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1 **Childhood overweight/obesity amidst migration, socioeconomic factors and**  
2 **obesogenic behaviours: Insights from the Growing Up in New Zealand study**

3

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## Abstract

Research on migration as a risk factor for obesity has produced inconsistent findings. Potential influence of migration as a social determinant of obesity has not been previously explored in New Zealand as a migrant receiving country. This study aimed to investigate the link between maternal migration status and residential duration and childhood overweight/obesity risk in New Zealand, considering socio-demographic characteristics and obesogenic behaviours.

Data on 5506 four-to -five-year-old children and their mothers were taken from a large and nationally representative cohort study in New Zealand (the Growing Up in New Zealand Study). Multivariable logistic regression analyses were conducted to examine the association between maternal migration status, maternal residential duration, and child's overweight/obesity risk and the risk of adopting obesogenic behaviours independent of socio-economic influences.

A lower proportion of children of foreign-born mothers presented with overweight/obesity (26%) at age five compared with children of NZ-born mothers (29.6%) (AOR 0.85, 95% CI [0.74, 0.98]). Maternal residential duration had no association with children's weight status among migrant families. Regarding obesogenic behaviours, the findings were mixed with children of foreign-born mothers having lower odds of consuming fast-food (AOR 0.77, 95% CI [0.65, 0.91]) and soft drinks (AOR 0.87, 95% CI [0.76, 0.99]) however they had higher odds of having inadequate sleep duration (AOR 2.25, 95% CI [1.85, 2.73]).

The lower prevalence of overweight/obesity and lower odds of consuming fast-foods and soft drinks among children of foreign-born mothers indicate potential protective factors within migrant families. However, the increased likelihood of inadequate sleep duration highlights an area of concern that warrants further attention and intervention. The findings emphasise the importance of considering diverse social determinants of health and specific risk factors when developing targeted interventions to address childhood overweight/obesity.

# Introduction

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The high prevalence of childhood obesity is a global public health concern [1]. Children with overweight and obesity are at risk of maintaining their weight status in adulthood, which in turn is associated with an increased risk of morbidity and premature mortality from non-communicable diseases [2]. Apart from the enduring impacts of carrying excess body weight, children also experience immediate outcomes, including being stigmatised, facing bullying at school, undergoing social isolation, grappling with diminished self-esteem, depression, and feeling dissatisfied with their body image [3].

Migratory flows everywhere are of substantial interest when studying childhood obesity [4, 5], as migration is considered as a social determinant of health which can positively or negatively impact individuals and their family’s health and health behaviours (such as diet and nutritional, screen and sleep habits, and physical activities) [6-9].

Migration and settlement can be a stressful experience, posing an additional path to increased childhood obesity [10, 11]. Migrants commonly encounter social seclusion and barriers in reaching essential health and social services, including programmes aiding access to healthy foods, offering nutritional education, and facilitating physical activity opportunities for children [12]. Moreover, the stress induced by migration can result in notable changes in energy metabolism and increased intake of inexpensive, energy-dense and sugar-laden comfort foods within migrant households and, as a result, an escalated the likelihood of childhood obesity [13]. In line with this argument, an international literature review concerning how migration impacts the likelihood of obesity and diabetes in various ethnic populations has unveiled a greater occurrence of obesity in migrant communities in contrast to those residing in their native countries, confirming the role of environmental aspects such as diet and lifestyle habits, acculturation, and supporting convergence theories [14]. However, previous research on the link between migration and obesity risk is not always in favour of native-born groups with some reporting better weight outcomes for migrant families [15] or even no significant differences between migrant and non-

1 migrant families [16] highlighting the needs for further research in this field. Moreover, the potential role  
2 of the length of stay in the host country in decreased or increased risk of developing health issues such as  
3 unhealthy weight outcomes among migrant population is also contested [17].

4 Among developed nations, New Zealand (NZ) is ranked third highest for childhood obesity rates [18],  
5 with around 1 in 3 children aged 2–14 years (30.8%) identified with overweight or obesity (OW/OB) in  
6 2022, up from 29.9% in 2019/20 [19]. New Zealand’s immigrant population is also growing with over a  
7 quarter of the population (27.4%) born overseas in 2018, up from 25.2% in 2013 [20].

8 Previous research in NZ has found significant disparities in overweight/obesity prevalence rates among  
9 different ethnic groups, with Pacific and Māori (indigenous people of NZ) children consistently identified  
10 as having the highest overweight/obesity rates (61.7% and 39.6% respectively) relative to their European  
11 (26.5%) and Asian (22.1%) counterparts [19]. These differences are often attributed to a complex set of  
12 socio-economic, cultural, behavioural, and environmental factors that can vary across different  
13 populations [21].

14 While there is partial overlap between immigrants and ethnic subgroups (e.g., some ethnic minorities may  
15 face similar social exclusion and socio-economic disadvantages as immigrants), internationally, the health  
16 needs of these two groups (ethnic minorities versus immigrant groups) are often dealt with separately by  
17 researchers and policymakers. Recognising the unique experiences and challenges facing each group, and  
18 tailoring interventions, accordingly, can lead to more effective and equitable health outcomes for all sub-  
19 populations [22].

20 Despite the alarming prevalence of overweight/obesity and associated serious health consequences, there  
21 is a paucity of evidence in New Zealand, as a migrant receiving country, regarding the impact of  
22 migration background and residency duration of parents on children’s overweight/obesity risk. The  
23 potential contributing factors regarding probable discrepancy such as socioeconomic characteristics or  
24 differences in the adoption of unhealthy weight related or obesogenic behaviours have also not been  
25 explored in the NZ context.

1 We aimed to address these gaps by analysing data from New Zealand largest contemporary child cohort  
2 study (Growing Up in New Zealand (GUiNZ) study). Our research pursued three primary objectives: (1)  
3 to contrast the prevalence of OW/OB among children of NZ-born mothers with those of foreign-born  
4 mothers, while controlling for socio-economic factors, (2) to examine potential impact of maternal length  
5 of stay/residence in the country on OW/OB risk among migrant population by exploring differences in  
6 OW/OB prevalence rates between children of recent migrants and those of settled migrants; and (3) to  
7 investigate the influence of well-known behavioural risk factors (referred as obesogenic behaviours) on  
8 potential OW/OB disparities identified in the first part of the study.

9

## 10 **Materials and Methods**

### 11 **Participants**

12 Data on NZ children and their parents were collected as part of the GUiNZ study, a nationally  
13 representative longitudinal cohort study of children born in NZ between 3 March 2009 and 14 May 2010.  
14 During the recruitment period, 11% of all born children were enrolled, and the research group  
15 encompassed a wide range of ethnic backgrounds and indicators of socioeconomic position, making its  
16 findings applicable to all families with children in NZ at that time [23]. The GUiNZ methodology and  
17 study design details are described elsewhere [23]. We excluded children for whom data on weight and  
18 height were missing in the fifth Data Collection Wave (DCW) ( $n = 351$ ). To prevent interrelated  
19 observations, we restricted our sample to one child per mother, excluding 75 children where mothers gave  
20 birth to twins or triplets. This resulted in a sample size of 5506 children and their mothers for this study.

### 21 **Measures**

#### 22 **The outcomes of interest**

##### 23 **Childhood overweight/obesity**

24 Trained interviewers objectively measured the weight and height of cohort children at 54 months of age,  
25 following a standardised protocol that involved removing shoes, hats, jackets or jumpers, and taking two  
26 measurements for accuracy. Age and sex-specific Body Mass Index (BMI) was computed as weight  
27 divided by the square of height ( $\text{kg}/\text{m}^2$ ). Childhood overweight/obesity was determined based on the

1 International Obesity Task Force (IOTF) age-and-sex-specific criteria (with overweight and obesity  
2 defined as BMI values above 25 and 30 kg/m<sup>2</sup>, respectively, extrapolated from young adults aged 18 to  
3 children) [24].

4

#### 5 **Child's obesogenic behaviours:**

6 Four key mother-reported obesogenic behaviours were assessed including excessive screen time,  
7 inadequate sleep duration, and frequent fast-food and soft drink consumption.

8

#### 9 **Screen time**

10 Screen time was assessed at the age 54-month time point. The mother responded to the following  
11 questions about child's screen time:

12

13 **Thinking about a usual weekday, approximately how many hours and minutes does your**  
14 **child spend at home:**

15 (1) Watching television programming, including free-to-air, online, and pay-tv, or DVDs either on  
16 TV or other media?

17 (2) Using electronic media, e.g., computer or laptop, including children's computer systems such  
18 as Leapfrog, iPads, tablets, smartphones, and any electronic gaming devices?

19 We summed the responses to these two questions to find the child's screen time in total. Following NZ  
20 Ministry of Health guidelines for screen viewing limitations at age 2 to 5 years, total screen time was  
21 broken into a dichotomous variable representing children whose screen-viewing time was limited to less  
22 than one hour per day (met the guideline) vs those who viewed one hour or more per day (exceeded the  
23 guideline so defined as excessive screen time) [25].

24

#### 25 **Night sleep duration**

26 At the age 45-month time point, mothers were asked, "On average, how much time does your child spend  
27 asleep at night in total?". Responses were converted to a dichotomous variable that distinguished children

1 who slept 10 hours or more per night vs those who slept less than 10 hours (defined as inadequate sleep  
2 duration). This cut-point follows NZ Ministry of Health guidelines for sleep duration, which recommend  
3 preschoolers (3-4-year-olds) sleep equal or greater than 10 hours per day [25].  
4

#### 5 **Fast-food consumption**

6 At the age of 54-month time point, mothers were asked, “Can you tell me how often he/she has eaten  
7 takeaways from places like McDonald’s, KFC, Burger King, pizza shops or fast-food outlets over the last  
8 four weeks?”. Responses were converted into two categories: Frequent (at least once a month), and  
9 none.  
10

#### 11 **Soft drink consumption**

12 At the age of 54-month time point, mothers were asked, “Can you tell me how often (he/she) has eaten  
13 soft drinks & energy drinks over the last four weeks?”. Responses were converted into two categories:  
14 Frequent (at least once a month), and none.  
15

#### 16 **Main exposure of interest: Immigration status**

17 All children included in the study cohort were born in NZ. To identify migration status, maternal rather  
18 than children’s immigration status was used. Recent versus settled migrants were identified based on  
19 maternal residential duration. Following the NZ Ministry of Business, Innovation & Employment, five  
20 years’ residency was chosen as a benchmark to differentiate between settled and recent migrants [26]  
21 with mothers who had resided in the country for more than five years at the time of the antenatal DCW  
22 classified as settled migrants and those with five or less years’ residency classified as recent migrants.  
23

#### 24 **Other exposures of interest (covariates): Sociodemographic characteristics**

25 Potential covariates in multivariable analyses were measured during different DCWs from antenatal to fifth  
26 including child’s sex, maternal age at pregnancy, maternal education (categorized into four groups: no  
27 secondary school, secondary school, diploma/trade, tertiary), language spoken at home (English, non-

1 English), household annual income groups (four categories:  $\leq$  \$70K, \$70.1-\$100K, \$100.1-\$150K, >  
2 \$150K), receipt of income-tested benefit (yes/no), area-level deprivation index (NZDep2013), having a  
3 partner, having siblings, and high birth weight (no if  $<4\text{kg}$ , yes if  $\geq 4\text{kg}$  [27]).  
4 The NZDep2013 index, derived from the household's geographical location, was used to measure  
5 neighbourhood area deprivation. This index is measured at the mesh block level (the smallest census tract  
6 unit) by combining census data relating to seven domains (including income, homeownership, employment,  
7 qualifications, family structure, housing, access to transport and communications) [28]. The score is  
8 organised into deciles, where decile one represents the least deprived 10% of areas in NZ, and decile 10  
9 indicates the most deprived 10% of areas in NZ. For the purpose of analysis, deprivation scores were  
10 categorized into three groups: low deprivation (deciles 1 to 3), medium (deciles 4-7), and high deprivation  
11 areas (deciles 8-10).

12

### 13 **Analytical procedures**

14 All analyses were conducted using R. Sociodemographic characteristics of the whole sample and stratified  
15 by maternal migration status and residential duration are presented in **Table 1**. Chi-square tests were used  
16 to examine whether maternal migration status and residential duration were associated with  
17 sociodemographic characteristics (**Table 1**).

18 The prevalence rate of overweight/obesity by maternal migration status and residential duration are  
19 presented in **Table 2**. The bivariate associations between maternal migration status and residential duration  
20 and children's overweight/obesity at age five were also explored using univariate logistic regression models  
21 with results presented as unadjusted odds ratios (ORs) with 95% confidence intervals (CIs) (**Table 2**).

22 Then, to determine if the noted differences in the prevalence rates of overweight/obesity between children  
23 of migrant and non-migrant mothers found in the univariate analyses remained significant after controlling  
24 for sociodemographic characteristics, the following steps were taken:

1 - First, the bivariate association between each sociodemographic characteristic and children's  
2 overweight/obesity status at age five was explored using univariate logistic regression models with results  
3 presented as unadjusted odds ratios (ORs) with 95% CIs (**Table 1**).

4 - Second, multivariable logistic regression analyses were conducted, with maternal migration status and  
5 socio-demographic characteristics with significant association with overweight/obesity in stage 1 included  
6 as the exposures and child overweight/obesity as the outcome variable. The results were presented as  
7 adjusted odds ratios (AORs) with 95% CIs (**Table 2**). The same analyses were repeated with maternal  
8 residential duration as the main exposure variable (**Table 2**). Analyses on maternal residential duration  
9 were restricted to foreign-born mothers.

10 Finally, to explore the potential role of obesogenic behaviours (inadequate night sleep duration, excessive  
11 screen time, and frequent fast-food, and soft drink consumption) in the noted differences in the risk of  
12 overweight/obesity among children with migrant and non-migrant background (if found in previous  
13 analyses), differences in obesogenic behaviours between two groups were assessed through the following  
14 steps:

15 - Associations between obesogenic behaviours and the risk of overweight/obesity were assessed using  
16 univariate logistic regression and the results are presented in **Table 3**. The included variables have been  
17 widely considered as main obesogenic behaviours in the field of obesity research [e.g., 29].

18 - Characteristics of the whole sample and stratified by maternal migration status regarding obesogenic  
19 behaviour are presented in **Table 3**.

20 - Univariate and multivariable logistic regression analyses were conducted, with maternal migration status  
21 included as the exposure and obesogenic behaviours as the outcome variable. The results were presented  
22 as ORs and AORs after controlling for covariates with 95% CIs (**Table 3**).

23

## 1 Results

### 2 Sociodemographic characteristics of the study sample by maternal migration status 3 and maternal residential duration 4

5 Of the 5,506 mothers, 33.2% (n=1830) were born outside NZ. A higher proportion of foreign-born mothers  
6 had tertiary education, spoke a language other than English at home, lived with a partner, lived in highly  
7 deprived areas, and in a household with an income of less than \$70k than NZ-born mothers, while a higher  
8 proportion of NZ-born mothers reported the receipt of income-tested benefits. A lower proportion of  
9 foreign-born mothers aged less than 20 years at the time of pregnancy and had more than one child (study  
10 child had siblings) compared with the NZ-born group.

11 No significant differences were found between recent migrants and settled migrants regarding the  
12 deprivation index. However, a higher proportion of settled migrants had diploma-level and tertiary  
13 educations, received income-tested benefits, had more than one child, and earned more than \$150K  
14 compared with the recent migrants. A higher proportion of recent migrants spoke a language other than  
15 English at home and lived with a partner compared with settled migrants (**Table 1**).

16

17 **Table 1. Distribution of socio-demographic characteristics for the whole sample and by maternal migration**  
18 **status and residential duration**  
19

Socio-demographic Characteristics (Data collection wave)	Total sample (n=5506) n (%)	Maternal migration status			Maternal residential duration			Association with OW/OB <sup>†</sup> for the whole sample OR (95%CI)
		NZ-born mothers n=3676 n (%)	Foreign-born mothers n=1830 n (%)	p-value for $\chi^2$	Recent migrants (n=784) n (%)	Settled migrants (n=1035) n (%)	p-value for $\chi^2$	
<b>Child's sex (DCW1)</b>								
Male	2838 (51.5)	1880 (51.1)	958 (52.3)	0.414	406 (51.8)	546 (52.8)	0.717	Ref
female	2668 (48.5)	1796 (48.9)	872 (47.7)		378 (48.2)	489 (47.2)		<b>1.13 (1.00, 1.27)</b>
<b>Maternal age group (years) at pregnancy (DCW0)</b>								
<=20	328 (6)	279 (7.6)	49 (2.7)		19 (2.4)	28 (2.7)		Ref
21-30	2251 (40.9)	1464 (39.8)	787 (43)	<b>0.001</b>	402 (51.3)	383 (37)	<b>0.001</b>	<b>0.66 (0.52, 0.84)</b>
31-40	2784 (50.6)	1842 (50.1)	942 (51.5)		348 (44.4)	588 (56.8)		<b>0.50 (0.40, 0.64)</b>
>40	143 (2.6)	91 (2.5)	52 (2.8)		15 (1.9)	36 (3.5)		<b>0.48 (0.31, 0.74)</b>
<b>Maternal education (DCW0)</b>								
No secondary	317 (5.8)	274 (7.5)	43 (2.4)		10 (1.3)	33 (3.2)		Ref
Secondary	1209 (22)	801 (21.8)	408 (22.4)	<b>0.001</b>	199 (25.4)	206 (19.9)	<b>0.003</b>	<b>0.75 (0.58, 0.97)</b>
Diploma	1675 (30.5)	1149 (31.3)	526 (28.9)		219 (28.0)	306 (29.6)		<b>0.62 (0.48, 0.79)</b>
Tertiary	2292 (41.7)	1447 (39.4)	845 (46.4)		355 (45.3)	488 (47.2)		<b>0.37 (0.29, 0.47)</b>

<b>Languages spoken at home (DCW0)</b>								
English	4573 (83.2)	3616 (98.4)	957 (52.5)	<b>0.001</b>	329 (42)	622 (60.2)	<b>0.001</b>	Ref
Non-English	926 (16.8)	60 (1.6)	866 (47.5)		454 (58)	412 (39.8)		1.02 (0.87, 1.19)
<b>Area deprivation level (DCW5)</b>								
Low (1-3)	1721 (31.4)	1198 (32.7)	523 (28.8)	<b>0.001</b>	214 (27.4)	309 (30.1)	0.321	Ref
Medium (4-7)	2005 (36.6)	1345 (36.8)	660 (36.3)		297 (38)	359 (35)		<b>0.48 (0.42, 0.56)</b>
High (8-10)	1751 (32)	1116 (30.5)	635 (34.9)		270 (34.6)	358 (34.9)		<b>0.38 (0.33, 0.44)</b>
<b>Household income group (NZD) (DCW5)</b>								
<=\$70K	1591 (32.4)	1052 (31.4)	539 (34.6)	<b>0.024</b>	234 (35.9)	301 (33.6)	<b>0.006</b>	Ref
\$71K-\$100k	1078 (22)	721 (21.5)	357 (22.9)		163 (25)	193 (21.5)		<b>0.82 (0.62, 0.97)</b>
\$101K-\$150k	1234 (25.2)	866 (25.9)	368 (23.6)		158 (24.2)	208 (23.2)		<b>0.70 (0.59, 0.83)</b>
>\$150k	1003 (20.4)	710 (21.2)	293 (18.8)		97 (14.9)	195 (21.7)		<b>0.58 (0.49, 0.70)</b>
<b>Receipt of income tested benefit (DCW4)</b>								
Yes	1049 (19.1)	747 (20.4)	302 (16.6)	<b>0.001</b>	107 (13.7)	192 (18.6)	<b>0.007</b>	Ref
No	4444 (80.9)	2922 (79.6)	1522 (83.4)		672 (86.3)	842 (81.4)		<b>0.64 (0.56, 0.74)</b>
<b>Having a partner (DCW5)</b>								
Yes	4972 (90.4)	3272 (89.1)	1700 (93)	<b>0.001</b>	748 (95.7)	943 (91.1)	<b>0.001</b>	Ref
No	530 (9.6)	402 (10.9)	128 (7)		34 (4.3)	92 (8.9)		<b>0.71 (0.59, 0.86)</b>
<b>High birth weight (&gt;4 kg) (DCW1)</b>								
Yes	969 (17.6)	669 (18.2)	300 (16.4)	0.112	106 (13.6)	192 (18.6)	<b>0.005</b>	Ref
No	4533 (82.4)	3007 (81.8)	1526 (83.6)		675 (86.4)	842 (81.4)		<b>2.1 (1.82, 2.42)</b>
<b>Having siblings (DCW5)</b>								
Yes	4847 (88.1)	3302 (89.9)	1545 (84.5)	<b>0.001</b>	627 (80.2)	908 (87.7)	<b>0.001</b>	Ref
No	655 (11.9)	372 (10.1)	283 (15.5)		155 (19.8)	127 (12.3)		1.01 (0.85, 1.25)

<sup>†</sup> OW/OB: Overweight/obesity

### Maternal migration status and residency duration and child's weight status

A higher proportion of children of NZ-born mothers were identified with overweight/obesity (29.6%) compared with children of foreign-born mothers (26%,  $p < 0.005$ ) (Table 2). Maternal residential duration had no significant association with children's weight status, and children of both recent and settled migrants experienced a lower rate of overweight/obesity (24.5% and 27% respectively) compared with children of NZ-born mothers (29.6%) (Table 2).

The results of multivariable logistic regressions indicated that after adjustment for socio-demographic characteristics, children of foreign-born mothers had lower odds of overweight/obesity compared with the children of NZ-born mothers (Table 2). No significant difference was found between settled and recent migrants in terms of their children's risk of overweight/obesity (Table 2).

**Table 2. Association between maternal migration status and residential duration with child's weight status**

Exposure	N	BMI Mean (SD)	Prevalence of OW/OB <sup>†</sup> n (%)	Association with OW/OB <sup>†</sup>		
				OR (95% CI)	AOR <sup>††</sup> (95% CI)	
Maternal migration status	NZ-born mothers	3676	16.81 (1.91)	1089 (29.6)	Ref	Ref
	Foreign-born mothers	1830	16.59 (2.23)	476 (26)	<b>0.84 (0.74, 0.95)</b>	<b>0.85 (0.74, 0.98)</b>
Maternal residential duration	Recent migrants	784	16.42 (2.17)	192 (24.5)	Ref	Ref
	Settled migrants	1035	16.70 (2.22)	279 (27)	1.14 (0.92, 1.41)	1.05 (0.82, 1.36)

<sup>†</sup>OW/OB: Overweight/obesity

<sup>††</sup>AOR: Adjusted odds ratio (adjusted for mother's age at pregnancy, maternal education, household deprivation level, household income, receipt of income benefit, having partner, and child's birth weight and sex)

## Association between maternal migration status and obesogenic behaviours

The results of multivariable logistic regression modelling indicated that after adjustment for socio-demographic characteristics, children of foreign-born mothers had lower odds of consuming fast-food and soft drinks (**Table 3**) but higher odds of reporting inadequate night sleep duration (<10 h) (**Table 3**). No significant difference was found between two groups regarding screen time (**Table 3**).

**Table 3. Prevalence of obesogenic behaviours for the whole sample and by maternal migration status and their associations with OW/OB and maternal migration status**

Child's obesogenic behaviours	Whole sample (n=5506) n (%)	Association with OW/OB <sup>†</sup> OR (95%CI)	Maternal migration status		Association between maternal migration status and child's obesogenic behaviours	
			NZ-born mothers n=3676 n (%)	Foreign-born mothers n=1830 n (%)	OR (95% CI)	AOR <sup>††</sup> (95% CI)
<b>Fast food</b>						
None	829 (15.1)	Ref	497 (13.5)	332 (18.2)	Ref <sup>†††</sup>	Ref <sup>†††</sup>
>= 1/month	4673 (84.9)	<b>1.54 (1.29, 1.85)</b>	3178 (86.5)	1495 (81.8)	<b>0.70 (0.61, 0.82)</b>	<b>0.77 (0.65, 0.91)</b>
<b>Soft drink</b>						
None	2637 (47.9)	Ref	1721 (46.8)	916 (50.2)	Ref	Ref
>= 1/month	2846 (52.1)	<b>1.61 (1.43, 1.81)</b>	1954 (53.2)	910 (49.8)	<b>0.87 (0.78, 0.98)</b>	<b>0.87 (0.76, 0.99)</b>
<b>Screen time</b>						
<1 h	1045 (19.1)	Ref	676 (18.5)	369 (20.2)	Ref	Ref
>=1 h	4440 (80.9)	<b>1.51 (1.29, 1.79)</b>	2984 (81.5)	1456 (79.8)	0.89 (0.78, 1.03)	0.94 (0.81, 1.10)
<b>Night sleep duration</b>						
>=10 h	4864(88.4)	Ref	3345(91.1)	1519(83.1)	Ref	Ref
<10 h	636(11.6)	<b>1.61 (1.36, 1.91)</b>	327(8.9)	309(16.9)	<b>2.08 (1.76, 2.46)</b>	<b>2.25 (1.85, 2.73)</b>

<sup>†</sup>OW/OB: Overweight/obesity

<sup>††</sup> Adjusted for mother's age at pregnancy, maternal education, household deprivation level, household income, receipt of income benefit, having partner, and child's birth weight and gender

<sup>†††</sup> Children of NZ-born mothers were considered as the reference group across all obesogenic behaviours

## 1 Discussion

2  
3 This study aimed to investigate the prevalence of overweight/obesity in preschool- aged children (4-5  
4 years old) living in NZ by their mother's migration status and residential duration in the country. Potential  
5 roles of obesogenic behaviours as factors contributing to the noted differences in the prevalence rates of  
6 overweight/obesity among children of foreign-born mothers versus those of native-born mothers were also  
7 explored.

8 Our findings indicated lower odds of developing overweight/obesity among children of foreign-born  
9 mothers compared to their counterparts with NZ-born mothers. The noted differences remained significant  
10 after adjustment for socioeconomic differences. This finding is important particularly that children of  
11 foreign-born mothers were more likely to live in the most socioeconomically deprived areas or in a  
12 household with an income of less than \$70k than children of NZ-born mothers, two factors with established  
13 link with OW/OB [30]. Longer residency duration in NZ did not significantly alter the odds of  
14 overweight/obesity among children of recent versus those of settled migrants. Further, our findings were  
15 mixed regarding differences in obesogenic behaviours, as potential contributors to the noted differences in  
16 overweight/obesity rates, with consumption of unhealthy foods (fast-foods and soft drinks) to be more  
17 common among children of NZ born mothers while inadequate sleep duration, another risk factor for  
18 childhood obesity, was more common among children of foreign-born mothers.

19 The lower odds of overweight/obesity among children in migrant families found in this research is  
20 inconsistent with some previous studies which found an association between second-generation migration  
21 background and the higher odds of obesity [e.g., 31], but consistent with others that showed better health  
22 outcomes for children in migrant families [e.g., 32]. Our findings on lower risk of OW/OB among children  
23 of migrant families despite economic disadvantages are supported by the 'healthy migrant' effect, which  
24 refers to the similar or better health status among migrants than comparable natives, despite many risk  
25 factors for adverse health, such as decreased access to health insurance or socioeconomic challenges [33,  
26 34]. The healthy migrant effect is based on the migrant selectivity assumption: that is, those who choose to

1 migrate tend to differ from their home country population in a significant way. Specifically, they are more  
2 likely to have better socio-economic characteristics (e.g., better human capital such as higher education,  
3 better occupational skills, more favourable personality characteristics and personal attitudes), and tend to  
4 be healthier, on average, than the general population in their country of origin; all of which are prerequisites  
5 for successful integration in the labour market and the host society, which may contribute to adopting  
6 healthy lifestyles and habits transferable to their next generation.

7 Moreover, health selection criteria imposed by New Zealand's migration policy may further accentuate  
8 the positive self-selection of the health of potential immigrants. The immigration policy of New Zealand  
9 encompasses various goals aimed at generating concrete social and economic advantages. As a result, those  
10 applicants who meet NZ's selection criteria and have high human capital including good health and  
11 character, language competency, comparable work experiences and skilled employment, and tertiary  
12 qualification [35] are more likely to be granted a residency visa.

13 The healthy migrant effect has been shown in international research to be undermined by the Healthy  
14 Immigrant Paradox (HIP), where an immigrant's health deteriorates over time in the host country and  
15 gradually aligns with or even worse than that of the native population. This health deterioration can be seen  
16 in first-generation migrants over time, or sometimes in the next generations [34].

17 This health deterioration is usually explained through acculturation and lifestyle changes among migrant  
18 population – ironically suggesting that successful integration into the host society may produce negative  
19 health outcomes. Migrants to western countries, over time and generations, tend to forsake their customary  
20 dietary practices in favour of adopting westernized eating patterns characterised by elevated levels of fat,  
21 sugar, and salt, as well as moving toward sedentary lifestyles and less physical activity [36]. However, our  
22 findings showed a different pattern among children of immigrant mothers to NZ where children of settled  
23 migrants who resided in the country more than five years had similar odds of developing OW/OB as  
24 children of recent migrants who resided in the country less than 5 years.

25 These findings may partially be attributed to the fact that in our sample settled migrants had higher  
26 education and income levels than recent migrants, both of which are associated with lower odds of having

1 a child with overweight/obesity. These characteristics might have protected them against negative aspects  
2 of acculturation and moving toward those lifestyles that accelerate the risk of having a child with  
3 overweight/obesity, like increased consumption of fast-food and soft drink.

4 Moreover, the finding that children of foreign-born mothers had lower odds of frequent fast-food and soft  
5 drink consumption than their counterparts of NZ-born mothers is also in contrast to HIP. Given the well-  
6 known association between regular fast-food and soft drink intake and elevated risk of childhood  
7 overweight/obesity found in the current study as well as in other studies [37-39], it is likely that lower odds  
8 of overweight/obesity among children of migrant families is driven by lower consumption of these high-  
9 calorie, low-nutrient-dense foods. Thus, it seems that among this cohort of NZ children, weight status and  
10 food and drink behaviours of children of migrant mothers were not, at least by age 5, negatively affected  
11 by acculturation.

12 Unhealthy foods are widely promoted, more accessible, and often cheaper than healthier alternatives in NZ  
13 [40]. Unhealthy food and drinks outlets target children, population groups on low incomes and those living  
14 in deprived neighbourhoods in NZ and other high-income countries [41]. Sustainable education,  
15 intervention, and prevention strategies and action plans addressing complex relationships between each of  
16 these characteristics and obesogenic environment are required to tackle childhood obesity at the population  
17 level.

18 While not explored in the current study, research also found that foreign-born mothers had lower  
19 (healthier) pre-pregnancy weight than U.S.-born mothers that might have contributed to their children's  
20 lower risk of obesity [42].

21 Conversely, children of foreign-born mothers had higher odds of inadequate night sleep duration  
22 compared with children of NZ-born mothers which is a well-known obesogenic behaviour with significant  
23 link with overweight/obesity risk as found in the current study and previous studies [21, 43, 44]. This  
24 finding highlights a critical need to promote adherence to recommended sleep guidelines among immigrant  
25 families. This may include providing information on the importance of developing healthy sleep practices

1 for themselves and children, creating bedtime routines, recognising sleep problems, and addressing  
2 common sleep challenges faced by children.

### 3 **Strengths, Limitations, and Future Studies**

4 This study addressed a gap in research on associations between maternal migration status, maternal  
5 residential duration, and the risk of childhood overweight/obesity in NZ. To our knowledge, previous  
6 research has focused on ethnicity, and this study was the first to explore the link between maternal migration  
7 status and childhood overweight/obesity in NZ. Exploring the potential roles of commonly studied  
8 obesogenic behaviours in the noted difference was also a new contribution of our study. The other strengths  
9 include the usage of data on a large and nationally representative sample of children, focusing on the  
10 preschool-aged children, objective measure of overweight/obesity, and inclusion of a wide range of  
11 obesogenic behaviours and covariates.

12 Nevertheless, this study had some limitations. First, all the children of this cohort were born in NZ, which  
13 means that we were unable to assess obesity disparity among the first generation of foreign-born versus  
14 NZ-born children from migrant families. As a result, we applied maternal place of birth as an indicator for  
15 migration status. Second, one of the most critical obesogenic behaviours, physical activity, was not explored  
16 as there were no appropriate questions and scoring instructions in GUiNZ dataset for children by 4-5 years  
17 of age. This is of particular interest as a previous systematic review has revealed a deficit of sufficient  
18 physical activity among migrant children [45]. Third, while we benefited from utilising a longitudinal  
19 dataset to capture a wide range of exposure and outcome variables, our analytical approach was based on a  
20 cross-sectional examination. Future research employing a longitudinal approach is recommended to further  
21 investigate the dynamics of the variables studied and to provide more robust insights into changes over  
22 time. Fourth, an eight-year interval between data collection and analysis means the most current trends and  
23 developments in migration, obesity, and obesogenic behaviours may have not been fully captured in this  
24 research. Therefore, our findings should be interpreted within the context of the data's original time frame  
25 (2009-2015). Finally, the deliberate exclusion of ethnicity as an exposure variable aimed to mitigate the  
26 risk of multicollinearity and confounding effects, allowed us to more precisely isolate and analyse the

1 impact of migration background on childhood obesity. However, future research may delve into these  
2 intertwined factors to unveil the intricate relationships between migration status and ethnicity and to provide  
3 a deeper intersectional understanding of their combined influence on childhood obesity.  
4 We also encourage future research to investigate other obesogenic behaviours and contributors to  
5 overweight/obesity among children of foreign-born and NZ-born mothers (e.g., sedentary behaviours,  
6 mealtime and other household routines, and quality of sleep). Examining intersection of social and  
7 environmental factors with migration status is also crucial, given research indicating their significant roles  
8 in promoting childhood obesity. Interdisciplinary collaborations between researchers, healthcare  
9 professionals, and community organisations are required to identify and address underlying social  
10 determinants of childhood obesity, such as cultural factors, socioeconomic influences, and environmental  
11 determinants.

## 12 **Conclusion**

13 In summary, we found that children of migrant mothers had lower rates of overweight/obesity compared  
14 with children of NZ-born mothers. Lower consumption of fast-food and soft drinks among children of  
15 foreign-born mothers may partially explain better weight status among their children. However, migrant  
16 children, despite the lower odds of overweight/obesity, were worse off in insufficient night sleep duration.

17 Health education and nutritional support by implementing comprehensive health education programs  
18 targeting all families (particularly the native-born) to promote healthy eating habits and discourage the  
19 consumption of fast-food and sugary drinks are recommended. This can include nutritional workshops,  
20 culturally sensitive resources, and partnerships with community organisations to provide access to  
21 affordable, nutritious food options as well as school-based interventions.

22 Higher odds of insufficient night sleep duration among children of migrant families provides imperative  
23 to development of sleep education programs specifically tailored for migrant families. These education  
24 programs may contribute to the overall well-being of children and promote equitable health outcomes for  
25 all children within the community. Overall, our findings emphasise the importance of considering diverse

1 social determinants of health and specific risk factors when developing targeted interventions to address  
2 childhood overweight/obesity.

3

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#### 6 **Author Contributions**

7 MR: conceptualisation, methodology, statistical analysis, and writing original draft. AB:

8 conceptualisation, review, editing, and supervision. LH: conceptualisation, methodology, review, editing,

9 and supervision. All authors contributed to the article and approved the submitted version.

#### 10 **Competing Interests**

11 The authors declare no competing interests.

#### 12 **Data Availability Statement**

13 The datasets analysed during the current study are not publicly available, but access request can be

14 submitted to GUiNZ data access committee.

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