Prevalence and protective factors for *walu-win ngawaal* (healthy weight) status in Aboriginal children living in urban and regional Australia

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Abstract

Objective: To identify factors protective of healthy weight for Aboriginal children living in urban and regional Australia.

Methods: Data were collected from 1139 Aboriginal children aged 2–19 years from the Study of Environment on Aboriginal Resilience and Child Health (SEARCH). BMI z-scores were calculated using WHO age and sex specific cut-offs. Poisson regression models were used to examine the association between BMI z-scores and child- and family-level socio-demographic, lifestyle, and environmental factors.

Results: A majority of children had a healthy weight (67 %); 17 % had overweight and 16 % had obesity, with similar percentages for females and males in all three categories. Children were more likely to have a healthy weight if they were younger, had a lower waist-to-height (WHtR) ratio, a caregiver with a healthy weight and had housing affordability problems. For every extra hour of physical activity undertaken per day children were 7 % more likely to have a healthy weight.

Conclusions: Healthy weight prevalence decreased with increasing age and decreasing physical activity levels in Aboriginal children and was strongly linked to caregiver BMI.

Implications for public health: Implementing effective, community-led, culturally sensitive programs that support increased physical activity and promote healthy weight in childhood should be a public health priority.

Key words: Aboriginal and Torres Strait Islander, indigenous, child, Body mass index (BMI), healthy weight

Introduction

Aboriginal and Torres Strait Islander peoples have lived on the unceded lands now known as Australia for 65,000 years.[1,2] European invasion and subsequent colonial policies and systems, have led to the dispossession of Aboriginal and Torres Strait Islander peoples from ancestral lands, reduced availability and access to traditional foods and enforced dietary changes to rations of Western foods, and to detrimental impacts on the environment.[3–5] Colonisation, urbanisation and changes to the food environment have resulted in reduced access to nutrient dense traditional food sources and a shift towards more energy-dense Western diets.[6,7] These changes are major contributors to weight status in both Aboriginal and Torres Strait Islander children and adults.[3,8]

Healthy weight is an important indicator of health and wellbeing for Aboriginal and Torres Strait Islander peoples during childhood,

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adolescence and in adulthood. Establishing and maintaining a healthy weight reduces the risk of social and emotional wellbeing difficulties, musculoskeletal disorders, asthma, sleep apnoea, and range of metabolic disorders in childhood and in later life.[9–14] Child weight is influenced by a complex set of interrelated biological, lifestyle, behavioural and environmental factors,[11,12,15,16] which are exacerbated by ongoing impacts of colonisation such as intergenerational trauma, socioeconomic inequities, land rights, food insecurity, insecure and poor quality housing, racism, high rates of child removals, alarming rates of child incarceration and inequitable access to health and other services .[3,17–23]

Most research on weight status has focused on overweight and obesity due to its association with poor health outcomes.[10,11,24,25] This is problematic for Aboriginal and Torres Strait Islander health because it perpetuates a deficit-based approach which has shown to impact on health and wellbeing.[26] The most recent nationally representative data (2018/19) showed that 54 % of Aboriginal and Torres Strait Islander children aged 2-14 years have a body mass index (BMI) in the normal range, and this decreased to 50 % at age 15-17 years and dropped further to 22 % at age 18 years and over it.[27]

A recent review has highlighted that available evidence on Aboriginal and Torres Strait Islander health has predominately focused on rural and remote communities.[28] Therefore, there is a need for evidence on the health and wellbeing of Aboriginal and Torres Strait Islander children in urban and regional areas to better understand the factors that can support a healthy weight to inform relevant child health programs.[8,29] This article utilises data from the Study of Environment on Aboriginal Resilience and Child Health (SEARCH), a large cohort study of Aboriginal and Torres Strait Islander children and adolescents living in urban and regional areas of New South Wales, Australia.[30] We aimed to describe[1]: the proportion of children aged 2–19 years in the baseline data from SEARCH with a healthy weight, by sex and age group, and [2] the association between healthy weight and a range of individual, family, and environmental factors.

Methodology

The SEARCH study was designed in partnership with four Aboriginal Community Controlled Health Services (ACCHSs), the Aboriginal Health and Medical Research Council, the Sax Institute and Aboriginal and Torres Strait Islander and non-Indigenous researchers to investigate Aboriginal and Torres Strait Islander community-identified priority areas. The focus was on child health and wellbeing, and included focus areas of: otitis media, social and emotional wellbeing, resilience, child development, obesity, chronic disease, housing, and the environment. A detailed description of the SEARCH study has been published previously.[30,31]

This project used a subset of data from the SEARCH study and applied a strengths-based approach to quantitative analysis, as detailed by Thurber et al.[26,32] Working closely with staff from the partner Aboriginal Community Controlled Health Services who are co-authors on this article ensured that Aboriginal and Torres Strait Islander perspectives as well as the strengths and outcomes valued by the SEARCH communities were central to the study. This included meetings to discuss the available variables from the broader SEARCH study, which ones should be included for the analysis for this article, what the key findings from the study were and what they mean locally for policy and program advocacy.

Positionality of the research team

The first author (SS) is a Wotjobaluk woman who has grown up on Wiradjuri Country, which is one of the partner communities for the research and has a background in Aboriginal and Torres Strait Islander health promotion and public health. SS has worked with the Aboriginal Community Controlled Health Sector (ACCHS) for over 15 years. LB is a non-Indigenous woman who is a biostatistician and has worked in partnership with ACCHSs for over 10 years on the SEARCH project. MD is a Darkinjung/Ngarigo woman with a background in Aboriginal and Torres Strait Islander health promotion and public health and has worked in partnership with ACCHSs for over 20 years. EB is a non-Indigenous woman who has a background in epidemiology and has worked in Aboriginal and Torres Strait Islander health research for 17 years. SE is a Noongar woman who is a medical epidemiologist and has worked closely with the ACCHS sector for most of her career. NS is a Wiradjuri woman, who has a background in Aboriginal and Torres Strait Islander health promotion and a trained Aboriginal Health Worker who has worked in an ACCHS her whole career, including on the SEARCH study. LW is a Dunghutti man who has a background in policy and Aboriginal and Torres Strait Islander health, including within the ACCHS sector. JC is a non-Indigenous man who has a background in paediatric nephrology and clinical epidemiology and has worked in Aboriginal and Torres Strait Islander health research for 17 years. LAB is a non-Indigenous woman who has a background in paediatrics, public health and childhood obesity, and is the primary PhD supervisor of SS. SM is a non-Indigenous woman who has a background in public health nutrition and has worked in Aboriginal and Torres Strait Islander health research in partnership with ACCHSs for over 12 years on the SEARCH project.

Study design

Children aged 0–17 years and their caregivers were eligible for recruitment into the SEARCH project at the four partner ACCHSs in NSW. All baseline data were collected from 2008–2012 by local Aboriginal Research Officers employed at the ACCHSs. Two of the ACCHSs (Tharawal Aboriginal Corporation and Greater Western Sydney Aboriginal Health Service) are located in metropolitan Sydney city and the other two ACCHSs (Awabakal Ltd and Riverina Medical and Dental Aboriginal Corporation) are located in large regional areas and serve as hubs for smaller surrounding towns. Some children in SEARCH were cared for by adults who were not biological parents, consistent with culturally appropriate child rearing practices and kinship systems.[33] Therefore, we use the term 'caregiver' which refers to both parents and caregivers. All caregivers provided informed written consent for themselves and their children to participate in the study.

Ethics approval for this study was provided by the Aboriginal Health and Medical Research Council of New South Wales Ethics Committee (reference, 568/06) and the University of Sydney Human Ethics Committee (reference, 8506).

Measures

Anthropometric measurements

Using a standard protocol, children and caregivers were weighed in light clothing without shoes using Electronic Body Scales (TCS-200, China), with results recorded in kilograms to the nearest 0.05 kg. Height measurements were obtained using Harpenden Portable Stadiometers (Holtain Ltd, Crosswell, UK). Waist circumference measurements were obtained using Seca 201 measuring tapes (SECA, Vogel & Halke GmbH & CO. KG, Hamburg, Germany) over the top of light clothing or directly on the skin and recorded to the nearest 0.1 cm.

This analysis excluded children who were less than 2 years of age at the time of anthropometric measurement (n=176), had implausible height or weight measurements (n=40) according to the WHO guidelines,[34] and children with missing height and/or weight measurements (n=277). BMI was calculated as weight/ height^2. For children, age and sex-specific BMI z-scores were calculated using SAS macros provided by the World Health Organization (WHO) based upon the 2006 WHO Child Growth Standard for children <61 months (5.08 years)[35] or the 2007 WHO Growth Reference for children aged between ≥61 months to 228 months (19.0 years).[36] For one adolescent aged 19.7 years we calculated the z-score based on the age of 19.0 years. We then assigned each BMI score to one of the four categories (underweight, normal weight, overweight, obesity) as defined by the WHO guidelines (Table S1) and excluded those classified as underweight due to small numbers (n=37). The remaining children's BMI were categorised as either healthy weight or having overweight/obesity, as outlined in Table S1. Caregiver BMI was categorised according to WHO criteria for adults.[37] The characteristics of the children included in the study were compared with those eligible but excluded from the study. Waist to height ratio (WHtR) was calculated as waist circumference (in cm) divided by height (in cm), and a cut off of 0.5 was used to differentiate low WHtR from high WHtR.[38–40]

Survey variables

Aboriginal Research Officers completed surveys via article forms with caregivers using the relevant 0–3 years or 4–17 years survey questionnaires for their children and a parent/caregiver survey to gather demographic, family, environmental, social and health data. However, because data were collected over several years some adolescents who were 17 years of age at recruitment were between 17–19 years of age at survey or clinical measurement. Study surveys were developed through discussions with Aboriginal and Torres Strait Islander researchers and community members from the partner ACCHSs, and from existing sources such as the NSW Population Health Survey [41] and the Western Australian Aboriginal Child Health Survey .[42]

Child level factors included were: sex; age; attended formal childcare/ preschool between 3-5 years; breastfeeding duration; exposure to cigarettes in utero, social and emotional wellbeing, dietary intake, physical activity and screen time. For children aged 4-17 years of age, mental health was measured using the Strengths and Difficulties Questionnaire (SDQ) ,[43] which was the tool decided by the SEARCH communities at the time. Although some research has found the SDQ to be an acceptable and valid tool for use among the SEARCH children,[44,45] more recently there have been limitations identified with the use of the SDQ tool among Aboriginal and Torres Strait Islander children,[46] and therefore this may not be the most appropriate measurement of SEWB. We considered children with a total SDQ score below the threshold for high risk of emotional or behavioural problems (<17) as having 'good' mental health.[47–49]

Child dietary intake was measured in both the 0-3 years and 4-17 years surveys which were adapted from the Many Rivers Diabetes study [50,51] and the NSW Child Health Survey.[52,53] In the 0-3 years survey, caregivers reported on servings of vegetables, fruit, red meat, fruit juice, and soft drink, cordials (flavoured syrup) and sports drinks consumed per day by the child. The 4-17 years survey included all the above dietary variables and the following additional ones: hot chips, french fries, wedges or fried potato; potato crisps or other salty snacks. We used the Australian Dietary Guidelines to see if our sample of children were meeting the guidelines for fruit and vegetable intake for their age and sex[54] (Appendix S1).

Physical activity and screen time questions in the 4-17 year survey were measured with standardised questions from the NSW population health survey.[41] For children, caregivers who answered the 4-17 years survey were asked the number of days during the week and weekend the child did physical activity outside of school time and how many hours on those days. We calculated the total hours over the whole week and divided by 7 to get the average hours per day. They were also asked how many days per week their child spent doing at least 30 minutes of moderate physical activity (0-2, 3-5 or 6-7 days). Caregivers were asked the number of days during the week and weekend their child spent playing video/computer games and how many hours on those days, and the number of days during the week and weekend their child spent watching TV/videos/DVDs and the number of hours on those days. We then averaged out the hours across the week that the child spent playing video/computer games and spent watching TV/videos/DVDs. We combined watching TV/videos/DVDs and playing video/computer games variables to get the average hours per day on both activities. We used The Australian Physical Activity and Sedentary Behaviour Guidelines[55] to see if the children met the recommended daily physical activity and screen time usage (S1 Appendix). Caregivers were asked in the parent/carer survey how many days per week they spend doing at least 30 minutes of moderate physical activity.

Caregiver/household level factors were: caregiver sex; caregiver Aboriginal and Torres Strait Islander status (self-identifies as Aboriginal and/or Torres Strait Islander); education; employment; caregiver's relationship to the child; food security; substance or gambling problems in the household; physical activity; housing and housing affordability[56]; availability of public transport; participation in Indigenous, sporting or mother's groups; community belonging and caregiver psychological distress.[57–60]

Statistical analyses

Descriptive characteristics of the sample were presented by the three BMI categories (healthy weight, overweight, obesity) as counts and percentages for categorical variables and medians and interquartile range (IQR) for continuous variables, which were all skewed. To examine the association between each explanatory variable and the two-level BMI outcome (overweight/obesity vs healthy weight) prevalence ratios (PR) were calculated using Poisson regression

models with robust variances.[61] Unadjusted PRs, and PRs adjusted for basic demographics (ACCHS, age and sex) were calculated for each variable. All models were fitted using generalised estimating equations with an exchangeable correlation structure to account for children within families. The functional form of each of the continuous variables was checked using fractional polynomials, with age requiring a two-term second-degree power transformation [62] (Table S2).

To assess potential bias due to missing data, the analyses were repeated in a dataset with multiply imputed data for the missing values of the explanatory variables. Under the assumption that the missing data were missing at random, multilevel multiple imputation was performed using REALCOM-IMPUTE software [63] with the outcome and all explanatory variables in the imputation models. We created 50 imputed data sets, which incorporated variability due to uncertainty in the exact values, with a burn-in period of 2500 iterations and 500 iterations between imputations. Estimates of coefficients obtained for each dataset were combined using Rubin's rules.[64] All analyses were conducted in Stata version 14.2 (StataCorp, College Station, TX, USA).

Results

After the exclusion of underweight children (n=37, 3 %), there were 1139 children (male, 53 %) included, with a median age at BMI measurement of 7.2 years (IQR 4.5, 10.8 years) (Table 1). Children included in the study had a comparable gender distribution but were more likely to be older when compared with those excluded (n=317) (Table S3). There were 539 caregivers, with most being a parent (84 %; n=951) or other relative (10 %; n=117) who identified as Aboriginal and/or Torres Strait Islander (79 %; n=853). Forty-three percent of the children had a caregiver with a trade, certificate, or diploma level of education (n=414) and 38 % (n=360) had a caregiver who had completed year 10 or below. Most children had a caregiver who was doing home duties or retired (57 %; n=607), and 30 % (n=315) were employed either full-time or part-time. Caregivers had a median BMI (n=382) of 29.2 kg/m^2 (IQR: 24.3, 35.6), of whom 2 % (n=8) were underweight, 27 % (n=105) were a healthy weight, 26 % (n=98) were overweight and 45 % (n=171) had obesity.

The majority of the children (67 %; n=768) had a healthy weight ("normal" BMI), with 17 % (n=194) having overweight and 16 % (n=177) having obesity (Table 1). The prevalence of healthy weight was similar between females (68 %; n=363) and males (67 %; n=405). The percentage of children with a healthy weight decreased as the child's age increased: 86.5 % at 2-4 years; 77.5 % at 5-6 years; 58.1 % at 7-9 years; 49.2 % at 10-11 years; and 48.1 % at ≥12 years (χ^2 test for trend $p<0.0001$). Prevalence of healthy weight was associated with caregiver BMI, decreasing from 74.5 % to 8.7 % among children whose caregivers had a healthy weight and obesity, respectively. Of the 912 children with breastfeeding data, 45 % (n=415) were never breastfed, 4 % (n=42) were breastfed for <1month, 24 % (n=221) for 1≤6months and 26 % (n=234) for >6 months. Those who had ever attended formal childcare or preschool between 3-5 years of age had a higher prevalence of healthy weight (n=246, 76 %), than those who had never attended (n=140, 56 %). Age specific physical activity and screen time guidelines were met by 67 % (n=336) and 23 % (n=102), respectively, and that for vegetable and fruit serves per day were met by 11 % (n=111) and 76.3 % (n=766), respectively among children in the study.

After adjustment for age, sex and ACCHS, several characteristics were associated with a healthy weight among children in our sample (Figures 1-3, unadjusted and adjusted PR in Table S4). Children were more likely to have a healthy weight if: they were younger ((2–4 years (PR 1.72, 95%CI 1.48,2.01); 5–6 years (PR 1.53, 95%CI 1.30,1.80)) compared with children who were aged ≥12 years; they had a lower waist:height ratio (PR 1.87 95%CI 1.68,2.08); their caregiver had a healthy weight (PR 1.17 95%CI 1.04,1.31) and reportedly had housing affordability problems (PR 1.10 95%CI 1.002,1.21). For every extra hour of physical activity performed per day children were 7 % more likely to have a healthy weight (PR 1.07 95%CI 1.01,1.13).

For most variables the proportion of missing data was less than 20 % (Table S5). However, for six variables there were large amounts of missing data (variables: ever attended formal childcare/preschool ages 3-5 [44 % missing], carer BMI [31 %], average hours per day in physical activity [45 %], watching TV/videos/DVDs [42 %], playing video/computer games [44 %], and screen time [52 %]). The results from the analyses using the imputed data were relatively consistent with the complete case analyses, indicating that the impact of bias due to missing data was likely to be minimal (S5 Table). While the PRs did not change substantially for most of the explanatory variables, the effect of housing unaffordability weakened and did not achieve significance when using the imputed data.

Discussion

Our study used a strengths-based approach to examine healthy body weight and its associated protective factors among Aboriginal and Torres Strait Islander children living in urban and regional areas of Australia. The majority of Aboriginal and Torres Strait Islander children (62 %) aged 2-19 years in our study had a healthy weight. Children aged 2-4 years had the highest prevalence of healthy weight; however, this decreased from mid-childhood and was the lowest among those ≥12 years. Factors associated with healthy weight in Aboriginal and Torres Strait Islander children included being younger, having a lower waist:height ratio, being more physically active, having a caregiver with a healthy BMI and having housing affordability problems. This knowledge on the health and wellbeing of Aboriginal and Torres Strait Islander children gathered from this study will inform the development of local health promotion strategies within the SEARCH partner ACCHSs. The data have been provided in a disaggregated format through visual presentations at workshops for the partner communities to use the data to inform service planning, advocate for program funding and the development of new child and youth healthy lifestyle programs.

Our results are comparable to healthy weight prevalence among 2-–14-year old and 2–17-year old Aboriginal and Torres Strait Islander children reported in two consecutive national surveys in 2012-13 and 2018-19.[65] There is evidence from other studies showing similar decreases in healthy weight prevalence with age,[24,65,66] including national data showing a marked decrease at about 10 years of age and another showing a decrease around the ages of 6-9 years in Aboriginal and Torres Strait Islander children.[27,66] A systematic review of studies among Aboriginal and Torres Strait Islander children has shown that healthy weight decrease with age is higher amongst those of primary school age than those at preschool age.[24] Several

Table 1: Characteristics of participants according to body mass index (BMI) categories.

	BMI category			
	Healthy weight	Overweight	Obesity	Total
	n (%)	n (%)	n (%)	n (%)
Total	768 (67.4)	194 (17.0)	177 (15.5)	1139 (100)
Sex				
Male	405 (67.2)	103 (17.1)	95 (15.8)	603 (52.9)
Female	363 (67.7)	91 (17.0)	82 (15.3)	536 (47.1)
Age group (years)[a]				
2-4	302 (86.5)	34 (9.7)	13 (3.7)	349 (30.6)
5-6	158 (77.5)	24 (11.8)	22 (10.8)	204 (17.9)
7-9	144 (58.1)	52 (21.0)	52 (21.0)	248 (21.8)
10-11	62 (49.2)	29 (23.0)	35 (27.8)	126 (11.1)
≥12	102 (48.1)	55 (25.9)	55 (25.9)	212 (18.6)
Median age (IQR)[a]	6.1 (4.0,9.4)	9.2 (6.0,12.3)	10.1 (7.8,12.9)	7.2 (4.5,10.8)
Carer of Aboriginal and/or Torres Strait Islander descent				
No	152 (67.9)	40 (17.9)	32 (14.3)	224 (20.8)
Yes	579 (67.9)	142 (16.6)	132 (15.5)	853 (79.2)
Carer education				
< year 10	117 (71.3)	23 (14.0)	24 (14.6)	164 (17.2)
Year 10	132 (67.3)	34 (17.3)	30 (15.3)	196 (20.6)
Year 11–12	76 (72.4)	23 (21.9)	6 (5.7)	105 (11.0)
Trade/certificate/diploma	284 (68.6)	63 (15.2)	67 (16.2)	414 (43.4)
University	45 (60.8)	17 (23.0)	12 (16.2)	74 (7.8)
Carer employment status				
Unemployed	90 (66.2)	23 (16.9)	23 (16.9)	136 (12.9)
Employed (full-time/part-time/student working/Other)	201 (63.8)	58 (18.4)	56 (17.8)	315 (39.8)
Home duties/Retired	425 (70.0)	98 (16.1)	84 (13.8)	607 (57.4)
Carer BMI (excluding underweight)				
Healthy weight	155 (74.5)	35 (16.8)	18 (8.7)	208 (26.4)
Overweight	144 (70.2)	35 (17.1)	26 (12.7)	205 (26.0)
Obesity	231 (61.8)	71 (19.0)	72 (19.3)	374 (47.5)
Median carer BMI (IQR)	28.4 (24.3,34.9)	30 (24.8,36.8)	32.9 (28.0,37.0)	29.5 (24.5,35.9)
Carer central obesity (waist to height ratio ≥0.5)				
No	94 (70.1)	24 (18)	16 (11.9)	134 (17.8)
Yes	410 (66.5)	111 (18.0)	96 (15.6)	617 (82.2)
Relationship of carer to child				
Parent	641 (67.4)	174 (18.3)	136 (14.3)	951 (83.6)
Other relative	72 (61.5)	15 (12.8)	30 (25.6)	117 (10.3)
Foster carer	53 (76.8)	5 (7.2)	11 (15.9)	69 (6.1)
Median child BMI z-score (IQR)	0.1 (-0.6,0.6)	1.5 (1.3,1.9)	2.6 (2.3,3.2)	0.6 (-0.2,1.6)
Child central obesity (waist to height ratio ≥0.5)				
No	508 (80.9)	91 (14.5)	29 (4.6)	628 (59.4)
Yes	201 (46.7)	93 (21.6)	136 (31.6)	430 (40.6)
Breastfeeding duration				
<1 month	307 (67.2)	83 (18.2)	67 (14.7)	457 (50.1)
≥1 to <4 months	131 (73.6)	26 (14.6)	21 (11.8)	178 (19.5)
≥4 to <6 months	28 (65.1)	9 (20.9)	6 (14.0)	43 (4.7)
≥6 months	157 (67.1)	37 (15.8)	40 (17.1)	234 (25.7)
Ever attended formal childcare/preschool (between ages 3-5 years)				
No	140 (55.6)	57 (22.6)	55 (21.8)	252 (42.8)
Yes	246 (76.2)	42 (13.0)	35 (10.8)	323 (56.2)
Child exposure to cigarettes in utero				
No	312 (68.9)	76 (16.8)	65 (14.3)	453 (47.2)
Yes	347 (68.4)	83 (16.4)	77 (15.2)	507 (52.8)
Social and emotional difficulties [b]				
Low/moderate risk	332 (62.6)	100 (18.9)	98 (18.5)	530 (69.1)
High risk	159 (67.1)	40 (16.9)	38 (16.0)	237 (30.9)

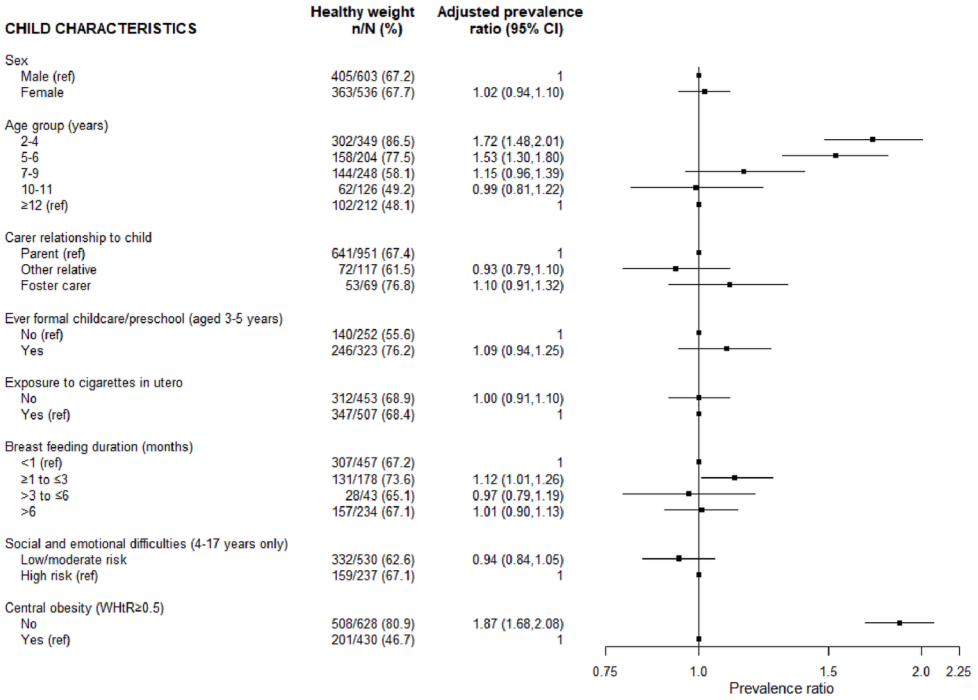
(continued)

TABLE 1. Continued

	BMI category			
	Healthy weight	Overweight	Obesity	Total
	n (%)	n (%)	n (%)	n (%)
Carer psychological distress (K10 score ≥22)				
No	530 (67.9)	125 (16.0)	125 (16.0)	780 (79.3)
Yes	144 (70.6)	33 (16.2)	27 (13.2)	204 (20.7)
Median physical activity average hours/week (IQR)	2.0 (1.0,2.9)	1.8 (0.9,2.9)	1.4 (0.8,2.3)	1.9 (0.9,2.7)
Median screen time average hours/week (IQR)	3.1 (2.0,4.7)	3.1 (1.5,4.9)	3.3 (2.3,6.0)	3.1 (2.0,5.0)

Percentages were estimated excluding participants with missing responses (see Table S5 for missing data).
[a]Age at BMI measurement.
[b]For children aged 4-19 years only.

Figure 1: Healthy weight prevalence and prevalence by child characteristics.



Prevalence ratios are adjusted for age, sex and Aboriginal Community Controlled Health Service (ACCHS), as appropriate.

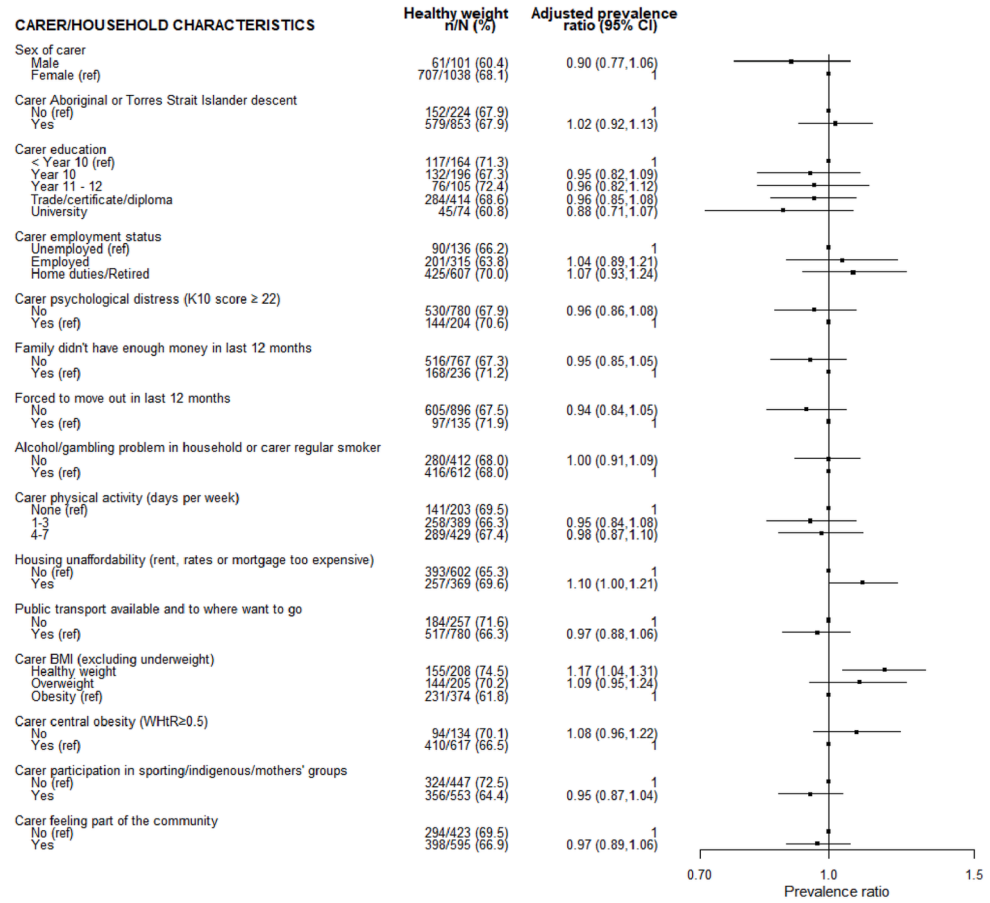
Ref= reference category.

factors are related to this decrease in healthy weight, including the introduction of unhealthy processed foods, increased screen time,[67] children having more control over foods they consume,[67,68] lower physical activity and often more sedentary activities aligned with the school learning program [67,68] and pressure on caregivers to provide quick and easy meals.[67] Given the observed decrease in healthy weight as Aboriginal and Torres Strait Islander children enter primary school age, a coordinated effort at both the national and state level to identify and implement effective, community-led programs to support the maintenance of healthy weight prevalence throughout the early primary school years should be a public health priority.

The results of the present study demonstrate that child weight is associated with that of caregiver weight. This is consistent with other international studies which show an association between parental and child weight status and that a normal parental BMI increases the likelihood of having a child with a healthy weight.[69–73] The association between the weight status of caregivers and that of their children may be linked to genetic factors that may predispose the family to overweight as well as other environmental exposures .[74,75] This highlights the importance of family-based interventions as an important strategy for the promotion of heathy weight ,[76] and is commonly used in programs at the SEARCH partner ACCHSs. This approach aligns with Aboriginal and Torres Strait Islander ways of raising children, where children learning and growing naturally on their own by observing adults and other children in their family and community is encouraged.[77–79]

Our study showed that children with a healthy weight had a lower waist:height ratio (WHtR), a measure of better cardiometabolic health

Figure 2: Healthy weight prevalence and prevalence ratios by carer/household characteristics.



Prevalence ratios are adjusted for age, sex and ACCHS.

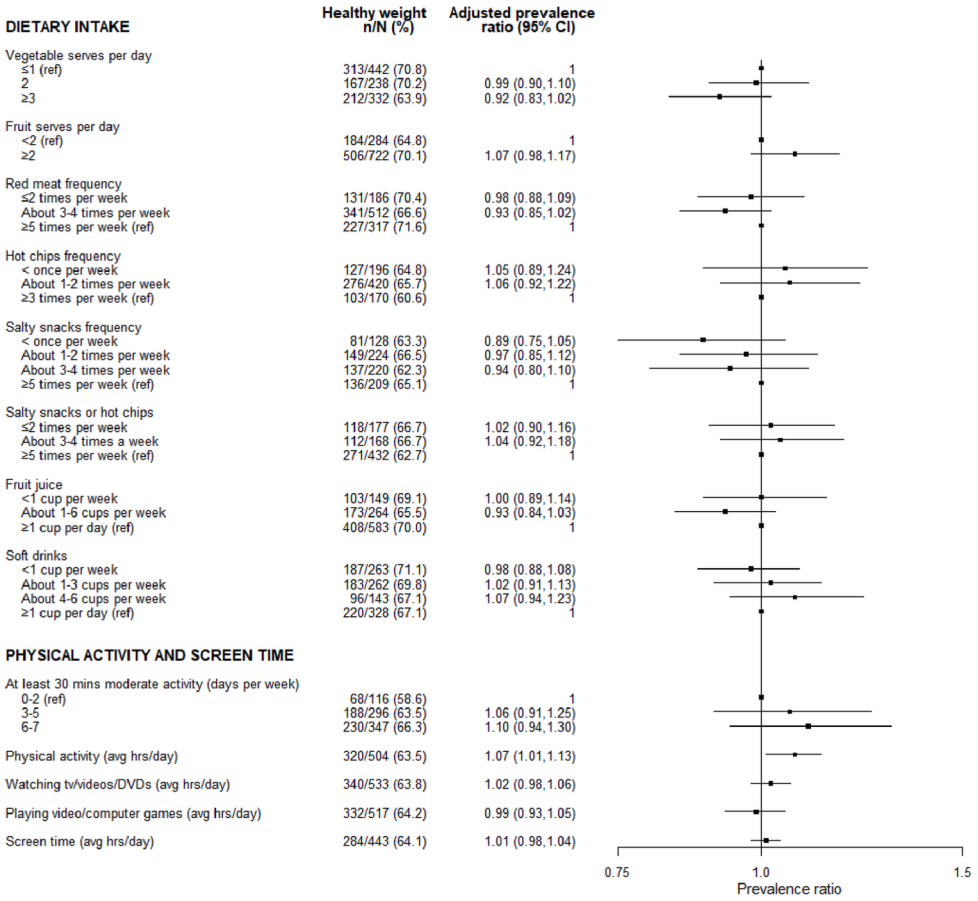
Ref= reference category.

in children and adolescents.[80–82] This finding is consistent with a 2008 study of Aboriginal and Torres Strait Islander children which showed a decreased prevalence of the metabolic syndrome in Aboriginal and Torres Strait Islander children with lower waist circumference.[83] This finding highlights an important area for program and service delivery within the SEARCH ACCHSs such as including routine identification of children with an increased risk of metabolic disorders which is critical for prevention and treatment of chronic disease.

In our study, physical activity was found to be a positive factor associated with healthy weight, with 67 % of our sample of children meeting national physical activity guidelines.[84] Our findings are consistent with that of another study conducted among Aboriginal and Torres Strait Islander youth in Northern Australia that shows higher physical activity levels to be associated with healthy weight.[85] A secondary analysis of national ABS data from over 12,000 Aboriginal and Torres Strait Islander children aged 5-17 years found that physical activity levels decreased with age, particularly around puberty.[86] At a national level, physical activity and sport have been identified as an important strategy in 'Closing the Gap' and supporting better health outcomes.[87] A recent review found limited programs focused on supporting physical activity to improve healthy weight among Aboriginal and Torres Strait Islander children in Australia; most of them did not report findings on impact on improving healthy weight in children .[88] Among the few is the culturally adapted, NSW Go4Fun program that promotes healthy eating and game-based activities to improve participation among Aboriginal and Torres Strait Islander children. Though it was unsuccessful in demonstrating an improvement in the BMI of children, positive improvements related to physical activity, sedentary behaviour, nutrition (sweet drink consumption) and self-esteem were noted. Data from the NSW Active Kids program has shown good reach among Aboriginal and Torres Strait Islander children who are more likely to meet physical activity guidelines.[89] Programs that support Aboriginal and Torres Strait Islander children to participate in physical activities such as sport outside of school time or active recreational games that are facilitated by Aboriginal and Torres Strait Islander sports role models [90] could be an effective way to establish a healthy lifestyle and maintain a healthy weight in childhood. In addition, programs that target healthy lifestyles should have local Aboriginal and Torres Strait Islander community leadership across all stages of development, implementation and evaluation to ensure they are appropriate and effective for Aboriginal and Torres Strait Islander children.[91]

Healthy weight among children in this study was associated with housing affordability problems experienced by their caregivers. This

Figure 3: Healthy weight prevalence and prevalence ratios by dietary intake.



Prevalence ratios are adjusted for age, sex and ACCHS.

Avg = average.

Ref= reference category.

finding is contrary to observations in non-Indigenous families, in whom lower socio-economic status is linked to lower rates of healthy weight.[92] However, our study findings are consistent with several studies among Aboriginal and Torres Strait Islander children in Australia [21,25,66,93–96] including a systematic review which showed that children living in areas with the highest disadvantage had a much lower risk of childhood obesity.[97] Two of the studies included in the systematic review showed that Aboriginal and Torres Strait Islander children living in the most disadvantaged areas had 80 % and 91 % lower odds of obesity, compared to those living in higher advantaged areas.[93,96] This finding highlights the need for further evidence on the social determinants of weight status among Aboriginal and Torres Strait Islander children to better understand and address health inequities.

The study found no association between healthy diet and healthy weight; this may have been due to a lack of variability in intake with a large proportion of children reported to be consuming salty snacks (≥ 5 times a day), red meat (>3 times a week) and not meeting guidelines for daily vegetable intake. Additionally, this could have been due to participants reporting desirable responses of fruit and vegetable intake or misunderstanding of serving sizes. Without strategic efforts to address the wider socio-economic and food environment, existing child health programs may not be effective to support the establishment and maintenance of healthy weight among Aboriginal and Torres Strait Islander children.[98] Currently there are several state or territory programs targeting child weight status in childcare, preschool, and early primary school settings, but less so for middle primary to high school aged children .[99–102] There is evidence that healthy lifestyle programs that take a whole of family approach are preferred among Aboriginal families to individual child-focused programs.[103]

There are several limitations to the study. The study used cross-sectional data and, therefore, cause-and-effect relationships between variables could not be established. A further limitation is missing survey data and anthropometric measurements. We addressed this by repeating the analyses on imputed data, which did not show any major changes. The variables with the largest amounts of missing data were variables derived from multiple survey questions that were then combined into one. The study sample is not representative, and prevalence estimates may not be generalisable across the total Aboriginal and Torres Strait Islander population in Australia. Another limitation is that the SEARCH project was developed over 16 years ago and used a suite of Western measurement tools, therefore whilst the research question for this project is strengths-based there are

cultural limitations and a lack of important contextual information that are needed to fully understand weight status among Aboriginal and Torres Strait Islander children. There are now more appropriate tools available that measure health and wellbeing from an Aboriginal and Torres Strait Islander perspective, including measurements of bush tucker intake which should be incorporated within dietary measurements. The study participants attended primary health care services (their local ACCHS) and, as a result, may have better health than Aboriginal and Torres Strait Islander children and adults not accessing their local ACCHS. However, this could also be construed as a strength of the study as all surveys and clinical information were collected by local Aboriginal Research Officers employed in the ACCHSs participating in the study. This helped with recruitment, allowed participants to feel comfortable in answering personal details and ensured cultural safety.

Conclusion

The study highlights the need for public health policy and programs that support increased physical activity to maintain healthy weight throughout childhood. Given the strong association between caregiver and child weight, family-based programs could be an important and culturally appropriate responses for achieving healthy weight among Aboriginal and Torres Strait Islander children. Importantly, policies and programs require sustainable funding and a high level of Aboriginal and Torres Strait Islander leadership and ownership, in order to provide long-term improvements for the health and wellbeing of Aboriginal and Torres Strait Islander children.

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Ethics approval

Ethics approval for this study was provided by the Aboriginal Health and Medical Research Council of New South Wales Ethics Committee (reference, 568/06) and the University of Sydney Human Ethics Committee (reference, 8506).

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 article.

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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.2025.100293.