Early childhood weight status among Aboriginal and Torres Strait Islander and non-Aboriginal children in Victoria, Australia: A repeated cross-sectional analysis

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Submitted: 8 April 2025; Revision requested: 8 October 2025; Accepted: 17 November 2025

Abstract

Objective: To assess early childhood weight status among Aboriginal and Torres Strait Islander and non-Aboriginal children in Victoria, focussing on age and geographic differences.

Methods: We analysed deidentified Maternal and Child Health records (2010-2015) across 68 Victorian Local Government Areas, comparing differences in Body Mass Index z-score (zBMI) and prevalence of healthy weight ($1<zBMI \leq 1$) at 8 weeks, 4 months, 8 months, 1 year and 2 years. Disparities were examined by geographic remoteness and area-level socioeconomic position using linear mixed models.

Results: At 8 weeks, 70.5% of Aboriginal and Torres Strait Islander and 70.7% of non-Aboriginal children had a healthy weight. Differences in zBMI at 8 weeks were only present among children in the least advantaged areas and major cities. Disparities in healthy zBMI appeared at 4 months and persisted through 2 years. From 4 months, zBMI was significantly higher among Aboriginal and Torres Strait Islander children ($p<0.0001$), including within socioeconomic and remoteness subgroups, except at age 2 in rural areas ($p=0.34$).

Conclusions: Disparities in weight status emerge from 4 months with place-based differences at 8 weeks.

Implications for public health: Findings underscore the importance of accessible, culturally safe maternal and infant health care and action on socioeconomic inequity.

Key words: Aboriginal and Torres Strait Islander health, maternal and child health, child development, body Weight, health inequities

Introduction

Aboriginal and Torres Strait Islander children represent the future of the world's oldest culture, sustained in Australia for over 65,000 years despite the profound injustices imposed by colonisation. The National Agreement on Closing the Gap, a commitment agreed between all levels of government and Aboriginal and Torres Strait Islander representative organisations, includes a target to increase the proportion of Aboriginal and Torres Strait Islander children who "thrive in the early years".[1] This target is not on track to be met, and a recent review by the Productivity Commission revealed limited government progress on implementing the Closing the Gap reforms.[2] The review recommended empowering Aboriginal Community Controlled Organisations (ACCOs), including through access to government-held data to enhance self-determination in designing culturally safe programs and services.[2] The principles of Indigenous Data Sovereignty enshrine the right of Indigenous peoples to exercise control over Indigenous data and that these data should be

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Aust NZ J Public Health. 2026; Online; https://doi.org/10.1016/j.anzjph.2025.100299

disaggregated and contextualised to empower self-determination and community-level planning.[3,4]

Victoria is home to over 4000 Aboriginal and Torres Strait Islander children aged 0–2 years and early years programs are a strategic priority for the Victorian Aboriginal Community Controlled Health Organisation (VACCHO), the state's peak Aboriginal health body.[5] However, lack of place-based data about Aboriginal and Torres Strait Islander children's health limits focused health planning. Health disparities begin in early life and the first 1000 days are a critical window for optimising growth and development.[6] Anthropometric measures are among the most important indicators of early childhood development and nutrition,[7] yet detailed data on these indicators are not routinely reported for children in Australia. While data on birthweights for Aboriginal and Torres Strait Islander babies born in Victoria have been reported for over a decade,[8] evidence about growth in the early years of life is lacking.

Maternal and Child Health (MCH) is a universal primary health care service, funded by the Victorian state government and delivered by local governments, that offers ten scheduled consultations from birth to 3.5 years.[9] At each 'key age and stage' consultation the MCH nurse assesses growth and development and provides parents with health information and support across various topics.[9] MCH nurses routinely collect data on various indicators, including children's weight and length/height, but these data are not regularly made publicly available. To fill this gap, VACCHO partnered with researchers to analyse a de-identified dataset extracted from the Victorian MCH system. To support VACCHO service planning and advocacy, this analysis utilises existing data to gain insights into early childhood growth among Aboriginal and Torres Strait Islander children in Victoria and to better understand current data limitations.

Methods

We report this repeated cross-sectional study according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for observational studies and the CONSolIDated critERia (the CONSIDER statement) for strengthening reporting of health research involving Indigenous peoples.[10,11] This project was informed by the principles of Indigenous Data Sovereignty,[3] in that we worked with VACCHO to ensure Aboriginal and Torres Strait Islander control over decisions on what data to include, how data were used and analysed, and the translation of data to ensure it was relevant and accessible to local Aboriginal organisations to support self-determination. Together, we sought to answer the following questions:

1. To what extent does weight status differ between Aboriginal and Torres Strait Islander and non-Aboriginal children in Victoria at 8 weeks, 4 months, 8 months, 12 months and 2 years?
2. How do inequalities in weight status differ by geographic remoteness and area-level socioeconomic position?

Research team

This study was undertaken by a team of Aboriginal (removed initials for blind peer review) and non-Aboriginal (removed for blind peer review) researchers with expertise in public health nutrition (removed initials for blind peer review), biostatistics (removed initials for blind peer review) and Aboriginal health research (removed initials for blind peer review). The research team supports Aboriginal and Torres Strait Islander self-determination and worked closely with staff from VACCHO to design a study that reflected the priorities of the Aboriginal community-controlled health sector in Victoria. VACCHO provided a letter of support for the funding application and collaborated with the research team, providing guidance on project design, implementation, data analysis, interpretation, and translation of findings. Grant funding was used to employ an Aboriginal early career researcher and a statistician with experience in analysing Aboriginal and Torres Strait Islander child health data.

Data source, setting and participants

A deidentified dataset of demographic and anthropometric data was extracted from the electronic databases of Maternal and Child Health (MCH) services in Victoria for analysis.[12] MCH services are funded and centrally coordinated by the Victorian state government's Department of Health (previously by the Department of Education and Early Childhood Development) and operated by the 79 local government areas (LGAs) in Victoria. The extracted data included anonymous child height, weight, age in days, sex, postcode and Aboriginality, which are routinely recorded during MCH visits. To be included in the analysis, children needed to be born at term (37 to 41 weeks' gestation) and have attended at least one MCH consultation with anthropometric measurements recorded at 8 weeks, 4 months, 8 months, 1 year or 2 years of age between 2010 and 2015. Duplicate records and those with missing data for sex, age, height, weight, Aboriginality, gestational age at birth or postcode; and records with postcodes outside Victoria were excluded. Due to variations in data recording and electronic storage, not all LGAs had data available in the 2010-2015 period and 68 LGAs were included in the analysis sample.

Children's ages at each consultation were calculated from birth and consultation dates and categorised into one of the five consultation age groups: 8 weeks (7 weeks to 3.49 months) 4 months (3.5-6.99 months), 8 months (7-9.99 months) 1 year (10-16 months), and 2 years (22-30 months). Aboriginality was coded as a binary variable (Aboriginal and/or Torres Strait Islander or neither Aboriginal nor Torres Strait Islander, hereafter referred to as 'non-Aboriginal') based on children's MCH records in the database. Height and weight measurements recorded by MCH nurses during consultations were used to calculate BMI (weight (kg)/height (m)^2), and age- and sex-specific BMI z-scores (zBMI) with reference to the WHO Child Growth Standards.[13] Biologically implausible values were removed according to the WHO guidance (zBMI $<$-5 or $>$5).(13) The co-primary outcomes were zBMI and healthy weight category ($-1 <$ zBMI ≤ 1).

Children's residential postcodes were used to derive area-level socio-economic position, using the Australian Bureau of Statistics Socio-economic Index for Areas (SEIFA), Index of Relative Economic Advantage and Disadvantage (IRSAD), and remoteness classification from the Australian Statistical Geography Standard Remoteness Structure classifications (Major Cities, Inner Regional, Outer Regional, Remote and Very Remote). In both cases the classifications from the closest preceding year were used.[14,15] IRSAD scores were classified into Victoria-specific tertiles of relative advantage-disadvantage.

Remoteness classifications were reduced to three levels (major cities, inner regional, and combined outer regional and remote areas).

Statistical analysis

A linear mixed model was fitted for each age group to compare mean zBMI of Aboriginal and Torres Strait Islander and non-Aboriginal children in the whole sample and within sexes. The model included Aboriginality, sex, Aboriginality×sex, with LGA as a random effect. We further adjusted for calendar year, IRSAD tertile and remoteness (3 levels). These covariates were the only sociodemographic and contextual factors available in the MCH dataset for inclusion in analyses of the relationship between Aboriginality and weight status. Differences in prevalence of healthy weight (binary outcome) between Aboriginal and Torres Strait Islander and non-Aboriginal children for each age group for all children and by sex were estimated using a logistic mixed model involving the same factors as the linear mixed model. From each model we report estimates and 95% confidence intervals of marginal means (zBMI) or marginal prevalences (healthy weight) and the difference between Aboriginal and Torres Strait Islander and non-Aboriginal children for all children, for boys and girls. We also report the p-value for the Aboriginality×sex interaction that assesses effect modification. Because both remoteness and area-level socioeconomic status (IRSAD) might act as mediators of the "effect" of Aboriginality on child weight we also fitted models only adjusting for calendar year as a sensitivity analysis. Estimates from these models are shown in Supplementary Tables 1 and 2.

We further fitted linear mixed models for each age group to assess whether inequalities in weight status differed by a) area-level IRSAD (SEP) tertile, or b) levels of remoteness (Major Cities, Inner Regional, Outer Regional/Remote). All models included LGA as a random effect and the following fixed effects: a) Aboriginality, SEP, Aboriginality×SEP, sex, calendar year, and remoteness; and b) Aboriginality, remoteness, Aboriginality×remoteness, sex, calendar year, and SEP. All analyses were performed using Stata version 18.0.

Results

Participant characteristics

Data were available for 68 of the 79 LGAs in Victoria, representing approximately 86% of the total population of Victoria in 2015.[17] The initial dataset included 655,491 children with at least one visit recorded between 2010 and 2015. 130,954 (20.0%). Of these, did not attend at least one visit at 8 weeks, 4 months, 8 months, 1 year or 2 years and were therefore excluded from the analysis. A further 129,874 children were excluded due to missing or invalid anthropometric data (0.8% of the initial sample), missing postcode (2.5%), missing Aboriginality (4.5%), missing gestational age (5.6%) or not being born at term (6.4%).

The final analysis included 15,356 measurements from 5,057 Aboriginal and Torres Strait Islander children (4,200 Aboriginal, 221 Torres Strait Islander, 636 both Aboriginal and Torres Strait Islander), with a mean of 3.04 visits per child (SD1.41), There were also 1,329,635 measurements from 389,606 non-Aboriginal children (mean visits per child 3.41, SD 1.45). Among this sample, 19.5% of the Aboriginal and Torres Strait Islander children and 31.2% of the non-Aboriginal children had data for all 5 visits. There were 311,183 children (3,995 Aboriginal and Torres Strait Islander, 307,188 non-Aboriginal) with BMI data at 8 weeks. Numbers reduced with age, with the lowest number of children occurring at the 2-year visit (1827 Aboriginal and Torres Strait Islander and 198,847 (51%) non-Aboriginal children). Most children (regardless of Aboriginality) lived in major cities, followed by inner regional areas then outer regional/remote areas. Just under half (47-49% in each age group) of Aboriginal and Torres Strait Islander children lived in the most disadvantaged SEP areas, and around one in five lived in the most advantaged areas. Full details of the sample characteristics by age and Aboriginality are provided in Supplementary Table 3.

Prevalence of healthy weight by age, sex and Aboriginality

Table 1 presents the estimated prevalences by Aboriginality for each age group after adjusting for sex, calendar year, SEP tertile and remoteness. At all ages, the majority of children had a zBMI within the healthy range ($-1 <$ zBMI ≤ 1). At 8 weeks, 70.5% (95%CI 69.1,72.0) of Aboriginal and Torres Strait Islander and 70.7% (70.4 ,71.1) of non-Aboriginal children had healthy zBMI (p= 0.79). Prevalence of healthy weight reduced with age for all children but this reduction appeared to occur faster for Aboriginal and Torres Strait Islander children, noting that the sample size also reduced with age. Aboriginal and Torres Strait Islander children were less likely than non-Aboriginal children to have healthy weight at age 4 months (65.2% vs. 67.1%, difference -1.92 (95%CI -3.45, -0.38) p=0.014), 8 months (64.9% vs. 67.5%, difference -2.58 (-4.32, -0.85), p=0.0035), 1 year (59.2% vs. 65.3%, difference -6.10 (-7.94, -4.27), p<0.0001) and 2 years (55.7% vs. 60.4%, difference -4.71 (-7.00, -2.42), p=0.0001). Healthy weight was more prevalent in girls than boys across all age groups, for both Aboriginal and Torres Strait Islander and non-Aboriginal children. Conclusions remained the same when we excluded IRSAD and remoteness from the model (Supplementary Table 1).

BMI z-scores by age, sex and Aboriginality

Table 2 presents the estimated mean BMI z-scores (zBMI), among Aboriginal and Torres Strait Islander and non-Aboriginal children for each age group and gender after adjusting for calendar year, SEP tertile, and remoteness. The results for zBMI were similar to those for prevalence of healthy weight. zBMI increased with age in both Aboriginal and Torres Strait Islander and non-Aboriginal children, and tended to be higher among boys than girls, though the differences by sex were small at older ages. zBMI was significantly higher among Aboriginal and Torres Strait Islander children compared to non-Aboriginal children (difference at 8 weeks = 0.038, (95%CI: 0.008, 0.068), p = 0.0139; difference at 4 months= 0.15 (0.12, 0.19), 8 months= 0.19 (0.15, 0.22), 1 year= 0.20 (0.16, 0.24), 2 years= 0.13 (0.08, 0.18), all p<0.0001). Conclusions remained the same when we excluded IRSAD and remoteness from the model (Supplementary Table 2).

Place-based differences in BMI z-scores

Children living in more advantaged areas of Victoria tended to have a lower zBMI at 8 weeks, 4 months, 8 months and 1 year, but not at 2 years (**Figure 1**). Area-level socioeconomic position (SEP) inequities appeared to be larger for Aboriginal and Torres Strait Islander children, although the Aboriginality×SEP interactions were not significant, possibly due to lack of power. At 8 weeks, only for the lowest (least advantaged) SEP tertile areas Aboriginal and Torres Strait Islander children have a significantly higher mean zBMI than non-Aboriginal children (difference 0.062 (95%CI: 0.018, 0.106),

Table 1: Adjusted prevalence of healthy weight (-1<zBMI≤1) by age and sex among Aboriginal and Torres Strait Islander and non-Aboriginal children, 2010–2015.

	8 weeks		4 months		8 months		1 year		2 years	
	% (95%CI)	N	% (95%CI)	N	% (95%CI)	N	% (95%CI)	N	% (95%CI)	N
All children										
Aboriginal/Torres Strait Islander	70.5 (69.1, 72.0)	3,995	65.2 (63.6, 66.7)	3,794	64.9 (63.2, 66.6)	2,943	59.2 (57.2, 61.1)	2,797	55.7 (53.2, 58.2)	1,827
Non-Aboriginal	70.7 (70.4, 71.1)	307,188	67.1 (66.8, 67.3)	301,891	67.5 (67.2, 67.8)	263,998	65.3 (64.6, 65.9)	257,711	60.4 (59.3, 61.5)	198,847
Boys										
Aboriginal/Torres Strait Islander	69.3 (67.3, 71.4)	2,018	63.8 (61.6, 65.9)	1,927	63.9 (61.4, 66.3)	1,482	58.7 (56.1, 61.4)	1,413	55.2 (51.9, 58.6)	927
Non-Aboriginal	68.6 (68.2, 69.0)	157,558	64.9 (64.6, 65.2)	154,774	65.7 (65.3, 66.0)	135,186	63.8 (63.1, 64.5)	132,017	59.0 (57.9, 60.1)	101,778
Girls										
Aboriginal/Torres Strait Islander	71.8 (69.8, 73.8)	1,977	66.7 (64.5, 68.8)	1,867	65.9 (63.5, 68.4)	1,461	59.6 (56.9, 62.3)	1,384	56.1 (52.7, 59.5)	900
Non-Aboriginal	73.0 (72.6, 73.3)	149,630	69.4 (69.1, 69.7)	147,117	69.4 (69.0, 69.7)	128,812	66.8 (66.1, 67.5)	125,694	61.8 (60.7, 62.9)	97,069
Difference	**Diff (95%CI)**	**p**	**Diff (95%CI)**	**p**	**Diff (95%CI)**	**p**	**Diff (95%CI)**	**p**	**Diff (95%CI)**	**p**
All children	-0.20 (-1.62, 1.23)	0.7884	-1.92 (-3.45, -0.38)	0.0142	-2.58 (-4.32, -0.85)	0.0035	-6.10 (-7.94, -4.27)	<0.0001	-4.71 (-7.00, -2.42)	0.0001
Boys	0.71 (-1.31, 2.74)	0.4910	-1.13 (-3.30, 1.03)	0.3044	-1.79 (-4.24, 0.66)	0.152	-5.09 (-7.67, -2.52)	0.0001	-3.80 (-7.01, -0.60)	0.0201
Girls	-1.15 (-3.14, 0.85)	0.2586	-2.74 (-4.89, -0.59)	0.0127	-3.41 (-5.85, -0.98)	0.006	-7.17 (-9.76, -4.57)	<0.0001	-5.66 (-8.91, -2.42)	0.0006
Aboriginal × sex[a]		0.1926		0.2636		0.3155		0.2218		0.4021

Estimates from separate logistic mixed models for each age group, with LGA as random effect, including Aboriginality, sex, their interaction, and further adjusting for calendar year, ICSEA tertile and 3-level remoteness.

[a]Interaction effect.

Table 2: :Adjusted mean zBMI by age and sex among Aboriginal and Torres Strait Islander and non-Aboriginal children, 2010–2015.

	8 weeks		4 months		8 months		1 year		2 years	
	mean (95%CI)	N	mean (95%CI)	N	mean (95%CI)	N	mean (95%CI)	N	mean (95%CI)	N
All children										
Aboriginal/Torres Strait Islander	-0.10 (-0.14, -0.07)	3,995	0.04 (0, 0.08)	3,794	0.40 (0.35, 0.44)	2943	0.65 (0.60, 0.69)	2,797	0.74 (0.68, 0.80)	1,827
Non-Aboriginal	-0.14 (-0.17, -0.12)	307,188	-0.12 (-0.14, -0.09)	301,891	0.21 (0.18, 0.24)	263998	0.45 (0.42, 0.48)	257,711	0.61 (0.58, 0.65)	198,847
Boys										
Aboriginal/Torres Strait Islander	-0.07 (-0.12, -0.02)	2,018	0.06 (0.01, 0.11)	1,927	0.42 (0.36, 0.48)	1482	0.65 (0.59, 0.71)	1,413	0.73 (0.66, 0.81)	927
Non-Aboriginal	-0.12 (-0.14, -0.09)	157,558	-0.11 (-0.13, -0.08)	154,774	0.21 (0.19, 0.24)	135186	0.45 (0.42, 0.48)	132,017	0.62 (0.59, 0.66)	101,778
Girls										
Aboriginal/Torres Strait Islander	-0.14 (-0.19, -0.09)	1,977	0.02 (-0.04, 0.07)	1,867	0.37 (0.31, 0.43)	1461	0.65 (0.59, 0.71)	1,384	0.75 (0.68, 0.83)	900
Non-Aboriginal	-0.17 (-0.19, -0.14)	149,630	-0.13 (-0.15, -0.10)	147,117	0.21 (0.18, 0.23)	128812	0.44 (0.41, 0.47)	125,694	0.60 (0.56, 0.64)	97,069
Difference	**Diff (95%CI)**	**p**	**Diff**	**p**	**Diff**	**p**	**Diff**	**p**	**Diff**	**p**
All children	0.04 (0.01, 0.07)	0.0139	0.15 (0.12, 0.19)	<0.0001	0.19 (0.15, 0.22)	<0.0001	0.20 (0.16, 0.24)	<0.0001	0.13 (0.08, 0.18)	<0.0001
Boys	0.05 (0.01, 0.09)	0.0215	0.17 (0.12, 0.21)	<0.0001	0.21 (0.16, 0.26)	<0.0001	0.19 (0.14, 0.25)	<0.0001	0.11 (0.04, 0.18)	0.0011
Girls	0.03 (-0.02, 0.07)	0.2407	0.14 (0.10, 0.19)	<0.0001	0.16 (0.11, 0.22)	<0.0001	0.21 (0.15, 0.26)	<0.0001	0.15 (0.09, 0.22)	<0.0001
Aboriginal × sex[a]		0.4317		0.4861		0.2263		0.7773		0.3454

Estimates from separate linear mixed models for each age group, with LGA as random effect, including Aboriginality, sex, their interaction, and further adjusting for calendar year, ICSEA tertile and 3-level remoteness.

[a]Interaction effect.

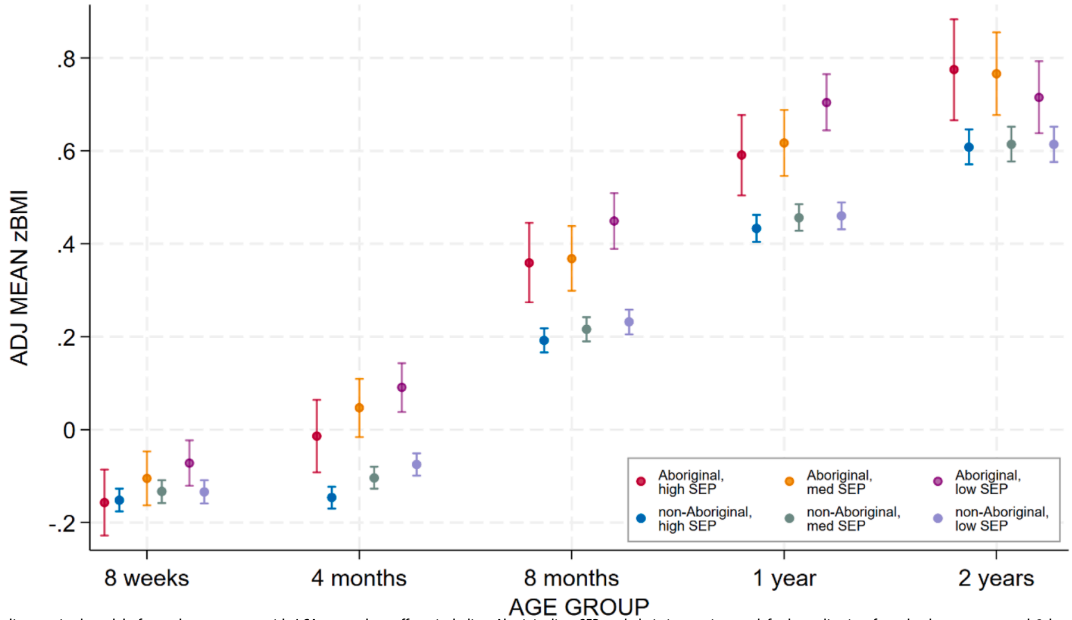
p=0.006). In all other age groups, Aboriginal and Torres Strait Islander children consistently had a significantly higher mean zBMI compared to non-Aboriginal children within all SEP tertiles. Except for 2-year-olds, the differences in mean zBMI between Aboriginal and Torres Strait Islander and non-Aboriginal children appeared to be larger within the least advantaged areas of Victoria; however, the AboriginalityxSEP interaction did not reach statistical significance.

When considering remoteness, the pattern of inequalities in zBMI was less clear (Figure 2). Children living in inner regional areas tended to have a lower zBMI than children in either major cities or outer regional/remote areas, at 8 weeks, 4 months and 8 months. At 8 weeks, only for those living in major cities did Aboriginal and Torres Strait Islander children have a higher zBMI than non-Aboriginal children (difference 0.051 (95%CI: 0.009, 0.093) p=0.017). At 4 months, 8 months and 1 year and in all remoteness levels, Aboriginal and Torres Strait Islander children had higher zBMI than their non-Aboriginal counterparts. While differences between Aboriginal and Torres Strait Islander and non-Aboriginal children appeared smaller in inner regional areas, the interaction Aboriginality × remoteness was not significant for any of the age groups.

Discussion

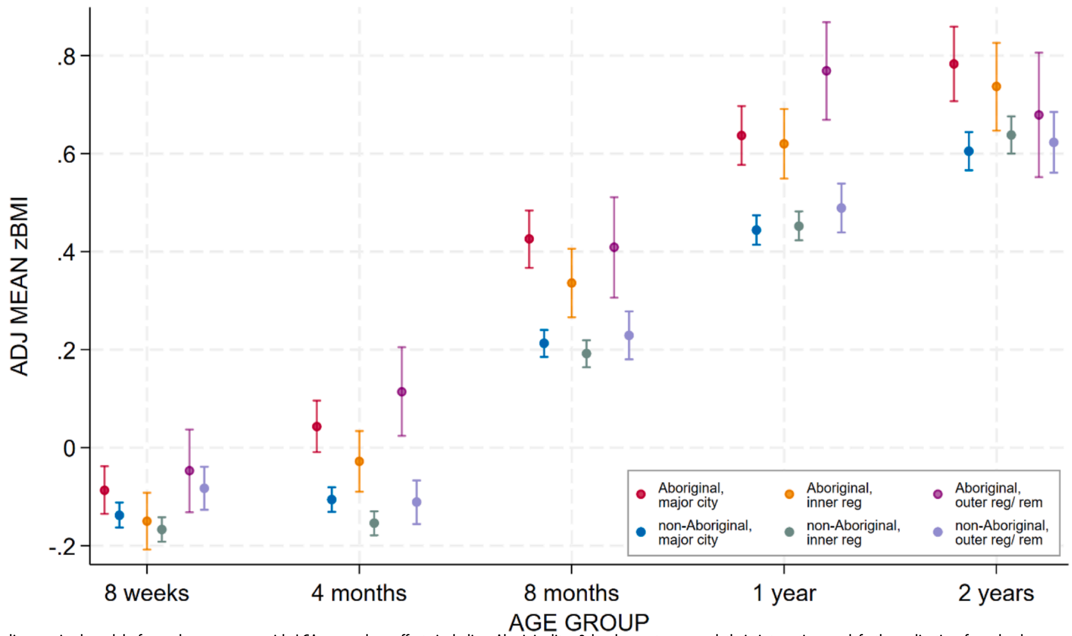
This cross-sectional analysis of Maternal and Child Health data included a large sample of children from across Victoria, representing over 5000 Aboriginal and Torres Strait Islander children. Our findings

Figure 1: Adjusted mean zBMI, by age and tertile of relative socio-economic position among Aboriginal and Torres Strait Islander and non-Aboriginal children, 2010–2015.



Estimates from separate linear mixed models for each age group, with LGA as random effect, including Aboriginality, SEP and their interaction, and further adjusting for calendar year, sex and 3-level remoteness.
Tertile of socio-economic position derived from percentile score for postcode-level Index of Relative Socioeconomic Advantage-Disadvantage.
Differences between Aboriginal and Torres Strait Islander and non-Aboriginal children within SEP strata were significant for all age groups and SEP tertilelevel at $p<0.01$, except the highest and middle SEP tertiles at age 8 weeks. Aboriginality × SEP interaction was non-significant for all age groups.

Figure 2: Adjusted mean zBMI, by age and three-level remoteness classification among Aboriginal and Torres Strait Islander and non-Aboriginal children, 2010–2015.



Estimates from separate linear mixed models for each age group, with LGA as random effect, including Aboriginality, 3-level remoteness and their interaction, and further adjusting for calendar year, sex and SEP tertile.
Differences between Aboriginal and Torres Strait Islander and non-Aboriginal children were significant at $p<0.001$ for all remoteness classifications at ages 4 months, 8 months and 1 year, and in major cities at age 2 years. Differences were also significant at $p<0.05$ in major cities at age 8 weeks, and in inner regional areas at 2 years. Aboriginality × remoteness interaction was non-significant in all age groups.
Remoteness categories, based on postcode-level ARIA classification.

indicate that while the majority of children, both Aboriginal and Torres Strait Islander and non-Aboriginal, were within the healthy BMI range in early infancy, there was a notable decline in healthy weight prevalence with age. Although there was no difference in mean zBMI between Aboriginal and Torres Strait Islander and non-Aboriginal children at 8 weeks, significant disparities in BMI outcomes were observed at older ages, which were influenced by socioeconomic position and remoteness.

Our finding that Aboriginal and Torres Strait Islander children living in more advantaged areas tended to have a lower zBMI is at odds with a previous systematic review of cardiometabolic risk markers among Aboriginal and Torres Strait Islander children and adolescents.[18] McKay and colleagues reported that higher area-level SEP appeared to be associated with increased childhood obesity, however, Aboriginal and Torres Strait Islander children from Victoria may have been underrepresented in this review as no Victorian studies were included. [18] The lower zBMI observed in socioeconomically advantaged areas in our analysis is consistent with studies in the general Victorian and Australian populations,[12,19] and provides important new evidence about Aboriginal and Torres Strait Islander children in Victoria, underscoring the protective effect of broader social determinants on health outcomes.

Evidence from Australian longitudinal studies demonstrates that weight status tracks from early to middle childhood.[19,20] The Longitudinal Study of Indigenous Children observed a rapid rise in childhood obesity among Aboriginal and Torres Strait Islander children between the ages of 3 and 9 years.[20] Furthermore, research from Victoria found that older Aboriginal and Torres Strait Islander children (8–13 years) are less likely than non-Aboriginal children to have a healthy weight.[21] Taken together, this evidence suggests that the apparent reduction in inequalities in zBMI at age 2 in our data is likely due to selection bias in the sample, particularly among Aboriginal and Torres Strait Islander children, attending the 2-year MCH visit. Our findings highlight the importance of early intervention during the first 1000 days of life and the need for culturally responsive MCH services that meet the needs of Aboriginal and Torres Strait Islander families.

Our findings regarding the impact of remoteness on zBMI are particularly noteworthy. Onset of inequalities in weight status occurred later for Aboriginal and Torres Strait Islander children living in inner and outer regional/remote areas compared to those in major cities. Although our observation that zBMI and inequalities between Aboriginal and Torres Strait Islander and non-Aboriginal children appeared lower in inner regional areas did not reach statistical significance, possibly due to small sample sizes within each age and remoteness category, our analysis underscores the importance of understanding demographic and place-based differences in health outcomes and reinforces the need to disaggregate data beyond the remote/non-remote urban/regional binaries. The 2012–13 National Aboriginal and Torres Strait Islander Health Survey did not report child weight status by remoteness or jurisdiction and only provided early childhood data for 2-4 year-olds,[22] making our granular data particularly valuable.

VACCHO has long advocated for culturally responsive primary health care during pregnancy and early childhood. The Koori Maternity Services program was established in 2000 and now provides multi-disciplinary, culturally safe maternity care in 14 sites across urban and regional Victoria. Until recently, this care was limited to pregnancy and the early postpartum period, after which time ongoing maternal and child health care was provided by local government services. According to data from 2017–18, attendance at local government MCH consultations in Victoria was near-universal at the first visits, then decreased with age.[23] Access to MCH services was notably lower for Aboriginal and Torres Strait Islander families, with 67.5% attending the 12-month visit, compared to 83.4% of non-Aboriginal families.[23] In response, VACCHO successfully advocated for the establishment, in 2017, and expansion in 2019–20, of an Aboriginal MCH (AMCH) program, which transferred the delivery of MCH services for Aboriginal and Torres Strait Islander families to their local ACCO. The objective of the AMCH program was to increase access to MCH services for Aboriginal and Torres Strait Islander families by enhancing cultural safety, acceptability and continuity of care from the postpartum period into early childhood. The present analysis of MCH data collected between 2010 and 2015 predates this initiative and, therefore, provides useful baseline data against which the AMCH program could be evaluated by VACCHO and its member ACCOs.

In addition to the findings presented in this article, we have produced a summary report of regional-level outcomes so VACCHO can communicate locally-relevant findings to its member ACCOs. Although Aboriginal and Torres Strait Islander peoples do not currently own, control, or govern MCH data, this study demonstrates what would be possible if Aboriginal community organisations routinely had access to, and possession of, age and context-specific child health data, and could determine the processes by which data are analysed and interpreted, through the exercise of Indigenous Data Governance. This aligns with the recommendations from the recent review of the National Agreement on Closing the Gap and the Maiam Nayri Wingara Indigenous Data Sovereignty principles, both of which emphasise the need for greater governance and control of Indigenous data by Indigenous people to enable self-determination and empowerment of Aboriginal and Torres Strait Islander peoples and communities.2,3 The opportunities that emerge from this process, in this case for VACCHO, to inform policy positions, advocacy, and the development of ACCO service delivery, are considerable.

This study was designed with VACCHO to empower Victorian ACCOs with evidence on a priority health issue. A key strength is the large population-based sample, including over 5000 Aboriginal and Torres Strait Islander babies. To our knowledge, this is the largest analysis of Aboriginal and Torres Strait Islander children's growth during the critical first 1000 days of life. The size of the MCH dataset enabled examination of place-based differences in child weight outcomes, both within the Aboriginal and Torres Strait Islander population and compared to non-Aboriginal children. This is significant because Victoria, with its smaller Aboriginal and Torres Strait Islander population compared to other states and territories, is often under-represented in population health surveys that lack the power to detect within-group differences.

Data were unavailable for 11 of the 79 Victorian LGAs due to area-level administrative factors. The excluded LGAs represented a mix of major cities, inner and outer regional areas, as well as IRSAD tertiles. We were not able to access data for the LGAs of Greater Shepparton and Campaspe, the Victorian LGAs with the largest Aboriginal and Torres Strait Islander population on Yorta Yorta Country. As a result, we were unable to provide ACCOs in this First Nation with location-specific information to inform their service planning. Due to the decrease in MCH attendance with age, particularly for Aboriginal and Torres Strait Islander children,[23] the number of Aboriginal and Torres Strait Islander children aged 2 years in our sample was less than half of those aged 8 weeks. This smaller sample size limited our power to detect place-based differences for this age group. Additionally, the reduced sample size with age means we cannot rule out the possibility that those who left the sample differ in weight status to those who remained. Furthermore, IRSAD tertiles were used as a proxy for area-level socioeconomic position but do not reflect the full range of social and cultural factors, including experiences of racism, contributing to health outcomes and influencing access to MCH services for Aboriginal and Torres Strait Islander people.[25]

Similarly, in analysing differences in weight status between Aboriginal and Torres Strait Islander and non-Aboriginal children, Aboriginality is not conceptualised as a biological variable but as reflecting the lived realities of colonisation, structural racism and social inequity. Area-level SEP was included in our analysis to examine the additional structural inequity experienced by Aboriginal and Torres Strait Islander children beyond that which could be explained by place-based factors alone. While the Indigenous Relative Socioeconomic Outcomes (IRSEO) index provides an Aboriginal and Torres Strait Islander-specific indicator of area-level socioeconomic inequalities,[26] it was not suitable for this analysis which also included non-Aboriginal children. Given that area-level SEP and remoteness might be pathways through which health inequities manifest, adjusting for them may have underestimated some of the inequities between Aboriginal and Torres Strait Islander and non-Aboriginal children. However, when we fitted the models excluding the area level variables, our main findings were unchanged (Supplementary Tables 1 and 2).

Our analysis was also constrained by the limited set of de-identified variables available, with no means to independently verify the accuracy of the data. However, the impact of potential errors in the dataset was likely reduced by the large sample size and the measures taken to exclude extreme values. The high rate of missing Aboriginality data in the dataset meant that we were forced to exclude a large number of children from the analysis, which may introduce bias. In addition, because Aboriginality was recorded within mainstream MCH services and previous research identified multiple errors in identification of Aboriginal and Torres Strait Islander babies in Victorian maternity services,[24] there is potential for underreporting of Aboriginality, further highlighting the importance of ACCHO leadership and data governance in MCH. A longitudinal analysis was not conducted due to the substantial missing data across repeated measures. The repeated cross-sectional approach adopted limited the ability to track growth trajectories over time but enabled population-level, place-based insights into early childhood weight status.

We recognise the importance of using a strength-based approach and acknowledge that quantifying inequalities between Aboriginal and Torres Strait Islander and non-Aboriginal children risks perpetuating a deficit narrative.[27] This comparative analysis was requested by VACCHO to support their advocacy efforts. Our intention was to provide VACCHO and its members with evidence for funding advocacy without positioning non-Aboriginal people as the 'ideal' standard. Future research should focus on diversity within Aboriginal and Torres Strait Islander populations and identify protective factors that support positive maternal and child health outcomes. Developing an Aboriginal MCH minimum dataset, designed and governed in line with Indigenous Data Sovereignty and governance principles, would be a meaningful step forward.

Conclusions

This study provides unique insights into early childhood weight outcomes among Aboriginal and Torres Strait Islander children in Victoria, identifying the age at which disparities emerge between Aboriginal and Torres Strait Islander and non-Aboriginal children and highlighting opportunities for early intervention. Our findings underscore the importance of accessible, culturally safe maternal and infant health care, particularly in disadvantaged areas and major cities where the majority of Aboriginal and Torres Strait Islander peoples live. This study offers valuable baseline data for Aboriginal and Torres Strait Islander-specific MCH initiatives currently active in Victoria. Further access to routinely collected data is essential to evaluate the effectiveness of these culturally responsive health services. This research should be governed and controlled by the Victorian ACCO sector.

Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Funding

This study was funded by a Deakin University Faculty of Health Research Capacity Building grant. JB and MN receive funding from the National Health and Medical Research Council (MN: GNT2002234, JB: GNT2027736). SS and FM receive funding from the Medical Research Future Fund (GA341372). The funding sources had no influence on any aspect of study design, analysis or reporting. The Victorian government's (former) Department of Education and Early Childhood Development supported the research by providing approvals and facilitating access to deidentified data.

Ethics

The MCH data extraction and analysis were approved by the Deakin University Human Ethics Advisory Group (Health) (HEAG-H 113_2014) and the Victorian State Government Department of Education and Training Research in Schools and Early Childhood settings process (2014_002421). Our additional analysis for this publication received exemption from further ethics review by Deakin University Human Research Ethics Committee (2023-143). In the absence of an Aboriginal Community controlled ethics committee in Victoria, we worked closely with VACCHO throughout the project, consistent with the principles of the *marra ngarrgoo, marra goorri* Victorian Aboriginal Health, Medical and Wellbeing Research Accord.[16]

Authors' contribution

MN designed the study with JB, LO, NL, and AR. DB performed the data analysis with supervision from LO. AR and NL assisted with interpretation and contextualisation of findings. SS and JB led the manuscript writing, with support from NL and FM. All authors reviewed and approved the final manuscript.

Availability of data

The de-identified data we analysed are not publicly available and cannot be made available by the authors. Researchers may apply for data access for approved research purposes directly to the Victorian Government. Analytic codes are available on request from the corresponding author.

Acknowledgements

The authors acknowledge the traditional owners of the lands now known as Victoria where these data were collected and where this research took place.

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Appendix A Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.anzjph.2025.100299.