

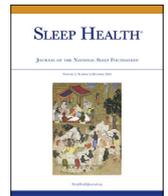


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## How long do preschoolers in Aotearoa/New Zealand sleep? Associations with ethnicity and socioeconomic position

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### ABSTRACT

**Objectives:** To investigate potential sleep inequities in preschoolers in Aotearoa/New Zealand, by examining sleep durations and week/weekend sleep duration differences of Māori (indigenous) and non-Māori preschoolers; and independent associations between ethnicity (child and maternal), socioeconomic position (SEP) and preschoolers' sub-optimal and inconsistent week/weekend sleep durations.

**Design:** Cross-sectional analysis of questionnaire data from the *Moe Kura: Mother and Child, Sleep and Wellbeing in Aotearoa/New Zealand* longitudinal study when children were 3 to 4 years old.

**Participants:** 340 Māori and 570 non-Māori preschoolers and their mothers.

**Measurements:** Measures included preschoolers' usual nighttime sleep duration on week nights (week nighttime sleep) and weekends (weekend nighttime sleep); usual sleep duration across 24 hours, including naps, on week nights (week sleep [24 h]) and weekends (weekend sleep [24 h]) (<10 h/10–13 h/>13 h); and the difference between week and weekend sleep durations per 24 hours (sleep [24 h] difference) (>1 h/≤1 h). Log-binomial regression models investigated associations between child and maternal characteristics and sleep duration measures. Child models included child ethnicity, child gender and child SEP (area and individual socioeconomic deprivation). Maternal models included maternal ethnicity, maternal age and maternal SEP (area and individual socioeconomic deprivation).

**Results:** Ethnicity and low SEP were independently associated with week day sleep (24 h) <10 h, weekend sleep (24 h) <10 h, and with sleep (24 h) difference >1 h.

**Conclusions:** Ethnic and socioeconomic inequities in sleep durations are evident as early as 3 to 4 years of age in NZ, highlighting the importance of addressing the socio-political drivers of sleep inequities early in the life course.

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### Introduction

Short sleep in the preschool years is associated with poorer physical and emotional health outcomes<sup>1,2</sup> and an increased risk of developing obesity.<sup>3</sup> Consistency in sleep duration is also important. Greater differences between week and weekend sleep durations are associated with internalizing behavior in children<sup>4</sup> and increased intake of fat and protein in preschoolers with obesity.<sup>5</sup> Identifying the determinants of poor sleep health early in the life course is therefore important for informing interventions to prevent sleep, and potentially associated health, problems.

International research indicates that children's sleep is socially patterned.<sup>6</sup> In Australia, children classified as being persistent short sleepers across the first 7 years of life were more likely to live in a household experiencing financial hardship.<sup>7</sup> In the US, minority race/ethnicity and low socioeconomic status has been associated with young children having shorter sleep durations at night<sup>8</sup> and across 24 hours.<sup>9</sup> However the relationship between ethnicity and sleep health is not always consistent. A US study found that the distribution of children's sleep differed by race/ethnicity, with Black children more likely to frequently nap, continue to nap through to older age and sleep less at night, but that total weekly sleep durations were similar, compared to Non-Hispanic White children.<sup>10</sup>

In Aotearoa/New Zealand (NZ), the colonization and marginalization of Māori (the indigenous people of NZ) has led to significant ethnic inequities in social and health outcomes.<sup>11</sup> For example,

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Māori children have higher rates of obesity and asthma than non-Māori children. Socioeconomic inequities in child health also exist, with children living in the most deprived neighborhoods having higher rates of obesity, respiratory conditions and communicable diseases such as rheumatic fever, compared to children living in the least deprived areas.<sup>12,13</sup> In regard to sleep, the odds of short sleep duration are greater for Māori adults compared to non-Māori adults, and for adults living in more socioeconomically deprived areas.<sup>14</sup> However, whether ethnic and socioeconomic inequities in sleep duration and consistency exist in early childhood in NZ is unknown.

Aligning with US National Sleep Foundation (NSF) guidelines,<sup>15</sup> the Ministry of Health in NZ advise that preschool-aged children (3–4 years) sleep 10 to 13 hours per 24-hour period and have consistent sleep/wake patterns.<sup>16,17</sup> Current information indicates that 84% of 3 to 4 year olds are obtaining the recommended 10 to 13 hours per day of sleep<sup>17</sup> and 90% of 4 year olds are sleeping 10 to 13 hours at night.<sup>18</sup> However, as associations with ethnicity and socioeconomic position (SEP) have not been reported it is unclear if, or where, inequities exist.

One longitudinal examination of child (n = 939: 19.3% Māori, 11.8% Pacific, 8.0% Asian, 60.9% New Zealand European; age 4–12 years at baseline) sleep in NZ over a 2-year period found that Pacific children had shorter average sleep durations than New Zealand European children, after controlling for age, sex, socioeconomic deprivation, weight status and behavioral factors.<sup>19</sup> There was no significant difference between sleep duration of Māori and New Zealand European children, or by area-level socioeconomic deprivation. Findings were based on secondary analyses of data from two weight management interventions that were not designed to investigate sleep per se, the age range of children was broad, and the sample was geographically limited. The generalizability of results may therefore be limited, warranting further investigation in this area.

The current study considers preschoolers' sleep using a social determinants of health framework<sup>20,21</sup> and an associated socioecological model of sleep.<sup>22,23</sup> The societal context (eg, economic and political systems and policies, institutional racism) is viewed as the fundamental driver of sleep health inequities. Power, privilege and social and economic resources (social determinants) are unevenly distributed across society, resulting in social stratification (eg, by ethnicity, SEP, age, gender) and differential living conditions and behaviors that support or inhibit sleep.

Therefore, we posit that 2 pathways may be involved in determining preschoolers' sleep durations. Preschoolers' own social position within society (indicated by child ethnicity and SEP) may influence how long they sleep. Thus, we predict that Māori children and those who experience greater socioeconomic deprivation will have shorter and more inconsistent sleep durations than non-Māori children and those who have greater socioeconomic resources. Alternatively, given children's young age and maternal dependence, it may be the position that mothers hold in society (indicated by maternal ethnicity and SEP) that influences how long preschoolers sleep. Therefore, we expect that children of Māori mothers and those whose mothers experience greater socioeconomic deprivation will have shorter and more inconsistent sleep durations than children of non-Māori mothers or children whose mothers have greater socioeconomic resources.

The main aims of this study were to: (1) investigate sleep durations and week/weekend sleep duration differences of Māori and non-Māori preschoolers and (2) examine independent associations between ethnicity (child and maternal), SEP and sub-optimal and inconsistent week/weekend sleep durations in a sample of 3 to 4 year olds from across NZ.

## Methods

### Participants

*Moe Kura: Mother and Child, Sleep and Wellbeing in Aotearoa/New Zealand (Moe Kura)* is a longitudinal program of research investigating maternal and child sleep and health in NZ. *Moe Kura* builds upon an existing NZ (69% from the Wellington region of NZ; 31% from the rest of NZ) pregnancy/birth cohort.<sup>24–26</sup> The *Moe Kura* study is guided by Kaupapa Māori epidemiological principles, which is an indigenous approach to undertaking epidemiological studies in NZ, including Māori participation and control at all stages of the research, appropriate classification of ethnicity data to identify and monitor disparities, and equal explanatory power for Māori and non-Māori.<sup>25</sup> Mothers completed sleep and health questionnaires about themselves and their child born in the study cohort when children were 3 to 4 years old. This analysis includes data from Māori (n = 293) and non-Māori (n = 617) mothers and their preschoolers (child ethnicity: Māori n = 340, non-Māori n = 570). Ethics approval was granted by the Central Health and Disability Ethics Committee of NZ (CEN/09/09/070/AM02).

### Measures

#### Child demographic measures

The social construct of *child ethnicity* was measured using the New Zealand Census 2006 ethnicity question.<sup>27</sup> Mothers identified the ethnic group(s) their child belonged to, rather than children's ethnicity defaulting to their mother's, an approach which is consistent with recommended ethnicity data collection protocols in NZ.<sup>28</sup> Children identified as Māori (with or without other ethnic groups) were categorized as 'Māori' and all others as 'non-Māori'.<sup>28</sup> *Child age* was calculated by subtracting child's birthdate from the questionnaire completion date. *Child gender* was dichotomized as girl/boy.

As all preschoolers usually lived with their mother for the majority ( $\geq 4$  nights) of the week, mothers' home and neighborhood environments were viewed as reflecting those of children. Two measures of maternal SEP were therefore used as proxies for child SEP: an area-level index of relative socioeconomic deprivation based on maternal residential address, *NZDep2013*,<sup>29</sup> and an individual-level index of socioeconomic deprivation, *NZiDep*,<sup>30</sup> based on maternal responses.

The *NZDep2013* index is an ordinal scale from 1 to 10 assigned to small geographical areas in NZ based on eight dimensions of deprivation, including income, means tested benefit receipt, transport, household crowding, home ownership, employment status, qualifications, support and internet access.<sup>29</sup> Decile 1 represents the least deprived and decile 10 the most deprived scores. *NZDep2013* quintiles (ie, 5 levels, each representing 20% of small areas) were utilized in these analyses.

The *NZiDep* is an individual-level index incorporating experiences of deprivation in the previous year (yes/no responses to the following situations: being out of paid work, receiving a means-tested benefit, having to buy cheaper food, feeling cold to save money on heating, wearing worn out shoes due to cost, foregoing fresh fruit and vegetables to pay for other necessities, getting help from a community organization in the form of clothes or money, and seeking assistance to obtain food eg, a food bank).<sup>30</sup> As per the standardized scoring protocol, positive responses were summed to produce a score from 1 to 5 (1 = no deprivation characteristics, 2 = 1 deprivation characteristic, 3 = 2 deprivation characteristics, 4 = 3 or 4 deprivation characteristics and 5 = 5 or more deprivation characteristics).<sup>31</sup> *NZiDep* scores are not evenly distributed across the population.<sup>31</sup> For example, 31% of Māori and 54% of non-Māori, non-Pacific people have scores of 1

(no deprivation characteristics) and 29% of Māori and 5% of non-Māori, non-Pacific people have scores of 5 ( $\geq 5$  deprivation characteristics).<sup>31</sup>

### Maternal demographic measures

The social construct of *maternal ethnicity* was self-identified by mothers using the New Zealand Census 2006 ethnicity question<sup>27</sup> and categorized as 'Māori' or 'non-Māori' as described above. *Mother's age* when their child was born was calculated by subtracting child age from maternal age at questionnaire completion and categorized (<20 y/20 to <30 y/30 to <40 y/ $\geq 4$  y). Maternal SEP was measured using the area-level deprivation measure *NZDep2013*<sup>29</sup> based on women's residential address and the individual-level deprivation measure *NZiDep*,<sup>30</sup> described above. We also explored using *maternal education* as a measure of maternal SEP, with women's highest completed educational qualification categorized as no qualification/secondary school qualification/tertiary qualification.

### Child sleep measures

Mothers answered questions about their child's sleep habits over the past 7 days, including "what time did your child usually go to sleep?" and "what time did your child usually wake up?" Nighttime sleep was calculated by subtracting preschoolers' usual sleep start times from usual wake times, during the week (Sunday to Thursday) and on weekends (Friday and Saturday), to produce *week nighttime sleep* and *weekend nighttime sleep*.

Sleep durations per 24 hours, including naps, were measured using a modified version of the Children's Sleep Habits Questionnaire sleep duration question ("what is your child's usual amount of sleep each week day/night, i.e. Sunday to Thursday night? [combining nighttime sleep and naps]"; "what is your child's usual amount of sleep each weekend day/night, i.e. Friday and Saturday? [combining nighttime sleep and naps]")<sup>32</sup> to produce *week sleep (24 h)* and *weekend sleep (24 h)* variables. Sleep (24 h) variables were categorized as <10 h/10–13 h/ $> 13$  h, based on NSF sleep duration guidelines.<sup>15</sup>

*Sleep (24 h) difference* was the absolute difference (in hours) between week and weekend sleep durations per 24 hours. This was categorized as  $> 1$  h/ $\leq 1$  h, based on recommendations that children's sleep schedules should not vary by more than 30 to 60 minutes across the week.<sup>33</sup> *Napping transition* was categorized as stopped napping completely/napping at least some days. This was based on responses to the question "Is your child transitioning away from napping (now not needing a nap every day)?" (yes [does not nap every day]/no [naps every day]/has stopped napping completely) (B. Galland, personal communication, October 24, 2012).

### Statistical analysis

An  $\alpha$  level of .05 was used for analyses. Descriptive statistics and univariate analyses by ethnicity (independent *t* tests) were produced for continuous demographic and sleep variables using IBM SPSS statistical software (Version 23.0). SAS (Version 9.4) was used to calculate unadjusted prevalence estimates, 95% confidence intervals (CI) and Pearson chi-squares for categorical demographic and sleep variables.

Log-binomial regression models were fit using PROC GENMOD (SAS, Version 9.4) to produce fully adjusted prevalence ratios and 95% confidence intervals for sleep duration outcome variables. Independent variables in *child models* were child ethnicity, child gender, child proxy *NZDep2013* quintile and child proxy *NZiDep* score. *Maternal models* included maternal ethnicity, maternal age, maternal *NZDep2013* quintile and maternal *NZiDep* score. Maternal education was not included in models, as most women had at least a secondary

school educational qualification (Māori = 90.4%; non-Māori = 97.7%). Potential multicollinearity of independent variables was checked using PROC REG.

Child and maternal models were initially run with all relevant independent variables plus two interaction terms: ethnicity  $\times$  *NZDep2013* and ethnicity  $\times$  *NZiDep*, to examine whether associations between SEP and sleep durations differed by ethnicity at comparative area- and individual-levels of deprivation. No interactions were significant (Wald statistic:  $P > .05$ ) and therefore were excluded from the final models.

### Results

While most (93%) children belonged to the same ethnic group as their mothers, 16% of the 340 Māori children in the sample had a non-Māori mother and 1% of the 570 non-Māori children in the sample had a Māori mother. Children's ages ranged from 2.9 to 4.7 years for Māori children and 2.9 to 4.8 years for non-Māori children. Māori women were significantly younger than non-Māori women when their *Moe Kura* child was born, a greater proportion of Māori children and Māori mothers lived in socioeconomically deprived areas or experienced individual deprivation, and a smaller percentage of Māori women had a tertiary educational qualification (Table 1).

As outlined in Table 2, average nighttime sleep durations on weekends and average sleep durations (24 h) on weekdays and weekends were shorter for Māori preschoolers than non-Māori preschoolers. The average difference in sleep (24 h) between the week and weekend was larger for Māori children. A significantly greater proportion of Māori children had short sleep durations (24 h) on weekdays and weekends, and sleep (24 h) differences of more than 1 hour between the week and weekend. In contrast, no differences by ethnicity were observed for long sleep durations (24 h;  $> 13$  h). In addition, a smaller proportion of Māori preschoolers had stopped napping completely.

Results from child and maternal multivariate models on short sleep (24 h) and week/weekend sleep (24 h) differences of greater than 1 hour are summarized in Table 3. Model results for long sleep (24 h) were unable to be reliably interpreted due to few preschoolers sleeping  $> 13$  hours, and are therefore not reported.

Findings from child models (Table 3) indicate that Māori children were twice as likely as non-Māori children to have short and inconsistent week/weekend sleep durations, after adjusting for gender and SEP. Increasing neighborhood deprivation was associated with a greater prevalence of short sleep on week days. Preschoolers living in the most deprived neighborhoods (*NZDep* quintiles 4 and 5) were four times more likely to have short sleep during the week than children living in the least deprived areas, independent of ethnicity, gender and individual-level deprivation. In addition, children living in high deprivation neighborhoods (*NZDep* quintile 4) were twice as likely to have inconsistent week/weekend sleep durations than children living in the least deprived areas. Preschoolers whose mothers experienced high individual deprivation (*NZiDep* 5) were twice as likely as children of mothers reporting no deprivation characteristics to have short sleep on the weekend. Although differences in average sleep durations were observed between Māori and non-Māori boys (Table 2), gender was not associated with short or inconsistent week/weekend sleep duration after adjusting for socio-demographic variables (Table 3).

Maternal model results (Table 3) show that Māori mothers were more than twice as likely to have a preschooler with short sleep (24 h) during the week and on weekends, and three times as likely to have a preschooler with week/weekend sleep durations that differed by more than an hour, compared to non-Māori mothers. Mirroring the dose-response relationship observed in child models, increasing neighborhood deprivation was associated with an increasing

**Table 1**  
Demographic characteristics of children and mothers, by ethnicity

Characteristic	% (95% CI)		Māori vs non-Māori		
	Māori Children (n = 340)	Non-Māori Children (n = 570)	$\chi^2$	df	p
Child age (y), mean (SD) <sup>a</sup>	3.1 (0.31)	3.2 (0.27)	0.63	908	.53
Gender:			0.22	1	.64
Girls	49.3 (43.9–54.6)	50.9 (46.7–55.0)			
Boys	50.7 (45.4–56.1)	49.1 (45.0–53.3)			
Area-level deprivation (NZDep2013):			114.70	4	<.01
Quintile 1 (least deprived)	14.5 (10.7–18.3)	34.7 (30.7–38.8)			
Quintile 2	15.4 (11.5–19.3)	26.5 (22.8–30.2)			
Quintile 3	18.7 (14.5–23.0)	18.6 (15.3–21.8)			
Quintile 4	18.7 (14.5–23.0)	11.2 (8.6–13.9)			
Quintile 5 (most deprived)	32.6 (27.6–37.7)	9.0 (6.6–11.4)			
Individual-level deprivation (NZiDep score):			91.12	4	<.01
1 (least deprived)	28.3 (23.5–33.1)	55.2 (51.1–59.3)			
2	24.2 (19.6–28.7)	23.9 (20.4–27.4)			
3	16.5 (12.5–20.5)	10.1 (7.6–12.6)			
4	19.2 (15.0–23.4)	8.1 (5.9–10.4)			
5 (most deprived)	11.8 (8.3–15.3)	2.7 (1.3–4.0)			
	Māori Mothers (n = 293)	Non-Māori Mothers (n = 617)			
Maternal age (y) <sup>b</sup> , mean (SD) <sup>a</sup>	28.4 (6.20)	32.0 (5.07)	8.80	482	<.01
Highest educational qualification:			67.10	2	<.01
Tertiary	64.4 (58.8–69.9)	87.3 (84.7–90.0)			
Secondary	26.0 (20.9–31.0)	10.4 (8.0–12.8)			
No qualification	9.7 (6.3–13.1)	2.3 (1.1–3.5)			
Area-level deprivation (NZDep2013):			141.38	4	<.01
Quintile 1 (least deprived)	12.6 (8.8–16.5)	34.1 (30.2–37.9)			
Quintile 2	13.7 (9.7–17.7)	26.4 (22.9–30.0)			
Quintile 3	17.5 (13.1–22.0)	19.2 (16.0–22.3)			
Quintile 4	18.9 (14.4–23.5)	11.7 (9.1–14.3)			
Quintile 5 (most deprived)	37.2 (31.5–42.8)	8.6 (6.4–10.9)			
Individual-level deprivation (NZiDep score):			98.47	4	<.01
1 (least deprived)	26.4 (21.2–31.5)	54.1 (50.1–58.0)			
2	22.9 (18.1–27.8)	24.5 (21.1–27.9)			
3	17.5 (13.1–21.8)	10.1 (7.7–12.5)			
4	20.2 (15.6–24.8)	8.5 (6.3–10.7)			
5 (most deprived)	13.0 (9.1–16.9)	2.8 (1.5–4.1)			

<sup>a</sup> Independent *t* test (*t*, *df* and *P*) for comparison of means; <sup>b</sup>Maternal age when *Moe Kura* child was born. CI = confidence interval; *df* = degrees of freedom; SD = standard deviation.

likelihood of mothers reporting short preschooler sleep durations during the week. Mothers living in NZDep quintiles 2 to 5 went from being three to almost five times more likely to have preschoolers with short sleep durations during the week, compared to women living in the least deprived areas, after controlling for all other covariates. High maternal neighborhood deprivation (NZDep quintile 4) was also independently associated with inconsistent week/weekend sleep durations for preschoolers. Mothers who experienced the greatest degree of individual deprivation (NZiDep 5) were twice as likely to have a preschooler who had short sleep (24 h) on weekends than mothers who reported no deprivation characteristics.

## Discussion

This study reports the first normative data on sleep durations of Māori and non-Māori preschoolers and provides evidence that ethnic and socioeconomic inequities in sleep duration exist as early as 3 to 4 years of age in NZ. Results suggest that social patterns of short sleep previously reported for NZ adults<sup>14,34</sup> begin early in life. Whether these inequities are intergenerational and persistent across the life course remains to be determined.

Average sleep durations across 24 hours for Māori (week = 11.2 h, weekend = 11.0 h) and non-Māori (week = 11.4 h, weekend = 11.4 h)

preschoolers fell within the recommended 10 to 13 hours for this age group.<sup>15</sup> These normative data indicate that the majority of preschoolers in NZ obtain sufficient sleep, although an examination of short and long sleep indicated that approximately one fifth of Māori and one tenth of non-Māori preschoolers had sleep durations outside of the recommended range. Our findings underscore the importance of going beyond simply describing average durations in order to ascertain which children experience the greatest burden of sub-optimal sleep, and of examining sleep health by ethnicity to ensure that indigenous sleep data are not lost within statistics that include the predominant ethnic group.<sup>35</sup>

We explored the determinants of sub-optimal preschooler sleep durations using indicators of child and maternal social position. In child models, child ethnicity and SEP were independently associated with short and inconsistent sleep durations. Māori children and children living in more socioeconomically deprived environments were more likely to sleep less than 10 hours per 24 hours, and to have sleep durations that differed by more than an hour between the week and weekend, after taking into account child gender. Similarly, maternal models indicated that maternal ethnicity and SEP were independent predictors of preschoolers having short or inconsistent sleep. Results from both models were similar which is likely to reflect, at least in part, the fact that maternal measures of SEP were used as proxy measures of child SEP. It may also indicate that at this young

**Table 2**  
Preschoolers' sleep durations and week/weekend sleep duration differences in hours, by child ethnicity

Sleep variable	Māori (n)	Non-Māori (n)	Māori children	Non-Māori children	Māori vs non-Māori <sup>a</sup>		
			Mean (SD)	Mean (SD)	t	df	P
<b>Nighttime sleep:</b>							
<b>Week:</b>							
Girls	155	276	11.03 (0.82)	11.02 (0.67)	-0.08	270	.94
Boys	163	275	10.75 (1.00)	10.96 (0.77)	2.25	277	.03
All	321	556	10.88 (0.92)	10.99 (0.72)	1.83	547	.07
<b>Weekend:</b>							
Girls	153	272	10.87 (0.90)	11.00 (0.75)	1.44	271	.15
Boys	157	274	10.62 (0.95)	10.90 (0.84)	3.27	429	<.01
All	313	551	10.74 (0.93)	10.95 (0.80)	3.38	570	<.01
<b>Sleep (24 h):</b>							
<b>Week:<sup>b</sup></b>							
Girls	160	282	11.26 (1.58)	11.41 (1.02)	1.13	236	.26
Boys	165	272	11.15 (1.55)	11.46 (1.19)	2.23	281	.03
All	328	559	11.20 (1.56)	11.44 (1.12)	2.48	526	.01
<b>Weekend:</b>							
Girls	161	281	11.06 (1.49)	11.45 (1.11)	2.90	262	<.01
Boys	163	272	11.03 (1.56)	11.42 (1.18)	2.78	272	.01
All	327	558	11.04 (1.52)	11.42 (1.15)	3.96	544	<.01
<b>Sleep (24 h) difference<sup>c</sup>:</b>							
Girls	159	281	0.60 (0.98)	0.29 (0.53)	-3.68	210	<.01
Boys	162	270	0.69 (1.06)	0.34 (0.67)	-3.79	239	<.01
All	324	556	0.65 (1.02)	0.32 (0.67)	-5.13	487	<.01
			% (95% CI)	% (95% CI)	$\chi^2$	df	p
<b>Week sleep (24 h):</b>							
<10 h	328	559	14.3 (10.5-18.1)	4.5 (2.8-6.2)	28.62	2	<.01
10-13 h			79.6 (75.2-84.0)	90.9 (88.5-93.3)			
>13 h			6.1 (3.5-8.7)	4.7 (2.9-6.4)			
<b>Weekend sleep (24 h):</b>							
<10 h	327	558	15.0 (11.1-18.9)	5.6 (3.6-7.5)	23.44	2	<.01
10-13 h			79.8 (75.4-84.2)	90.3 (87.9-92.8)			
>13 h			5.2 (2.8-7.6)	4.1 (2.5-5.8)			
<b>Sleep (24 h) difference<sup>c</sup> &gt; 1 h:</b>							
>1 h	324	556	18.8 (14.5-23.1)	7.0 (4.9-9.1)	28.36	1	<.01
≤1 h			81.2 (76.9-85.5)	93.0 (90.9-95.1)			
<b>Napping:</b>							
Stopped napping completely	333	561	18.6 (14.4-22.8)	35.7 (31.7-39.6)	29.26	1	<.01
Naps at least some days			81.4 (77.2-85.6)	64.3 (60.4-68.3)			

<sup>a</sup> Independent t test (t, df and P) for comparison of means, and Pearson chi-square ( $\chi^2$ , df and P) for comparison of proportions, between Māori and non-Māori children; <sup>b</sup>Outlier of 4 h sleep duration removed; <sup>c</sup>Difference between week/weekend usual sleep duration (24 h). SD = standard deviation; df = degrees of freedom.

**Table 3**  
Adjusted prevalence ratios and 95% CI for short sleep durations (24 h) and week/weekend sleep duration (24 h) differences of greater than 1 hour, child models and maternal models

Child model:	Week sleep (24 h) <10 h <sup>a</sup>	Weekend sleep (24 h) <10 h <sup>b</sup>	Sleep (24 h) difference >1 h <sup>c</sup>	Maternal model:	Week sleep (24 h) <10 h <sup>a</sup>	Weekend sleep (24 h) <10 h <sup>b</sup>	Sleep (24 h) difference >1 h <sup>c</sup>
<b>Child ethnicity:</b>				<b>Maternal ethnicity:</b>			
Non-Māori	Ref	Ref	Ref	Non-Māori	Ref	Ref	Ref
Māori	2.23 (1.31-3.82)	2.04 (1.24-3.36)	2.47 (1.59-3.84)	Māori	2.73 (1.58-4.72)	2.51 (1.51-4.16)	3.31 (2.12-5.15)
<b>Child gender:</b>				<b>Maternal age:</b>			
Male	Ref	Ref	Ref	≥40 y	Ref	Ref	Ref
Female	1.00 (0.64-1.56)	1.00 (0.66-1.52)	0.91 (0.62-1.33)	30-<40 y	1.31 (0.33-5.22)	0.58 (0.24-1.39)	0.64 (0.27-1.51)
				20-<30 y	1.41 (0.35-5.72)	0.63 (0.25-1.57)	1.02 (0.43-2.42)
				<20 y	1.91 (0.41-8.94)	0.58 (0.18-1.89)	0.82 (0.26-2.59)
<b>NZDep2013:</b>				<b>NZDep2013:</b>			
Quintile 1	Ref	Ref	Ref	Quintile 1	Ref	Ref	Ref
Quintile 2	2.58 (0.93-7.17)	1.38 (0.62-3.06)	1.38 (0.70-2.71)	Quintile 2	3.19 (1.05-9.73)	1.48 (0.65-3.39)	1.35 (0.70-2.61)
Quintile 3	2.60 (0.92-7.39)	1.65 (0.75-3.65)	1.56 (0.80-3.08)	Quintile 3	3.22(1.04-10.00)	1.83 (0.80-4.17)	1.34 (0.68-2.64)
Quintile 4	3.91(1.43-10.72)	1.55 (0.68-3.54)	2.34 (1.23-4.43)	Quintile 4	4.71(1.57-14.15)	1.64 (0.70-3.86)	1.96 (1.04-3.70)
Quintile 5	4.14(1.54-11.12)	2.08 (0.97-4.45)	1.27 (0.63-2.55)	Quintile 5	4.52(1.52-13.48)	2.14 (0.96-4.78)	0.99 (0.49-1.98)
<b>NZDep score:</b>				<b>NZDep score:</b>			
1	Ref	Ref	Ref	1	Ref	Ref	Ref
2	0.89 (0.44-1.79)	0.65 (0.31-1.33)	1.22 (0.75-2.00)	2	0.86 (0.43-1.72)	0.64 (0.31-1.33)	1.18 (0.72-1.92)
3	1.38 (0.68-2.79)	1.31 (0.66-2.60)	0.59 (0.27-1.31)	3	1.28 (0.64-2.55)	1.19 (0.60-2.36)	0.63 (0.30-1.33)
4	1.48 (0.75-2.93)	1.70 (0.90-3.19)	1.33 (0.74-2.38)	4	1.26 (0.63-2.53)	1.66 (0.88-3.13)	1.13 (0.63-2.01)
5	1.84 (0.87-3.86)	2.38 (1.21-4.67)	1.52 (0.79-2.89)	5	1.45 (0.68-3.11)	2.05 (1.03-4.08)	1.31 (0.69-2.47)

<sup>a</sup> Usual week sleep duration (24 h): <10 h vs 10-13 h. <sup>b</sup>Usual weekend sleep duration (24 h): <10 h vs 10-13 h. <sup>c</sup>Absolute difference between week/weekend usual sleep duration (24 h): >1 h vs ≤1 h CI = confidence interval.

age, child and maternal experiences are intertwined due to children's developmental stage and associated parental/caregiver dependence. Longitudinal research that tracks relationships between child and maternal ethnicity, SEP and child sleep duration is recommended to ascertain how these patterns may change over time.

Unlike some previous research in the UK which found no relationship between deprivation and child sleep duration,<sup>36</sup> our findings indicate that greater neighborhood-level, and to a lesser extent individual-level, deprivation is associated with preschoolers obtaining insufficient sleep. A dose-response relationship was evident between SEP and short sleep, whereby increasing area-level deprivation was associated with increasing prevalence of short sleep. These results demonstrate unfair and preventable differences in sleep by SEP, indicating a critical role of power and politics that work to create sleep health inequities in NZ.

There are a number of potential pathways that might explain this association between SEP and sleep duration. For example, low socioeconomic status (based on parental education, occupation and income) and living in a disadvantaged neighborhood have been associated with parent and child stress and negative psychological outcomes in the US.<sup>37</sup> Lower socioeconomic status has been associated with a greater likelihood of children having pre-sleep worries<sup>38</sup> and maternal life stress has been associated with shorter sleep duration in preschoolers from low income and minority ethnic groups in the US.<sup>39</sup> It may therefore be that children and mothers with low SEP in our study experienced higher levels of psychosocial stress. This may have had a negative impact on preschoolers' bedtime routines, time in bed, sleep regulation<sup>38,39</sup> and, thus, sleep duration.

Evidence also suggests that low-income families are more likely to experience sub-optimal sleep environments (eg, too loud, too cold) and that this is associated with shorter sleep durations in preschoolers.<sup>40</sup> Although we did not look specifically at the impact of sleeping environments in this study, our measures of SEP incorporated household crowding (NZDep)<sup>29</sup> and cold housing temperatures (NZDep).<sup>30</sup> Therefore, it is possible that the association we found between lower SEP and sub-optimal sleep durations in children may reflect differences in housing and bedroom conditions. Future studies would benefit from further exploration of the pathways involved, including maternal work patterns, childcare arrangements and experiences of single- versus two-parent households. Nonetheless, the findings from our study suggest that addressing the socio-political drivers that result in differential access to socioeconomic resources, such as safe housing and reduced toxic stressors, for parents of young children may reduce inequities in preschooler sleep durations.

Ethnicity was consistently associated with sub-optimal child sleep durations even after controlling for individual- and area-based measures of SEP, suggesting that differences in SEP by ethnicity do not fully explain inequities in child sleep duration.<sup>41</sup> Racism is widely acknowledged to be a fundamental cause of ethnic inequities in health, including via the unfair structuring of the social determinants of health by race/ethnicity.<sup>42</sup> A recent study from Australia found that vicarious racism (via primary caregiver experiences) and direct experiences of racism are associated with school-aged children having greater difficulties settling or staying asleep.<sup>43</sup> In NZ, self-reported racial discrimination is higher for Māori caregivers than those from the European/Other ethnic grouping and up to 30% of Māori children (0-14 years) have experienced vicarious racism compared with up to 14% of European/Other children.<sup>44</sup> While not measured in this study, it may be that differences in experiences of racism between Māori and non-Māori children is an important driver of inequities in preschooler sleep durations. While this is an area requiring further research, our findings clearly show that Māori children are disproportionately impacted by poor sleep. Policies and interventions to improve the sleep health of preschool-aged children will therefore

require significant attention to the structural factors that underpin the unfair treatment of indigenous people in society.<sup>11,45</sup>

While nap durations were not measured in the current study, we did ascertain that a smaller proportion of Māori preschoolers had stopped napping completely, compared to non-Māori preschoolers. This is consistent with napping differences between Black and Non-Hispanic White children in the US reported by Crosby et al<sup>10</sup> and indicates that differences in nighttime sleep observed in our study are likely to have been influenced, at least in part, by daytime napping. This highlights the importance of measuring children's sleep across 24 hours and not assuming that napping cessation occurs at the same time for all children. This is important for informing early childhood education policy that is responsive to children's individual napping needs.

Overall, our study complements and extends the current body of research on the social determinants of preschooler sleep durations, which to date has largely been conducted in the US, by providing evidence of unfair and avoidable differences<sup>46</sup> in preschooler sleep durations within the NZ context. The fact that ethnicity and SEP were independently associated with short sleep across 24 hours (including naps) strongly suggests that children from Māori and low SEP families are unfairly disadvantaged and burdened by insufficient sleep, as opposed to such inequities reflecting choice or cross-cultural differences.<sup>47</sup>

Strengths of our study include the large sample size with a relatively high proportion of Māori participants (37% of children, 32% of mothers) by design. Further strengths include the narrow age range of children and a nationally recruited study cohort with an NZDep profile representative of the NZ general population.<sup>26</sup> The concurrent examination of ethnicity and SEP, of both children and mothers, in our models enabled us to identify the unique contribution of each of these factors in relation to children's sleep durations.

We also acknowledge a number of limitations. The cross-sectional nature of analyses impeded causal interpretations, therefore longitudinal follow up is recommended. We recognize that there may also be relationships between paternal ethnicity, SEP and preschoolers' sleep, however as these were not measured such associations were unable to be examined. Sleep duration was categorized based on NSF 'recommended' sleep durations, therefore some children with sleep durations in the 'may be appropriate' range (8-9 h; 14 h)<sup>15</sup> may in fact have obtained sufficient sleep for their individual needs, whereas we classified their sleep duration as sub-optimal. As sleep was maternally-reported, subjective durations may have differed from objectively measured sleep. The NZDep scores of women in our study did not completely align with the distribution of scores reported in the NZ general population,<sup>31</sup> thus potentially limiting the generalizability of our findings in relation to individual deprivation. That said, a similar overall pattern was evident in our sample and in a nationally representative data set,<sup>31</sup> whereby Māori were disproportionately represented in high individual-level deprivation and under-represented in low individual-level deprivation. As a small proportion of children usually slept more than 13 hours, we were unable to examine independent associations with long sleep. Future research with sufficient statistical power to examine the social determinants of sub-optimal (both short *and* long) child sleep durations is warranted. However, keeping these limitations in mind, we were able to describe the social patterning of preschoolers' sleep durations in NZ and identify areas requiring further research to better understand and address preschooler sleep inequities.

## Conclusions

Ethnic and socioeconomic inequities in sleep durations begin as early as 3 to 4 years of age in NZ, which is a critical public health issue. Māori and families who experience socioeconomic deprivation

are significantly disadvantaged in relation to the length and consistency of preschooler sleep. The findings should be understood in relation to the over-representation of Māori in the most deprived neighborhoods. While further research is required to understand the exact pathways involved, we contend that addressing socio-political drivers of the unequal distribution of power, privilege and resources experienced by Māori and families with low SEP is essential for reducing sleep inequities early in the life course and for preventing future adult sleep inequities.

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