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ORIGINAL RESEARCH ARTICLE

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Low sleep time is associated with higher levels of blood pressure and fat mass in Amerindian schoolchildren

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Abstract

Objectives: While altered sleep patterns (ie, low sleep time) have been studied and reported in adults as a new cardiometabolic risk factor, less information is available on how sleep patterns impact children of different ethnicities. The aim of this study was to compare the levels of blood pressure and other cardiometabolic risk factors in relation to different levels of sleep time in schoolchildren of Amerindian Mapuche or European-ancestry of Southern Chile.

Methods: In a cross-sectional study, 540 Chilean schoolchildren (6-13 years) were divided into two ethnic groups ($n = 119$ Mapuche Amerindians and $n = 421$ European-ancestry). Groups were analyzed according to sleep time per day as registered by parents' report and distributed into quartile categories of sleep time: Mapuche (quartile 1 [Q1] ≥10.0 h, $n = 34$; Q2 9.5-10.0 h, $n = 29$; Q3 8.5-9.0 h, $n = 31$; and Q4 ≤ 8.5 h, $n = 25$), and European (Q1, $n = 99$; Q2, $n = 77$; Q3, $n = 144$; Q4, $n = 101$). The main cardiovascular parameters (systolic [SBP] and diastolic blood pressure) were complemented with anthropometric/body composition (body mass, body mass index [BMI], waist circumference, fat mass, muscle mass, lean mass), cardiorespiratory (heart rate rest, oxygen saturation), and muscle strength (handgrip of dominant and non-dominant arm) outcomes.

Results: From Q1 and across Q2, Q3, and Q4, there was an increase in delta mean SBP in both Mapuche (Δ +17.6 mm Hg) and European (Δ +7.3 mm Hg) schoolchildren with 30-90 min of decreased sleep time (using ≥10 h as reference in Q1). The tendency for worsening of other cardiometabolic risk factors was maintained for delta mean BMI (Δ +2.6 kg/m^2), waist circumference (Δ +12 cm), and fat mass (Δ +8.3%) in Mapuches, whereas European peers showed only worsened waist circumference (Δ +6 cm) across Q2, Q3, and Q4 in comparison with reference Q1. There was also a higher prevalence of hypertension in Mapuche (31.1%) compared to in European schoolchildren (17.6%).

Abbreviations: BMI, body mass index; DBP, diastolic blood pressure; HTN, hypertension; SBP, systolic blood pressure; WC, waist circumference.

Conclusions: Mapuche and European schoolchildren show higher levels of SBP with a decrease in sleep time of 30 min; however, there is a higher prevalence of hypertension and obesity in ethnic Mapuches than in European schoolchildren. These findings indicate that more studies should be applied at early school ages for preventing low sleep time and their related cardiometabolic risk factors for hypertension development in different ethnic groups.

1 | INTRODUCTION

Hypertension is a matter of concern not only in the adult population but also in children, as those developing hypertension early in life are at greater risk of becoming hypertensive in adulthood (Juhola et al., 2012). Childhood hypertension has been associated both with genetic (Wang et al., 2018) and numerous environmental factors, including physical inactivity, fast food (Kar & Khandelwal, 2015), high salt consumption (Campanozzi et al., 2015), long screen time (Lissak, 2018), artificial light (Touitou, Reinberg, & Touitou, 2017), and is highly related with obesity. A previous study cohort showed differences in both obesity (19.1% and 12.2%) and hypertension (18.6% and 28.9%) prevalence between European and Mapuche schoolchildren (Álvarez et al., 2016). Additionally, governmental reports about schoolchildren from the Ministry of Education of Chile have recently described a prevalence of similar characteristics (24.6%) in relation to obesity but did not consider ethnic differences (MINEDUC, 2017). In addition, there is growing evidence for a disrupted pattern of sleep time as a new risk factor for developing hypertension (Lemola, Perkinson-Gloor, Brand, Dewald-Kaufmann, & Grob, 2015; Lissak, 2018). Indeed, a low sleep duration in children could be a risk factor for cardiometabolic conditions in general (Lucas-de la Cruz et al., 2018).

Sleep is an important modulator of neuroendocrine function and glucose metabolism across all ages (Van Cauter & Knutson, 2008). It was recently reported that low sleep duration is related to decreased slow wave sleep similarly related to decreases in heart rate, blood pressure, sympathetic nervous activity, cerebral glucose utilization, as well as the promotion of obesity and type 2 diabetes mellitus by affecting the major hormones that control appetite and energy expenditure, such as leptin and ghrelin (Van Cauter & Knutson, 2008). Thus, low sleep *duration* and *quality* are associated with unhealthy dietary patterns (ie, high fat and glucose consumption) (Kar & Khandelwal, 2015) and poor glucose control (ie, hyperglycemia and insulin resistance; Li et al., 2017). Also, a total bedtime of less than 9 h and 15 min was shown to increase the risk of metabolic syndrome in European children (Lucas-de la Cruz et al., 2018). Recent recommendations from the American Academy of Sleep Medicine state that children aged 6-12 years need to sleep around 9-12 h per day in order to promote an optimal health status (Paruthi et al., 2016). The benefits of meeting the aforementioned recommendations include improvements in children's attention (Li et al., 2013), behavior (Cassoff, Bhatti, & Gruber, 2014), learning, memory and emotional regulation (Vriend, Davidson, Rusak, & Corkum, 2015), quality of life (Wang, Sekine, Chen, Yamagami, & Kagamimori, 2008), as well as mental and physical health (Paruthi et al., 2016). Sufficient sleep duration has also been associated with improved markers of cardiometabolic health in children, including lower levels of adiposity (waist circumference, body fat) and blood pressure, and higher levels of high-density lipoproteins (Feliciano et al., 2018). Thus, meeting nocturnal sleep duration recommendations could be an important and modifiable risk factor that may protect children from overweight/obesity and cardiometabolic diseases in the future (Hunsberger et al., 2015), which is an important consideration in light of the pandemic of childhood obesity in the new millennium (Kimm & Obarzanek, 2002).

The prevalence of cardiometabolic risk factors (notably, obesity at school as example) is increasing in Latin American populations, including in some ethnic groups that are progressively adopting a Western lifestyle, as exemplified by the Mapuche—an indigenous South American population from Argentina and the South of Chile, and their ascendants (Carrasco et al., 2004). Yet, the potential impact of sleep duration on the cardiometabolic health status of these groups and their ascents remains to be determined. Interestingly, Mapuche children show higher levels of blood pressure and obesity than their Chilean peers of European descent, with physical inactivity (ie, do not adhere to 60 minutes of moderate/vigorous phisical activity per day) being especially detrimental (Álvarez et al., 2016). The aim of this study was to determine the association between sleep time and cardiometabolic markers in Mapuche schoolchildren from Southern Chile, as compared with children from the same geographical area but of European descent.

2 | METHODS

2.1 | Design

We followed a cross-sectional design with participants divided into two main categories based on their ethnic background (Mapuche or European descent) from the *Collilelfu* School of Los Lagos, in the South of Chile. All the school children and their parents/guardians signed a written informed consent after been informed in detail about the study aims and procedures. The inclusion criteria were the following: (a) aged 6-13 years, (b) to have Chilean nationality with either familial Mapuche or European descent, (c) to be included in the public health system of the local city (Los Lagos, Chile) with an adherence to school ≥70%, and (d) to receive daily food from the government food plan at school (ie, to receive a breakfast [200 cc of milk plus bread, or cereal plus yoghurt] and a have lunch [i.e., including a main plate, salad, plus a fruit] at school). The exclusion criteria were as follows: (a) to have muscle-skeletal disorders and (b) to wear metal or intra-abdominal devices that could affect bio-impedance measurements of body composition, and (c) to be taking medications that induce sleep. The study was performed in accordance with the Declaration of Helsinki and was approved by the Ethical Committee of the Family Healthcare Centre *Tomas Rojas* of Los Lagos.

From a total of 604 potentially eligible participants, 540 children who met all the inclusion criteria were formally enrolled in the study (Figure 1). To classify the ancestry of the schoolchildren, we used the two family surnames of the participants relating to a first degree of Mapuche or European or a second familial degree of Mapuche or European, similar to previous studies (Álvarez et al., 2016; Morgan, Wei, & Virnig, 2004).

2.2 | Endpoints

Sleeping time was measured using a questionnaire for parents/guardians that included eight items: (a) sociodemographic data (participant and family surnames), (b) family members and relatives (other ethnicity Mapuche/European link), (c) sleep time including bed and wake times, (d) type and

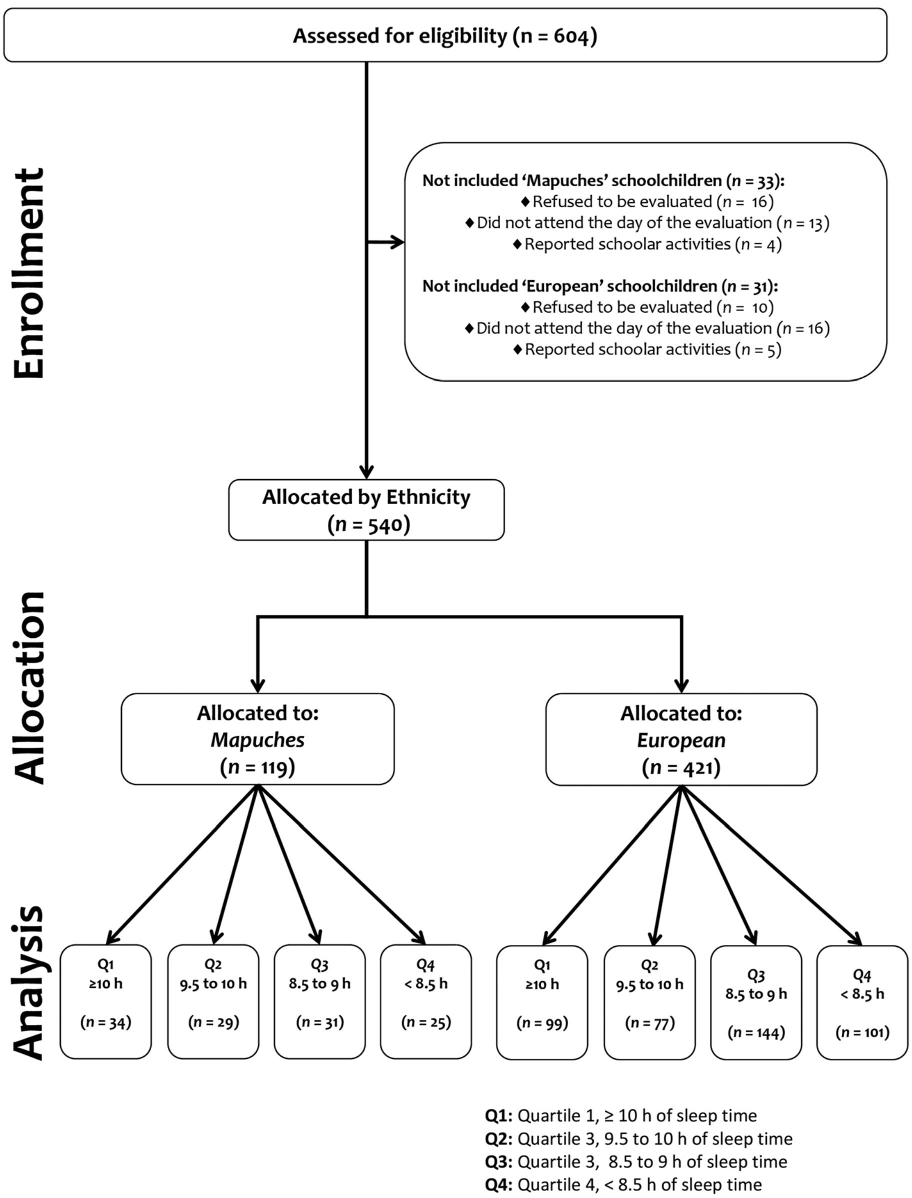

FIGURE 1 Participant's flow diagram

amount of electronic devices use, (e) type and time of light at home, (f) behavior in food consumption (number of extra-school meals/type and amount of beverages), (g) behavior in physical activity patterns (time of any physical activities intra- or extra-school), and (h) sedentary time (time of sedentary activities). Sleep time was calculated from the difference in hours between going to bed and morning awakening, according to the parents/guardians' information declared in the questionnaire.

The participants were assessed for anthropometry/body composition endpoints between 9:00 AM and 13.00 PM (morning) Body mass (in kg, to the nearest 0.1 kg) and height (in m, to the nearest 0.1 m, to determine body mass index [BMI]) were measured with a professional stadiometer and scale (Health o Meter Professional, Sunbeam Products Inc., Chicago, IL). Waist circumference (in cm, to the nearest 0.1 cm) was measured using a flexible and inextensible measuring tape (Hoechstmass, Sulzbach, Germany). Body fat (percentage, %) and muscle mass (kg) were assessed by bioelectrical impedance analysis using a digital scale (InBody 270, Biospace, Inc., Seoul, Korea) with two different (20 and 100 kHz) frequencies. This procedure was conducted without metal or watches to increase accuracy, and the average of three measurements was used.

Blood pressure was determined using an automatic monitor (Omron HEM 7114, Omron Healthcare Inc., Lake Forest, IL) in triplicate (2-min interval between measurements) and after 15 min of rest with the subjects in a seated position. The prevalence of normotension, prehypertension, and hypertension was estimated using standard criteria for children and adolescents (American Academy of Pediatrics, 2004).

Handgrip strength in the dominant (HGSd), and non-dominant (HGSnd) arm was assessed as determined elsewhere (Ramírez-Vélez et al., 2017) with an adjustable grip (Jamar, PLUS+, Sammons Preston, Patterson Medical, Bolingbrook, IL). Participants were instructed to gradually and continuously tighten their grip for at least 5 s of maximal effort while receiving standardized verbal motivation, performing the test twice (alternately with both hands).

Oxygen partial saturation (SpO2) was measured during 15-30 s with a finger pulse oximeter (model CMS50M, Therapeutics Goods, ARTG Inc., Australia), with a precision of 70 to ~100 ± 2%. Using the same device, we obtained the heart rate at rest, in a range of 30-250 beats/min, with precision ±2 beats/min or 2%. The mean of three data points (at 10, 20, and 30 s) was registered, and we included the mean value of these.

2.3 | Statistical analyses

Participants were grouped into quartiles (Q1; > 10 h, Q2; 9.5-10 h, Q3; 8.5-9 h, and Q4; ≤8.5 h) of sleeping time. The first quartile (Q1, ≥10 h) was used as the reference in most cases, and multiple comparisons were made across Q1 and Q4. Associations between the sleep patterns by quartiles of sleeping time were analyzed using the General Linear Model and Logistic regression. Additionally, the *P*-trend was calculated to test the worsening of the outcomes across the quartiles. A two-way analysis of variance was used for the analyses of continuous outcomes by ethnicity (ie, Mapuche vs European) and sleep time quartiles Q1-Q4 differences. In each ethnic group and using the Q1 reference for sleep time, we calculated the delta difference (ie, Q1+ or Q1−) from Q2, Q3, and Q4 in comparison with Q1 for each main (systolic blood pressure [SBP], diastolic blood pressure [DBP]) and secondary (BMI, waist circumference, fat mass, muscle mass) outcome studied. Similarly, using the same Q1 reference, we calculated the delta mean of increases/decreases within the Mapuche (ΔMap) and European (ΔEur) ethnic groups. All models were adjusted for age, sex, height, sedentary time, and sugar consumption by beverages in addition to the school-based food. Data were analyzed with SPSS software, version 23 (SPSS Inc., Chicago, IL), with α set at .05.

3 | RESULTS

3.1 | Within-group comparisons by quartiles of sleep time

In anthropometric outcomes, there were significant differences ($P < .05$) in body mass in Mapuche children between Q2 (50.0 kg; 95% confidence interval [CI] 31.8-68.2) and Q1 (40.4 kg; 95% CI 27.5-53.2), and between Q3 (39.0 kg; 95% CI 24.1-53.8) and Q2 (50.0 kg; 95% CI 31.8-68.2); as well as in European children between Q3 (37.4 kg; 95% CI 32.2-42.7) and Q1 (57.1 kg; 95% CI 46.6-67.6), between Q3 (37.4 kg; 95% CI 32.2-42.7) and Q2 (46.4 kg; 95% CI 36.6-56.1), and between Q4 (37.3 kg; 95% CI 30.6-43.9) and Q1 (57.1 kg; 95% CI 46.6-67.6; Table 1). Significant differences ($P < .05$) were also found in height in Mapuche children between Q4 (147.7 cm; 95% CI 135.5-159.9) and Q1 (137.5 cm; 95% CI 125.3-149.7); as well as in European children between Q3 (135.8 cm; 95% CI 130.8-140.8) and Q1 (154.6 cm; 95% CI 144.7-164.6), and between Q4 (147.7 cm; 95% CI 135.5-159.9) and Q1 (154.6 cm; 95% CI 144.7-164.6; Table 1). No inter-quartile differences in BMI, oxygen saturation and muscle strength were observed in intra-group comparisons (Table 1).

Between-group comparisons (ie, Mapuche vs European in Q1, Q2, Q3, and Q4), showed that body mass was higher in European (57.1 kg; 95% CI 46.6-67.6) vs Mapuche (40.4 kg; 95% CI 27.5-53.2) children in Q1 (Table 1). Also, height was significantly different in Q1 between European (154 cm; 95% CI 144.7-164.6) and Mapuche (137.5 cm;

TABLE 1 Characteristics of the sample according to quartiles of sleeping time in Mapuches and European schoolchildren

	Quartiles of sleeping time									
	(≥10 h) Q1 Mean (95%CI)		(9.5-10 h) Q2 Mean (95%CI)		(8.5-9 h) Q3 Mean (95%CI)		(<8.5 h) Q4 Mean (95%CI)			
	Mapuches	**European**	**Mapuches**	**European**	**Mapuches**	**European**	**Mapuches**	**European**	**Δ/*P*-trend Mapuches**	**Δ/*P*-trend European**
n	34	29	31	25	99	77	144	101		
Age (years)*	9.7 (7.9-11.5)	11.8 (10.3-13.2)	10.0 (7.4-12-5)	10.8 (9.5-12.1)	8.6 (6.6-10.7)	8.9 (8.2-9.6)	11.5 (9.7-13.2)	9.1 (8.2-10.0)		
Anthropometric										
Height (m)	137.5 (125.3–149.7)	154.6 $^{\text{Map}}$ (144.7–164.6)	141.5 (124.2–158.7)	147.7 $^{\text{Map}}$ (138.4–156.9)	136.6 (122.5-150.7)	135.8 $^{\text{E1}}$ (130.8–140.8)	147.7 $^{\text{M1}}$ (135.5–159.9)	133.6 $^{\text{Map, E1}}$ (127.3–139.9)	+4.4 $P = .342$	−15.5 $\boldsymbol{P < .0001}$
Body mass (kg)*	40.4 (27.5–53.2)	57.1$^{\text{Map}}$ (46.6–67.6)	50.0$^{\text{M1}}$ (31.8–68.2)	46.4 (36.6–56.1)	39.0$^{\text{M2}}$ (24.1–53.8)	37.4$^{\text{E1, E2}}$ (32.2–42.7)	41.5 (28.7-54.4)	37.3$^{\text{E1}}$ (30.6–43.9)	+3.1 $P = .084$	−16.7 $P = .121$
Body mass index (kg/m^2)	20.1$^{\text{Eur}}$ (18.9-21.1)	19.3 (18.2-22.8)	21.2 (19.2-23.8)	20.1 (18.6-22.3)	23.3$^{\text{Eur}}$ (22.5-24.1)	21.2 (19.1-24.1)	21.5 (19.0-23.6)	23.1$^{\text{Map}}$ (22.7-23.8)	+2.6 $P = .021$	+1.3 $P = .055$
Cardiorespiratory										
Heart rate rest (beats/min)*	83 (70-96)	96 (86-107)	83 (65-101)	90 (80-99)	89$^{\text{M1}}$ (75-104)	87 (81-92)	104$^{\text{M1}}$ (92-117)	89$^{\text{E1}}$ (83-96)	+9.0 $P = .102$	−7.6 $P = .211$
SpO_2 (%) *§	97 (95-99)	98 (96-100)	89 (84-93)	98$^{\text{Map}}$ (95-100)	98 (94-100)	98 (94-100)	97 (96-100)	96 (94-98)	−2.8 $P = .324$	−1 $P = .644$
Muscle strength										
HGSd (kg)*	18.3 (13.5-23.1)	19.6 (15.7-23.5)	22.7 (15.9-29.4)	19.3 (15.7-22.9)	16.6 (11.1-22.1)	16.6 (11.1-22.1)	19.0 (14.2-23.7)	15.2$^{\text{Map}}$ (12.7-17.6)	+1.1 $P = .421$	−2.5 $\boldsymbol{P = .031}$
HGSnd (kg)*	18.1 (14.2-22.5)	19.4 (16.0-22.7)	20.5 (14.6-26.4)	18.3 (15.2-21.4)	16.5 (11.7-21.3)	14.7 (13.0-16.4)	18.5 (14.4-22.6)	14.5$^{\text{Map}}$ (12.4-16.6)	+0.4 $P = .366$	−3.5 $\boldsymbol{P < .0001}$

The two-way ANOVA was used for testing the sleep time quartiles by ethnic group. (M1) Denotes significant differences vs Mapuches Q1 at $P < .05$; (M2) Denotes significant differences vs Mapuches Q2 at $P < .05$. (E1) Denotes significant differences vs European Q1 at $P < .05$; (E2) Denotes significant differences vs European Q2 at $P < .05$. (Map) Denotes significant differences between European vs Mapuches within-quartile at $P < .05$. (Eur) Denotes significant differences between Mapuches vs European within-quartile comparison at $P < .05$.

Abbreviations: BMI, body mass index; Q, quartile; SpO_2, peripheral oxygen saturation Age: Ptrend Mapuches: $P = 321$; Age: Ptrend European: $P = 288$.

95% CI 125.3-149.7) children, in Q2 between European (147.7 cm; 95% CI 138.4-156.9) and Mapuche (141.5 cm; 95% CI 124.2-158.7), and in Q4, where European children showed a lower height (133.6 cm; 95% CI 127.3-139.9) than Mapuche peers (147.7 cm; 95% CI 135.5-159.9; Table 1). In the Q2 comparison, oxygen saturation was higher in European (97.8 SpO_2; 95% CI 95.4-100) than in Mapuche (88.5 SpO_2; 95% CI 83.9-93.0) children, and in Q4 handgrip strength was lower in European children in both the dominant arm (15.2 kg; 95% CI 12.7-17.6) vs Mapuche (19.0 kg; 95% CI 14.2-23.7) and in the nondominant arm (14.44 kg; 95% CI 12.4-16.6) vs Mapuche (18.5 kg; 95% CI 14.4-22.6; Table 1).

In Mapuche schoolchildren, BMI was significantly higher in Q3 than in Q1 (+4.4 kg/m^2) and Q2 (+2.5 kg/m^2; Figure 2A). Similarly, in European peers, there was an

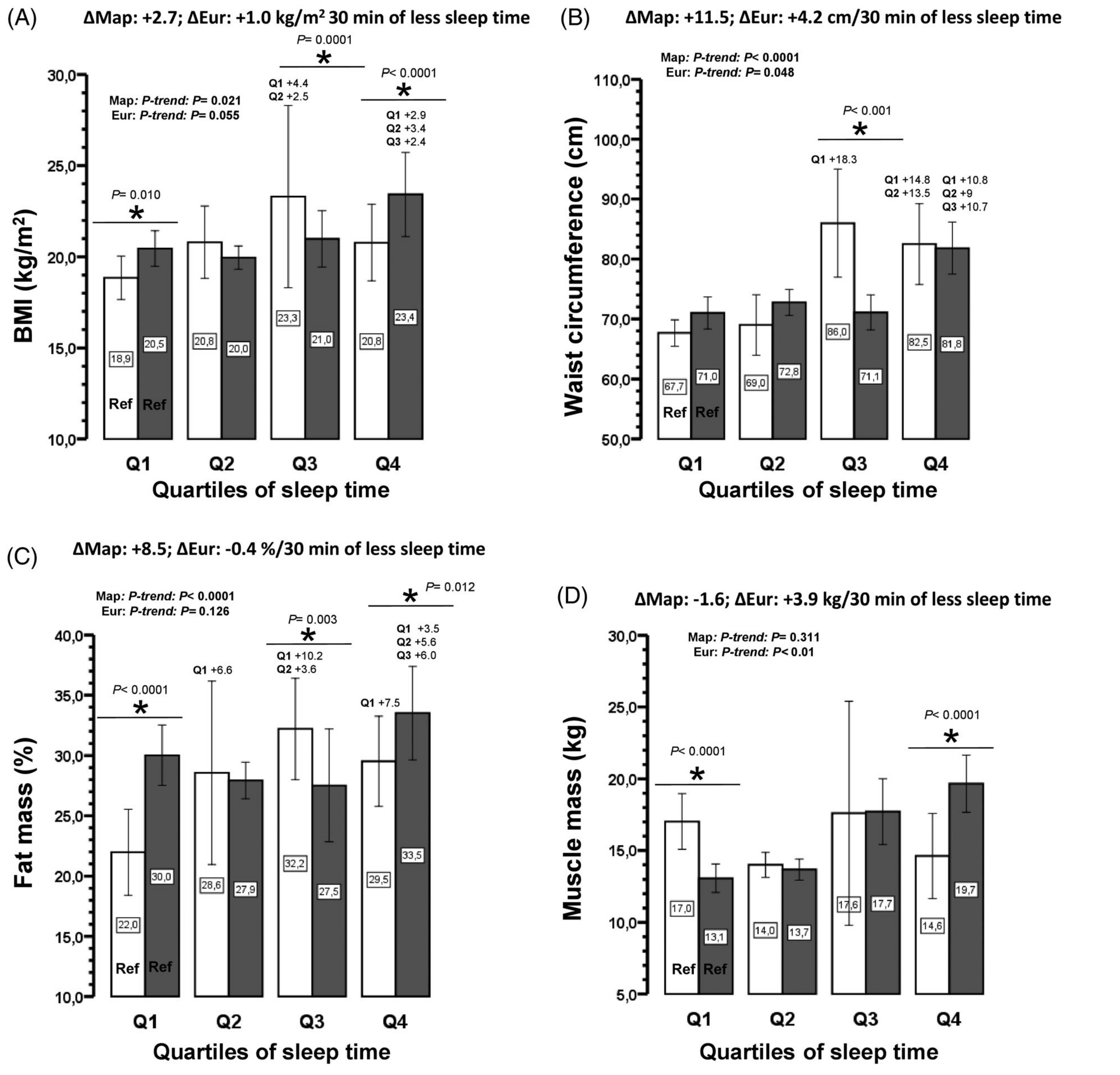

FIGURE 2 Body mass index (BMI, A), waist circumference (B), fat mass (C), and muscle mass (D) by group (ie, Mapuches [Map] or 'European' [Eur]) according to quartiles (Q) of sleeping time. Definition and ranges of Quartiles are described as follows: Q1, sleeping time >10 h; Q2, sleeping time = 9.5-10 h; Q3, sleeping time = 8.5-9 h; Q4, sleeping time <8.5. (Ref) denotes the reference quartile of Mapuches or European group. Differences between quartiles are described as (Q1) denotes significant ($P < .05$) differences from the Ref Q1 in the same respective Map or Eur group; (Q2) denotes significant ($P < .05$) differences from the Q2 in the same respective Map or Eur group; and (Q3) denotes significant ($P < .05$) differences from the Q3 in the same respective Map or Eur group; (*) denotes significant differences between Mapuches vs European at each respective Quartile with their P-value described

increase in BMI of +2.9, +3.4, and +2.4 in Q4 vs Q1, Q2, and Q3 (Figure 2A). There were also significant differences in mean ± SE BMI in Q3 between Mapuche (23 ± 5) and European (21 ± 2 kg/m^2) children and at Q4 (Mapuche 23.3 ± 3 vs European 21.0 ± 2) (Figure 2A). In Mapuches, waist circumference in Q3 was also higher (+18.3 cm) vs Q1, and in Q4 vs Q1, and Q4 vs Q2 [+14.8 and + 13.5 cm, respectively; Figure 2B). European peers showed +10.8, +9.0, and +10.7 cm higher waist circumference in Q4 vs Q1, Q2, and Q3, respectively (Figure 2B). In Q3, Mapuche children showed a significantly higher waist circumference, 86.0 ± 10 vs European 71.1 ± 3 cm ($P < .001$) (Figure 2B). Overall, the *P*-trend for increasing BMI, waist circumference, and fat mass was higher in Mapuches at Δ +2.6 kg/m^2 ($P = .021$), +12.0 cm ($P < .0001$) and +8.3% ($P < .0001$), respectively, than in European peers (Figure 2A-C), and also, exceptionally, in waist circumference of European school children (+6.0 cm, $P = .048$; Figure 2B).

There were significant differences in mean ± SE fat mass between Mapuche and European children in Q1 (22.0 ± 4 vs 30.0 ± 3%, $P < .0001$; Figure 2C). Additionally, in Mapuches, there was an increase in fat mass of +6.6% between Q2 vs Q1, +10.2% between Q3 vs Q1, +3.6% between Q3 vs Q2, and +7.5% between Q4 vs Q1 (Figure 2C). In Q4, European peers showed an increase of +3.5%, +5.6%, and +6.0% in fat mass vs Q1, Q2, and Q3, respectively (Figure 2C). Regarding muscle mass, Mapuches showed higher mean ± SE values in Q1 of 17.0 ± 3 vs 13.1 ± 2 kg and by contrast in Q4 showed less muscle mass of 14.6 ± 4 vs 19.7 ± 3 kg vs European peers (Figure 2D).

In cardiorespiratory parameters, heart rate at rest was significantly different ($P < .05$) in Mapuche school children between Q3 (89.3 bpm; 95% CI 74.7-103.9) and Q1 (83.0 bpm; 70.3-95.6), and between Q4 (104.2 bpm; 91.5-116.9) and Q1 (83.0 bpm; 70.3-95.6), as well as in European school children between Q4 (89.4 bpm; 82.8-95.9) and Q1 (96.1 bpm; 85.8-106.5; Table 1).

Figure 3 shows SBP (Figure 3A) and DBP (Figure 3B) changes in Mapuche and European school children by different quartiles of sleep time. Compared with the Q1 reference for Mapuche children, SBP increased by +12 (Q3 and Q4) with sleep deprivation (Figure 3A). Additionally, and compared with Q2, SBP increased by +14 mm Hg in Q3 and 4 (Figure 3A). In European children, there was an increase of +4 (Q3), and +9 mm Hg (Q4) vs Q1 reference. Additionally, there was observed +11 and +16 mm Hg (Q3 and Q4) of higher SBP vs Q1 reference (Figure 3A). There were a significant differences in mean ± SE in SBP between Mapuche 121 ± 5 mm Hg vs European 125 ± 6 mm Hg at $P < .001$ at Q1 reference, as well as in Q3 133 ± 4 vs 129 at $P < .021$ (Figure 3A). From the Q1 reference, the mean

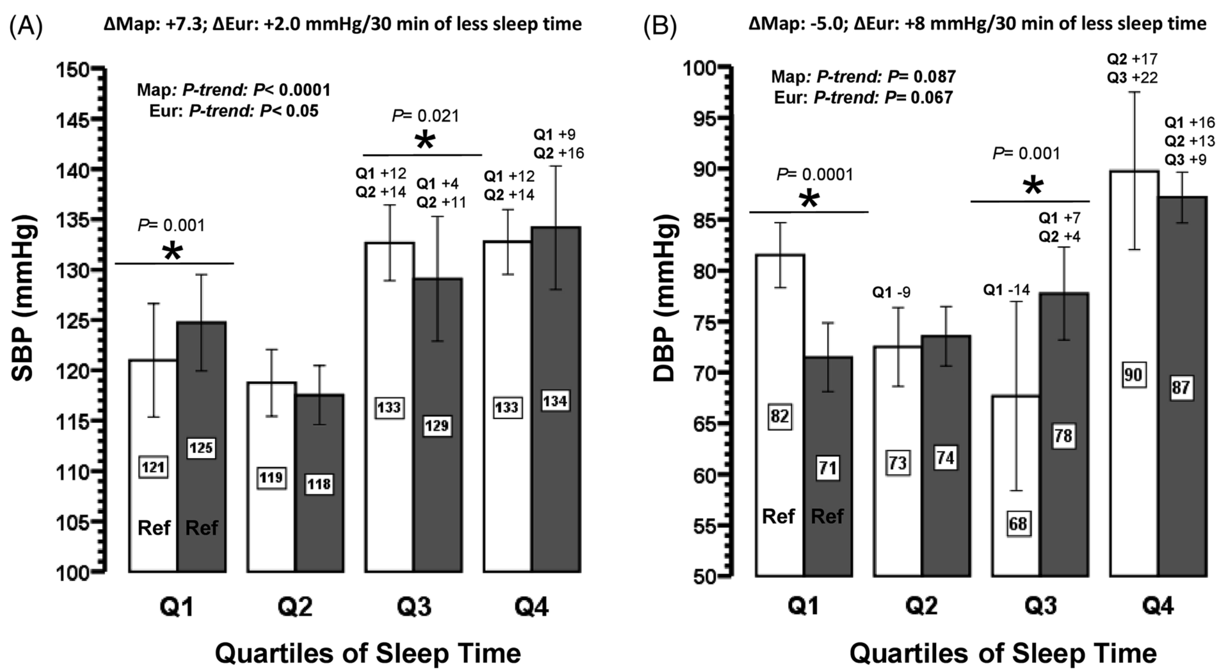

FIGURE 3 Systolic (A) and diastolic (B) blood pressure (BP) by group (ie, Mapuches [Map] or "European" [Eur]) according to quartiles (Q) of sleeping time. Definition and ranges of Q are described as follows: Q1, sleeping time >10 h; Q2, sleeping time = 9.5-10 h; Q3, sleeping time = 8.5-9 h; Q4, sleeping time <8.5. (Ref) denotes the reference quartile of Mapuches or European group. Differences between quartiles are described as (Q1) denotes significant ($P < .05$) differences from the Ref Q1 in the same respective Map or Eur group; (Q2) denotes significant ($P < .05$) differences from the Q2 in the same respective Map or Eur group; and (Q3) denotes significant ($P < .05$) differences from the Q3 in the same respective Map or Eur group; (*) denotes significant differences between Mapuches vs European at each respective *P*-value described

TABLE 2 Prevalence of obesity and hypertension in Mapuches and European schoolchildren

	Mapuches (n = 119)	European (n = 421)	Total (% mean; n = 540)	Between-group P-value
Obesity prevalence				
Normoweight, n (%)	53 (44.0%)	193 (46.0%)	246 (45.0%)	.322
Obesity Risk, n (%)	32 (7.0%)	99 (24.0%)	131 (15.5%)	.114
Obesity, n (%)	34 (29.0%)	129 (30.0%)	163 (29.5%)	.541
Hypertension prevalence				
Normotension, n (%)	68 (56.0%)	318 (73.0%)	386 (64.5%)	**<.0001**
Prehypertension, n (%)	16 (13.0%)	39 (9.0%)	55 (11.0%)	.077
Hypertension, n (%)	38 (31.0%)	76 (18.0%)	114 (24.5%)	**<.0001**

Data are presented as (n) and percentage of prevalence (%). Bold values denotes significant differences between groups at $P < .0001$.

delta (Δ) increase in SBP was +7.3 mm Hg ($P < .0001$) in Mapuche and + 2.0 mm Hg (P-trend $P < .05$) in European (Figure 3A) children.

In Mapuches, DPB showed a decrease of −9 mm Hg between Q2 and Q1, −14 mm Hg between Q3 and Q1, and an increase of +17 between Q4 and Q2 and +22 mm Hg between Q4 and Q3 (Figure 3B). The DBP in European children showed an increase of +7 mm Hg between Q3 and Q1, +4 mm Hg between Q3 and Q2, +16 mm Hg between Q4 and Q1, +13 mm Hg between Q4 and Q2, and +9 mm Hg between Q4 and Q3 (Figure 3B). The P-trend for decreasing/increasing DBP was nonsignificant in Mapuche (Δ −5) and European (Δ +8 mm Hg) school children across each 30-minute quartile of less sleep time (Figure 3B).

The obesity prevalence was similar between Mapuche (29.0%) and European (30.2%) schoolchildren (Table 2). The mean prevalence of hypertension was 20.5%, and there was a higher prevalence of hypertension in Mapuche (31.1%) than in European (18%; $P < .0001$) schoolchildren (Table 2).

4 | DISCUSSION

The aim of this study was to compare blood pressure and other cardiometabolic risk factors for hypertension between schoolchildren of Mapuche and European ancestry, and their association with different levels of sleep time. The main findings were that (a) from the reference Q1 (≥10 h) to Q2 (9.5-10 h), Q3 (8.5-9.0 h) and Q4 (<8.5 h of sleep time), there was an increase in SBP both in Mapuche (Δ +7.3 mm Hg) and European (Δ +2.0 mm Hg) school children, and (b) the tendency for worsening of other cardiometabolic risk factors was persistent for BMI (Δ +2.7 kg/m^2), waist circumference (Δ +11.5 cm), and fat mass (Δ +8.5%) in Mapuche children across Q2, Q3, and Q4 in comparison with Q1, whereas European peers showed only worsened waist circumference (Δ +6 cm). Also, less sleep time in European-ancestry school children was associated with decreased height (−15.5 cm) and handgrip strength in both dominant (−2.5 kg) and nondominant (−3.5 kg) arms. Finally, there was a higher prevalence of hypertension in Mapuche than in European schoolchildren.

Traditional cardiometabolic risk factors for hypertension development (ie, physical inactivity, diet, and genetic inheritance) have similar relevance in children. In a recent study, Gupta, Maranda, and Gupta (2018) studied the association between blood pressure and sleep duration in 120 hypertensive and normotensive children of 6-18 years. They reported that the weekday and weekend sleep patterns were more detrimental in hypertensive children that perceived subjective sleepiness, and they had less weekend sleep catch-up than normotensive peers. The authors concluded that more weekend sleep could potentially mitigate the effect of sleep deprivation during weekdays on blood pressure (Gupta et al., 2018). Similarly, Katsa et al. (2018) reported the lifestyle habits in 480 children of 5-12 years and showed that the hour of sleep before 22:00 h was strongly correlated with a decrease in waist circumference, and that short mid-day naps were inversely associated with SBP and DBP. Additionally, the time of sleep was associated with DBP and fasting glucose, and fast food and meat consumption were associated with BMI and waist circumference. Thus, diet and sleep habits apparently have an important role in the prevention of metabolic syndrome (Katsa et al., 2018). In a study of 2384 native Dutch, Ghanaian, Moroccan and African children of 5 years of age living in Amsterdam, and using a similar sleep time categorization (ie, low <10 h/night and normal sleep 10.0-11.0 h/night), an increase in overweight was reported among Dutch and Moroccans participants with low sleep duration (Anujuo, Vrijkotte, Stronks, Jean-Louis, & Agyemang, 2016). Interestingly, the authors found that the low sleep duration was not related to SBP and DBP, with the exception of African Surinamese children. The authors concluded that there is a need for improving sleep hygiene at younger ages. In contrast to these findings, we report here that 30 min less sleep time in Mapuche and European children of school age is associated with an increase in SBP of Δ +7.3 mm Hg and Δ +2.0 mm Hg, respectively.

In a study on pediatric hypertension in 9250 participants (8-17 years), including non-Hispanic white, non-Hispanic black, and Mexican Americans, analyses showed that non-Hispanic black adolescent boys had a higher prevalence of hypertension than their non-Hispanic white American peers, but the ethnic difference was not explained by predictors such as low weight birth or obesity in the black participants (Chen, Simonsen, & Liu, 2015). In the present study, we found a mean prevalence of hypertension of 20.5% (Mapuche 31.1% vs European 17.6%), with a significant difference between groups. We speculate that an excess of obesity (fat mass) and genetic factors can explain the more detrimental effects on Mapuche school children. In line with this, De la Cruz et al., (2018) reported a significant correlation between BMI and SBP among 325 children aged 10 years in Colombia, as well as inflammation markers (ie, C-reactive protein) with SBP levels in boys.

Another finding of our study was the increase in BMI (Δ +2.7 kg/m^2), waist circumference (Δ +11.5 cm) and fat mass (Δ +8.5%) in Mapuche children across a decrease in sleep time through the Q2, Q3, and Q4 quartiles (Figure 2A,B). Consistent with our findings, a cross-sectional study on a representative sample of 5528 Iranian students, living in central cities of 27 provinces, also reported that a low sleep duration among boys ages 14-18 increased the risk for abdominal obesity (Azadbakht et al., 2013). The relationship of short sleep duration with obesity may be associated with an upregulation of appetite, energy-expenditure reduction, increasing time spent eating, and adiposity. We found here that overweight/obesity has a strong association with high blood pressure in both Mapuches and nonethnic Europeans. Similarly, in a multi-ethnic study of 11 370 schoolchildren, there was a high correlation between BMI and SBP among Hispanics (r = .51) but a lower correlation among blacks (r = .29), with the authors concluding that overweight in children has an important role in increasing SBP and total cholesterol in different ethnic populations (Resnicow, Futterman, & Vaughan, 1993). Furthermore, in a study of 1070 school children in kindergarten (67% Hispanic, 26% African American) with a mean age of 8.9 years, BMI related to obesity (ie, BMI ≥95th percentile) was 28.7%, 17.9% were at risk for overweight, 28.8% had WC ≥90th percentile, and 9.4% had elevated (≥90th percentile) SBP and/or DBP. The authors concluded that monitoring simple outcomes such as waist circumference is relevant at early school age (Meininger et al., 2010). Indeed, in a study of cardiovascular risk status in rural children, the authors concluded that there is a significant problem of overweight and obesity in children and adolescents, in the main irrespective of ethnicity, with many cardiometabolic risk factors for hypertension (ie, elevated SBP/DBP, glycemia, total cholesterol [>170 mg/dL], high low-density lipoprotein level [>110 mg/dL], and high triglycerides [>150 mg/dL]), indicating that screening and intervention ought to begin at an early school stage (Davis et al., 2005).

Interestingly, we found that less sleep time resulted in a decrease in the handgrip strength in both the dominant (−2.5 kg) and nondominant (−3.5 kg) arm. This is in accord with the finding that low sleep time has a relationship with low levels of strength performance (Souissi et al., 2013).

Among other low sleep time consequences, a study in 4525 multi-ethnic children from the UK (9-10 years of age) found inverse relationships between sleep duration, adiposity, and diabetes mellitus risk markers. For example, 1 h longer sleep duration was associated with 0.19 kg/m^2 lower BMI, 0.03 kg/m^5 lower fat mass index, 2.9% lower homeostasis model assessment insulin resistance, and 0.24% lower fasting glucose (Rudnicka et al., 2017). The authors proposed that determining the causality of these relationships could provide a strategy for preventing diabetes.

There are some limitations of this study that deserve mention. We assessed the sleep time using a parent/guardian questionnaire. Also, the number of Mapuche participants was less than the European sample, and we did not stratify the participants by biological (sexual) maturation. Other potential confounders that were not addressed were sleep quality, sleep patterns from weekday/weekend, and socioeconomic analyses of parents. Some strengths were that we used electronic bio-impedance and sphygmomanometry for the body composition and blood pressure measurements, which are widely used in the literature, and we also included additional body composition, cardiorespiratory, and muscle strength co-variables in both groups which is easy to reply.

5 | CONCLUSION

In conclusion, Mapuche and European schoolchildren present higher levels of SBP with a decreased sleep time of 30 min. Also, there is a higher prevalence of hypertension and obesity in ethnic Mapuches than in European schoolchildren, indicating that more studies should be applied at early school age for preventing the low sleep time and their related cardiometabolic risk factors for hypertension development in different ethnic groups.

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CONFLICT OF INTEREST

There are no conflicts of interest to declare.

AUTHOR CONTRIBUTIONS

C.A. conceived and designed the research project. C.A., A.L., C.M., P.D.F., and R.R.C. reviewed the literature studies and conducted data extraction. CA and RRC conducted data analysis and fieldwork. C.A., A.L., R.R.C., C.M., P.E.F., A.A.M., E.L.C. and M.I. were responsible for data interpretation. C.A., A.L., P.D.F., and E.L.C. drafted the manuscript, and C.M., A.A.M., E.L.C., and M.I. revised it critically for intellectual contributions. C.A. coordinated the study development. All authors reviewed and edited the manuscript. All authors read and approved the final manuscript.

DATA ACCESSIBILITY

The datasets created during and/or analyzed during the current study are available from the corresponding author on reasonable request.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Prior to providing written informed consent, the clinical records of all participants were reviewed to ensure that they met all of the inclusion criteria. Additionally, all subjects were personally informed about the study procedures that would occur before, during and after the intervention. All procedures were approved by the Institutional Review Board of the Family Healthcare Centre Tomás Rojas.

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