taken to tackle racism and colonialism as the root causes of ethnic inequities in health, including poor adolescent sleep, and other social outcomes.[34]

Several limitations must be acknowledged. As all analyses were cross-sectional, we were unable to establish causal relationships and, due to the sampling strategy employed, results may not be generalizable to the entirety of NZ. This study utilized adolescent self-report survey data which may have been influenced by recall bias. Available sleep data only pertained to school days, therefore, we could not investigate inequities in, and social determinants of, nonschool day sleep, or possible inconsistencies in sleep timing across weekdays and weekends.[49] Due to limited numbers, we were unable to report on the sleep of transgender and nonbinary adolescents. Future research is therefore warranted that places transgender and nonbinary adolescents at the center to better understand their experiences of sleep and factors that may support or impede healthy sleep for this often marginalized population. The fact that adolescent sleep is associated with mental and physical health and academic achievement[3] also raises the question of whether the sleep inequities identified in our study contribute to inequities in health and learning.[50] Future research is therefore recommended to investigate whether sleep plays a mediating role in ethnic inequities in adolescent wellbeing.

Significant strengths of this study included the large, ethnically and socioeconomically diverse sample and the availability of multiple sleep and sociodemographic variables. This enabled us to both identify where adolescent sleep health inequities exist and to broaden understandings of a wide range of social determinants of adolescent sleep health. We were also able to build on previous research by confirming that sleep inequities exist in adolescence, as well as in early childhood[9,11-13] and adulthood[9,10] in NZ, thus indicating that structural inequities in sleep occur across the life course.

Conclusions

Ethnic inequities exist in adolescent sleep health in NZ and are partially explained by inequities in neighborhood socioeconomic deprivation, school-level deprivation, housing deprivation, sleeping elsewhere due to lack of adequate housing, unsafe environments, and racism. Our research provides evidence for urgent political action to redress the array of social inequities experienced by Indigenous and minoritized adolescents to ensure that, amongst other things, all young people are afforded the basic human right of good sleep health.

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Author contributions

DM: Conceptualization, Methodology, Writing (original draft), Writing (review and editing), Project administration, Funding acquisition. **TLS**: Conceptualization, Methodology, Writing (review and editing). **MS**: Formal analysis, Methodology, Writing (review and editing). **TF, TCC, SC, and LD**: Methodology, Writing (review and editing). **SJP**: Conceptualization, Methodology, Writing (review and editing).

Declaration of conflicts of interest

T.C. Clark is the Cure Kids Professorial Chair in Child and Adolescent Mental Health. The authors declare that they have no conflicts of interest.

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