Healthy weight, health behaviours and quality of life among Aboriginal children living in regional Victoria

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Abstract

Objective: To report the prevalence of healthy weight and related behaviours among Victorian Aboriginal and non-Aboriginal children and explore associations between these factors and health-related quality of life (HRQoL).

Methods: Analysis of cross-sectional data from two cluster randomised controlled trials using logistic and linear mixed models. The sample included Aboriginal (n=303) and non-Aboriginal (n=3,026) children aged 8–13 years.

Results: *More than two-thirds of Aboriginal children met guidelines for fruit (75.9%), sweetened drinks (66.7%), sleep (73.1%), screen time (67.7%) and objectively measured physical activity (83.6%);* and 79.1% reported consuming take-away foods less than once per week. Aboriginal children were more likely to meet vegetable consumption guidelines (OR=1.42, 95%CI: 1.05, 1.93), but less likely to have a healthy weight (OR=0.66, 95%CI: 0.52, 0.85) than non-Aboriginal children. Mean HRQoL scores were significantly higher among non-Aboriginal children and both Aboriginal and non-Aboriginal children meeting health guidelines.

Conclusions: Most Aboriginal children in this study met guidelines for fruit, physical activity, screen time and sleep, and those meeting these guidelines had significantly higher HRQoL.

Implications for public health: Promoting nutrition, physical activity and sleep is likely to benefit all children. Aboriginal community-controlled organisations can use these data to design culturally-specific programs that may improve disparities in healthy weight and HRQoL.

Key words: Aboriginal health, Indigenous health, nutrition, healthy weight, quality of life

Aboriginal and Torres Strait Islander peoples have lived on the lands, now known as Australia, for over 65,000 years, and are one of the world's oldest continuous populations.[1]

Compared to other states and territories, Victoria has the lowest proportion of Aboriginal and Torres Strait Islander peoples (0.9% of Victorians compared to 3.3% of the total Australian population).[2] However, they are supported by a thriving Aboriginal community-controlled health sector with 30 Aboriginal Community Controlled Health Organisations (ACCHOs) across the state, led by the Victorian Aboriginal Community Controlled Health Organisation (VACCHO). ACCHOs and their peak organisations play a vital role in service delivery, planning and policy advocacy that is responsive to the needs of local Aboriginal and Torres Strait Islander communities. In the following, we respectfully use the word Aboriginal when referring to Aboriginal and Torres Strait Islander peoples living and/or attending school on the lands now known as Victoria.

A challenge for Aboriginal health planning in Victoria is the lack of location-specific data. For example, although life expectancy and child mortality are the headline indicators in national policy, there is insufficient Aboriginal identification within Victorian mortality data for progress against these targets to be calculated.[3] Victoria is also poorly represented in the peer-reviewed Aboriginal health research literature, especially research among children and young people.[4,5] Recent reviews show that the majority of published Aboriginal health and nutrition research has been conducted in rural and remote communities, often in northern Australia.[6,7]

The vast majority of Aboriginal Victorians live in urban and regional areas and, over one-third (34%) of Aboriginal people are

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aged under 15 years but locally-relevant research evidence is lacking.[8] While Victorian data on Aboriginal maternal and infant health indicators have been available for more than 10 years,[8] there is scant evidence about the health and wellbeing of school-aged Victorian Aboriginal children. A 2018-19 survey provided, for the first time, data on Victorian children and young people's weight status and selected dietary behaviours.[9] However, these statistics were reported for the age group 2-17 years and specific information about Victorian Aboriginal children at different life stages is unavailable. Furthermore, the evidence-base for Aboriginal child health needs to better reflect an Aboriginal view of health, which is frequently defined as "not just the physical wellbeing of an individual but the social, emotional and cultural wellbeing of the whole Community".[5,10] Thus physical health and health behaviours should be reported in the context of broader measures of wellbeing and health-related quality of life (HRQoL).[4,5,11]

Access to location, age-specific and measured data is essential to ensure that Victorian ACCHOs can identify local priorities and plan culturally safe and relevant child health programs. Recognising this need, Aboriginal and non-Aboriginal researchers from Deakin University partnered with VACCHO, the peak body for Aboriginal health in Victoria, to undertake a secondary analysis of two Victorian child health datasets. Our aims were to: (i) report the prevalence of healthy weight, diet, physical activity and HRQoL among Aboriginal and non-Aboriginal primary school-aged children in regional Victoria; and (ii) explore whether HRQoL is associated with health behaviours and whether the association differed in Aboriginal and non-Aboriginal children.

Methodology

Cognisant of the potential for epidemiological data to further stigmatise Aboriginal peoples, we applied the strengths-based approach to quantitative data analysis proposed by Thurber et al.[12] This involved focusing the analysis on measuring positive outcomes (i.e. the prevalence of healthy weight rather than the prevalence of overweight/obesity) and identifying protective factors that contribute to greater quality of life for Aboriginal children. Our team included three Aboriginal authors (JR, TW, ME) and three VACCHO staff members (ME, BJ, AR) with qualifications and experience in public health, nutrition, and social and emotional wellbeing. Aboriginal authors contributed to the study design, literature searches, framing the results and writing and reviewing this article. We worked with Aboriginal and non-Aboriginal staff at VACCHO to design research questions and outputs that would meet the needs of the Victorian ACCHO sector.

Data source

Data from two cluster randomised controlled childhood obesity prevention trials in the Great South Coast region (Whole of Systems Trial of Prevention Strategies for Childhood Obesity, WHO STOPS) [13,14] and Ovens Murray and Goulburn region (Reflexive Evidence and Systems Interventions to Prevent Non-Communicable Disease, RESPOND)[15] of regional Victoria, Australia were utilised. We collected data from grade two (aged approx. 7-8 years), grade four (aged approx. 9-10 years) and grade six (aged approx. 11-12 years) primary school children between April-June 2019. Detailed information on the study design, recruitment methodology, sampling strategy and measures utilised have previously been published.[15,16] Briefly, all government, independent and Catholic primary schools within eighteen local government areas were invited to participate. A total of 138/247 (56%) of primary schools and 6,027/7,642 (79%) of children participated under an opt-out approach whereby students were enrolled into the study unless a signed opt-out form was received by their parent or guardian or the child verbally opted-out or was absent on the day of data collection.

Demographic information

The School Index of Community Socio-Educational Advantage (ICSEA) scores, obtained from the MySchool website,[17] were used to represent socioeconomic position, school rurality and type.[18] ICSEA takes into account both student and school-level factors to summarise educational advantage or disadvantage, with 1,000 being the median benchmark score.

Students completed a guided self-report questionnaire (grade 4 and 6 only) using an electronic tablet. The questionnaire included demographic information including date of birth, gender, residential postcode and language spoken at home. Aboriginality was assessed via the question "Are you Aboriginal or Torres Strait Islander?" with five possible responses: "Yes, Aboriginal", "Yes, Torres Strait Islander", "Yes, both Aboriginal and Torres Strait Islander", "No" and "Don't know". For analysis Aboriginal status was coded as a binary (Yes/No) variable, with "Don't know" coded as missing. School level variables were coded as follows: ICSEA was split into state tertiles, as low (<=989), middle (990 to 1,052), and high (≥1,053) advantage categories; rurality was recoded as two-level ("major city or inner regional"/"outer regional"), and school type as two-level (government/"Catholic or independent").

Anthropometric measures

Grade 4 and 6 students had their height and weight measured by trained researchers or health professionals during class time. Students wore light clothing and no shoes. Height was measured to the nearest 0.1 centimetre (cm) (Charder HM-200P Portstad, Charder Electronic Co Ltd, Taichung City, Taiwan) and weight to the nearest 0.1 kilogram (kg) (A&D Precision Scale UC-321; A7D Medical, San Jose, CA). Healthy weight status (yes/no) was defined according to the World Health Organization (WHO) age and sex-specific BMI growth reference, as BMI below or ≤1 z-score above the mean.[19] We used the WHO age and sex-specific growth reference to be consistent with the WHO Child Growth Standards for <5-years; which are recommended by the WHO for both clinical and epidemiological use.[20] Additional analyses were conducted using International Obesity Task Force (IOTF) age and sex specific cut-points approximating adult BMI <25.[21] Unless specified, "healthy weight" refers to WHO protocols. The Stata zanthro and zbmicat extension package was used to create WHO or IOTF classifications.[22]

Self-reported health behaviours

Students completed a questionnaire on health behaviours including self-reported physical activity, sedentary behaviour, sleep and indicators of dietary quality. Time spent in moderate-to-vigorous physical activity (MVPA) and recreational screen use over the previous seven days were assessed using validated questionnaires.[23,24] Students were asked to report their usual bedtimes and wake times on school nights, from which sleep duration was calculated. Self-reported intake of fruit (excluding juice) and vegetables (including potato, excluding hot chips), takeaway meals (burgers, pies, hot chips etc.), packaged snacks (potato chips,

lollies etc.), sugar-sweetened beverages (soft drinks, cordial, fruit or sports drinks) and water was assessed using questions from the Simple Dietary Questionnaire.[25,26]

Self-reported behavioural measures were coded as the following binary (yes/no) variables: met the physical activity (≥ 60mins/day of MVPA on ≥5 days/wk), sedentary behaviour (≤2hrs/day of screen-time for recreation on ≥ 5days/wk) and sleep (between nine and 11 hours/night) guidelines;[27] met Australian Dietary Guidelines for fruit (≥ 2 serves/day) and vegetable [≥ 5 serves girls (aged 9-13) and boys (9-11); ≥5.5 serves boys (aged 12-13)][28] and ≥ 5 glasses/day of water, based on the Nutrient Reference Values.[29] Australian Dietary Guidelines recommend discretionary foods should only be consumed sometimes and in small amounts,[28] with between 0 to 2½-3 serves per day recommended for children aged 8-13 years, depending on age, height and activity level.[30] As our dataset did not enable the quantification of the total number of serves of discretionary foods consumed each day, we used arbitrary cut points of ≤ once/week for takeaway meals, <once/day on average for packaged snacks and sugar-sweetened beverages to indicate whether or not students reported lower intakes of these individual discretionary food categories. These cut-points have been used in previous cross-sectional studies with primary school-aged children.[31,32]

HRQoL

Perceived HRQoL was measured using the Paediatric Quality of Life Inventory 4.0 (PedsQL)™.[33,34] This 23-item questionnaire examined self-rated quality of life in the physical, social, emotional and school domains. HRQoL scores were reverse coded and transformed into a score from 0-100 where higher scores represent higher HRQoL.[35] Global and psychosocial summary scores were calculated from the emotional, social, school and physical HRQoL sub-domains using standard procedures. The minimal clinically important difference (MCID) in HRQoL was ± 4.4 for the self-reported global score, ± 6.6 for the physical sub-domain and ± 5.3 for the psychosocial sub-domain scores.[36]

Physical activity

Objectively measured moderate to vigorous physical activity (MVPA), light physical activity (LPA), and sedentary time (ST) were examined using ActiGraph wGT3X-BT accelerometers (ActiGraph, Pensacola, Florida, USA). A sub-sample of children were asked to wear an accelerometer for seven consecutive days over the right hip (in the WHO STOPS trial) or on their non-dominant wrist (in the RESPOND trial) and to remove the device for water-based activities and boxing/sparring activities. Activity counts were accumulated using a 30Hz sampling rate and analysed using a five-second epoch. Non-wear time was calculated using the Toriano criteria of periods with ≥60mins of consecutive zero counts with one to two minutes of tolerance.[37] A valid day of wear was considered as ≥500 minutes/day (WHO STOPS) or ≥600 minutes/day (RESPOND) over a minimum of three days.[38] Duration spent in MVPA, LPA and ST was classified using age-specific metabolic equivalent units (METs) counts per 60 second epoch using Freedson et al.[39] cut-points (WHO STOPS) and the Chandler cut-points (RESPOND).[40,41] Accelerometry data were used to calculate the proportion of children who met the physical activity component of Australia's 24-hour movement guidelines (≥60minutes of MVPA/day)[27] using the *average across all days* method.[42]

Description of sample and missing data

The analysis sample included all WHO STOPS (end of intervention) and RESPOND (baseline) Grade 4 and 6 students measured in 2019 who completed the question on Aboriginality, identified binary gender, and all/most items on at least one PedsQL domain. Most children in the sample were aged nine to 12 years, with <1% aged either 8 or 13 years. Of 4164 Grade 4 and 6 students, 808 (19%) had missing data on Aboriginality, nine (0.2%) did not report a binary gender, and 18 (0.4%) did not complete enough HRQoL items to calculate at least one sub-scale score. The analysis sample included 3,329 children, 79.9% of the full sample. A further 135 children (4.1%) had missing data on BMI and 288 (8.7%) on sleep. All other health and HRQoL variables had <1% missing data. A subsample, of the analysis sample, of 1,939 children were invited to wear an accelerometer and 1,568 children (80.9%) had valid activity data. This included 140 Aboriginal children and 1,428 non-Aboriginal children.

Statistical methods

Demographic characteristics were compared between Aboriginal and non-Aboriginal children, overall and by study (WHO STOPS and RESPOND) using multinomial logistic models (for categorical characteristics) and linear models (for age) with robust standard errors to allow for clustering within school. Models for demographic characteristics did not include additional covariates. All subsequent models (described below) controlled for confounders including gender, grade, ICSEA tertile, school rurality, school type, study (WHO STOPS or RESPOND) and intervention (yes/no), and school as a random effect to account for within school clustering. Models including outcomes or exposures measured using an accelerometer additionally adjusted for average daily minutes of wear-time.

The prevalence of healthy weight status (WHO and IOTF) and meeting healthy eating, physical activity (both self-reported and objectively measured via accelerometer) and sleeping guidelines, was estimated and compared between Aboriginal and non-Aboriginal children by fitting a logistic mixed model for each outcome. Linear mixed models were fitted to compare continuous variables (BMI z-scores, HRQoL scores (physical, psychosocial and global), minutes of MVPA, LPA, and sedentary time) between Aboriginal and non-Aboriginal children. These models included Aboriginality (yes/no) and the set of potential confounders identified a priori. We reported raw prevalence and means for each 'group', estimated Odds Ratios and p-values for the differences between groups under the models.

To assess whether the associations between 'meeting guidelines/cut-points' (healthy weight (WHO) or one of the healthy behaviours) and HRQoL scores were modified by Aboriginality, we fitted linear mixed models. The models included one HRQoL score as outcome, one 'meeting guidelines/cut-points' (exposure), Aboriginality, 'meeting guideline/cut-point' × Aboriginality interaction and the set of confounders. For each 'meeting guideline/cut-point' exposure and HRQoL outcome combination, we reported adjusted mean HRQoL scores in the strata defined by Aboriginality and meeting guidelines/cut-points, together with two contrasts: the 'effect' of meeting the guideline/cut-point on mean HRQoL (beta) within 1) Aboriginal children and 2) non-

Table 1: Participant demographic characteristics by study location and Aboriginal and/or Torres Strait Islander status (N=3,329).

	Great South Coast (WHOSTOPS)							Ovens Murray & Goulburn (RESPOND)							Combined (Total)						
	Aboriginal			Non-Aboriginal				Aboriginal			Non-Aboriginal				Aboriginal			Non-Aboriginal			
	N	n	%	N	n	%	p	N	n	%	N	n	%	p	N	n	%	N	n	%	p
Boys	96	54	56.3	1,155	607	52.6		207	100	48.3	1,871	967	51.7		303	154	50.8	3,026	1,574	52.0	
Girls	96	42	43.8	1,155	548	47.5	0.4051	207	107	51.7	1,871	904	48.3	0.2401	303	149	49.2	3,026	1,452	48.0	0.6277
Grade 4	96	54	56.3	1,155	537	46.5		207	122	58.9	1,871	904	48.3		303	176	58.1	3,026	1,441	47.6	
Grade 6	96	42	43.8	1,155	618	53.5	0.0609	207	85	41.1	1,871	967	51.7	0.0054	303	127	41.9	3,026	1,585	52.4	0.0006
School - major city	96	0		1,155	0			207	9	4.4	1,871	86	4.6		303	9	3.0	3,026	86	2.84	
School - inner regional	96	71	74.0	1,155	957	82.9		207	190	91.8	1,871	1,527	81.6		303	261	86.1	3,026	2,484	82.1	
School - outer regional	96	25	26.0	1,155	198	17.1	0.1491	207	8	3.86	1,871	258	13.8	<0.0001	303	33	10.9	3,026	456	15.1	0.3949
School type - Gov	96	90	93.8	1,155	795	68.8		207	199	96.1	1,871	1,637	87.5		303	289	95.4	3,026	2,432	80.4	
School type - Cath	96	5	5.2	1,155	281	24.3		207	5	2.4	1,871	128	6.8		303	10	3.3	3,026	409	13.5	
School type - Ind	96	1	1.0	1,155	79	6.8	0.0001	207	3	1.45	1,871	106	5.7	<0.0001	303	4	1.3	3,026	185	6.11	<0.0001
No intervention as at 2019	96	73	76.0	1,155	722	62.5		207	207	100	1,871	1,871	100		303	280	92.4	3,026	2,593	85.7	
Intervention as at 2019	96	23	24.0	1,155	433	37.5	0.0897	207	0		1,871	0		.	303	23	7.6	3,026	433	14.3	0.0220
Language at home - Eng only	96	88	91.7	1,150	1,103	95.9		207	183	88.4	1,863	1,727	92.7		303	271	89.4	3,013	2,830	93.9	
Language at home - LOTE	96	8	8.3	1,150	47	4.1	0.0349	207	24	11.6	1,863	136	7.3	0.0656	303	32	10.6	3,013	183	6.07	0.0070
ICSEA Vic tertile 1	96	68	70.8	1,155	454	39.3		207	157	75.9	1,871	1,108	59.2		303	225	74.3	3,026	1,562	51.6	
ICSEA Vic tertile 2	96	26	27.1	1,155	414	35.8		207	42	20.3	1,871	560	29.9		303	68	22.4	3,026	974	32.2	
ICSEA Vic tertile 3	96	2	2.1	1,155	287	24.9	<0.0001	207	8	3.9	1,871	203	10.9	<0.0001	303	10	3.3	3,026	490	16.2	<0.0001
	N	mean	sd		mean	sd			mean	sd		mean	sd			mean	sd		mean	sd	
Age	96	10.74	1.09	1,155	10.95	1.07	0.0938	207	10.67	1.09	1,871	10.85	1.07	0.0175	303	10.69	1.09	3,026	10.89	1.07	0.0027

Notes:
** tests of global difference in risk for categorical characteristics obtained via multinomial logistic models with robust standard errors to allow for clustering within school*
*** tests of differences in means for age obtained via linear models with robust standard errors to account for clustering within school*

Aboriginal children; and the p-value for the exposure x Aboriginality interaction term. We conducted sensitivity analyses by refitting all models excluding the 456 children who were allocated to intervention communities. No substantive differences in effects sizes were found when the analyses were repeated excluding children from intervention communities (data not shown). All analyses were conducted in Stata version 16.1.[43]

Ethics

This study received ethical approval from Deakin University's Human Research Ethics Committee (2014_289 and 2018-381), the Victorian Department of Education and Training (2015_002622 and 2019-003943), the Catholic Archdiocese of Melbourne, Ballarat and Sandhurst.

Results

Participant characteristics

Aboriginal children represented 9% (N = 303) of the combined sample (Table S1). Significantly more Aboriginal children were in grade 4 (58.1% vs. 47.6%), attended a government primary school (95.4% vs. 80.4%), spoke a language other than English at home (10.6% vs. 6.1%), belonged to the most socioeconomically disadvantaged tertile (74.3% vs. 51.6%) and were younger (10.7 years vs. 10.9 years) than non-Aboriginal children (Table 1).

Prevalence of healthy weight and health-promoting behaviours

More than two-thirds of Aboriginal children met guidelines for fruit (75.9%), consumed sweetened drinks less than daily *(66.7%),* consumed takeaway once per week or less *(79.1%), and were achieving recommended amounts of sleep (73.1%), screen time (67.7%), and objectively measured physical activity (83.6%) (Table 2). Over half of Aboriginal children (58.4%) met the guidelines for water consumption, while fewer met guidelines for vegetables (20.5%), consumed packaged snacks less than daily (43.0%) or undertook recommended amounts of self-reported physical activity (35.9%).* Aboriginal children were more likely to meet the vegetable consumption guideline (OR=1.42, 95%CI: 1.05, 1.93), but were less likely to have a healthy weight (OR=0.66, 95%CI: 0.52, 0.85), consume takeaway once per week or less (OR=0.61, 95%CI: 0.45, 0.83), or meet

screen-time guidelines (OR=0.76, 95%CI: 0.58, 0.99) than non-Aboriginal children. Mean BMI z-scores (β=0.29, 95%CI: 0.14, 0.44) were higher among Aboriginal children than non-Aboriginal children. Aboriginal children reported lower HRQoL for all domains compared to non-Aboriginal children [global (β=-4.0, 95%CI: -5.7, -2.3), physical (β=-3.0, 95%CI: -4.9, -1.2) and psychosocial (β=-4.4, 95%CI: -6.3, -2.5)] (Table 2). The prevalence of healthy weight among Aboriginal children was 43% in the Great South Coast and 58.4% in the Ovens Murray and Goulburn regions, significantly lower than non-Aboriginal children in the Great South Coast (64.1%) but not Ovens Murray and Goulburn (64.7%) region (Table S2).

Associations between healthy weight, health behaviours and HRQoL

For Aboriginal children, the mean global HRQoL score was higher among those with a healthy weight, meeting fruit, screen-time and physical activity guidelines; and among those consuming takeaway foods less than once per week. These increases in global HRQoL score among Aboriginal children were higher than the MCID threshold (± 4.4) for healthy weight (β=5.1, 95%CI: 1.8, 8.4), takeaway (β=7.9, 95%CI: 4.0, 11.8) and accelerometry measured physical activity (β=7.1, 95%CI: 0.7, 13.4) (Figure 1, Table S3).

When exploring the HRQoL domain scores, among Aboriginal children, being a healthy weight (β=5.3, 95%CI: 1.6, 8.9), consuming takeaway less than once per week (β=8.7, 95%CI: 4.3, 13.0) and meeting screen-time (β=5.3, 95%CI: 1.6, 9.1) recommendations were associated with higher psychosocial domain scores that surpassed the MCID threshold (±5.3) (Figures 2 and 3, Tables S3 and S4). Further, meeting physical activity guidelines (β=9.5, 95%CI: 2.7, 16.3) was associated with higher physical domain scores that surpassed the MCID (±6.6). For the difference in effect on physical domain, only screen-time was significant, with the difference in scores in those meeting/ not meeting screen time guidelines less for Aboriginal children (β=1.9) than non-Aboriginal children (β=6.9).

Discussion

Our cross-sectional study of primary school children from regional Victoria indicates that the majority of Aboriginal children in grades 4 and 6 (aged 8-13 years) are meeting the guidelines for fruit consumption, physical activity, screen time and sleep, and most report consuming take-away foods less than once per week. Additionally, more than half of Aboriginal children met guidelines for water consumption and two-thirds reported consuming sugar-sweetened beverages less than once per day. Aboriginal children reported significantly higher vegetable intake than non-Aboriginal children and there were no differences between the groups in unhealthy snack consumption. Half of the Aboriginal children in our sample had a healthy body weight. For all children, mean HRQoL scores were significantly higher among those with a healthy weight and for those meeting fruit, screen-time and physical activity recommendations; and among children consuming takeaway foods less than once per week.

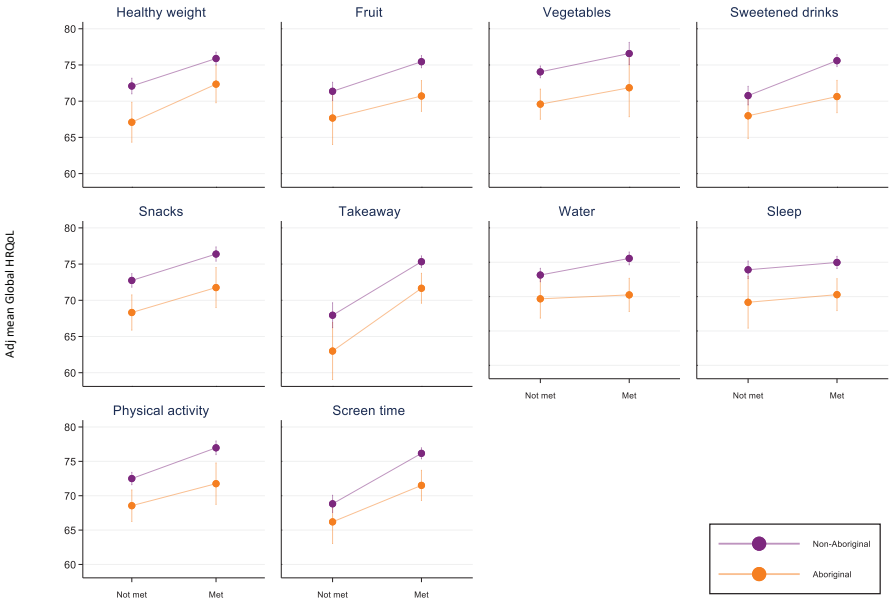
Our findings with regard to fruit and vegetable intakes are particularly noteworthy.

The 2018-2019 National Aboriginal and Torres Strait Islander Health Survey (NATSIHS) reported that 64% of Aboriginal and Torres Strait Islander children (4-14 years) nationally consumed the recommended amount of fruit and 3.2% consumed enough vegetables.[9] A low fruit and vegetable intake has been identified as a key factor contributing to the health gap between Aboriginal and non-Aboriginal Australians and modelling studies have demonstrated that increasing the proportion of the population meeting fruit and vegetable guidelines can significantly reduce chronic disease mortality.[44,45] For this reason, our finding that three-quarters of Victorian Aboriginal children met the fruit

Table 2: Prevalence of healthy weight and health-promoting behaviours among Aboriginal and non-Aboriginal children (N=3,329).

	From raw data						Model based estimates (ref: Non-Aboriginal)		
	Aboriginal			Non- Aboriginal					
	N	n	%	N	n	%	OR	(95%CI)	*p*
Weight status and behaviours									
Healthy weight									
WHO (BMI ≤+1 z-score)	283	151	53.4	2,911	1,876	64.4	0.66	(0.52, 0.85)	0.0014
IOTF (corresponding to adult BMI <25)	283	178	62.9	2,912	2,134	73.3	0.65	(0.50, 0.84)	0.0013
Fruit (≥ 2 serves/day)	303	230	75.9	3,025	2,283	75.5	1.11	(0.84, 1.47)	0.4736
Vegetables (≥5 serves/day, ≥5.5 for boys 12+)	303	62	20.5	3,023	470	15.5	1.42	(1.05, 1.93)	0.0243
Sweetened drinks (<1/day)	303	202	66.7	3,024	2,296	75.9	0.81	(0.62, 1.06)	0.1325
Snacks (<1/day)	302	130	43.0	3,024	1,388	45.9	1.03	(0.80, 1.32)	0.8339
Takeaway (≤ 1/week)	302	239	79.1	3,024	2,666	88.2	0.61	(0.45, 0.83)	0.0019
Water (≥ 5 glasses/day)	303	177	58.4	3,025	1,610	53.2	1.24	(0.97, 1.59)	0.0815
Sleep (9 - 11 hrs/day)	260	190	73.1	2,781	2,053	73.8	1.02	(0.76, 1.38)	0.8718
Physical activity (≥60mins MVPA min/day, ≥5 days/wk)	301	108	35.9	3,025	1,296	42.8	0.88	(0.68, 1.15)	0.3465
Screen time (≤ 2 hrs/ day, ≥5 days/wk)	303	205	67.7	3,022	2,287	75.7	0.76	(0.58, 0.99)	0.0440
Accelerometer (≥60 MVPA min/ day)	140	117	83.6	1,428	1,132	79.3	1.15	(0.65, 2.05)	0.6216
	N	mean	sd	N	mean	sd	coeff	(95%CI)	*p*
WHO zBMI	283	0.92	1.27	2,911	0.59	1.20	0.29	(0.14, 0.44)	0.0001
Health-related quality of life									
Global	302	72.5	16.9	3,021	77.5	14.0	-4.0	(-5.7, -2.3)	<0.0001
Physical	301	79.1	19.3	3,016	83.1	14.9	-3.0	(-4.9, -1.2)	0.0011
Psychosocial	302	69.0	18.7	3,018	74.5	15.7	-4.4	(-6.3, -2.5)	<0.0001

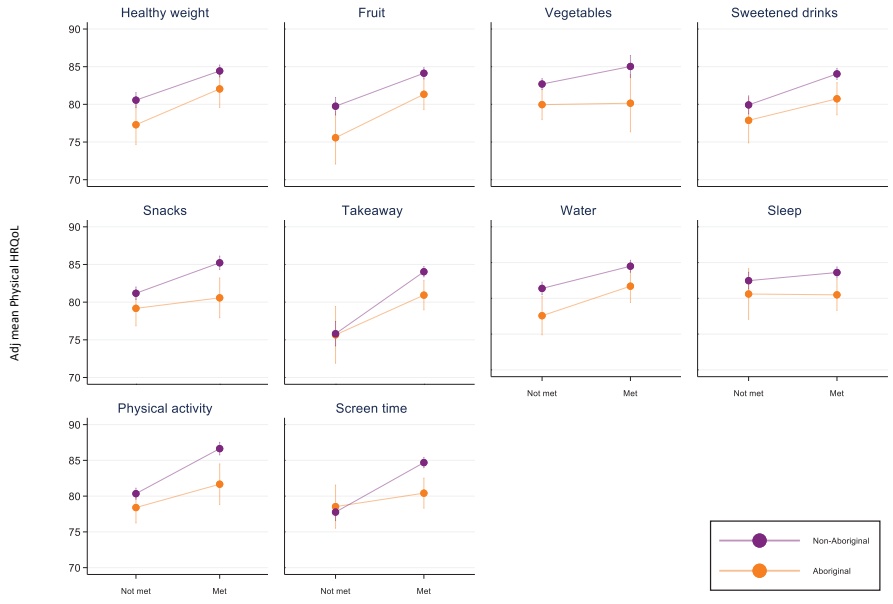
Figure 1: Global HRQoL among Aboriginal and non-Aboriginal children, and associations with healthy weight and health behaviour.



Note:

** separate models for each exposure - all were mixed linear models with school as random effect, including exp#Aboriginality interaction and adjusted for gender, grade, study, condition, school rurality, school type, and ICSEA tertile. Note that lines joining dots are included for ease of interpretation, and do not indicate repeated measures.*

Figure 2: Physical HRQoL among Aboriginal and non-Aboriginal children, and associations with healthy weight and meeting behavioural recommendations.



Note:

** separate models for each exposure - all were mixed linear models with school as random effect, including exp#Aboriginality interaction and adjusted for gender, grade, study, condition, school rurality, school type, and ICSEA tertile. Note that lines joining dots are included for ease of interpretation, and do not indicate repeated measures.*

consumption guidelines and one-fifth met the vegetable consumption guidelines is a positive one. The higher vegetable intake among Aboriginal children compared to non-Aboriginal children in this sample is a departure from previous health survey data.[46] This positive finding deserves further study to understand how Victorian Aboriginal communities are addressing this public health challenge. The lessons learned may have relevance to other communities and will provide insights for future strategies to promote healthy eating among Aboriginal children.

This study is the first to report on sleep among Victorian Aboriginal children. In contrast to our findings that most Victorian Aboriginal children were meeting sleep guidelines, research from other jurisdictions suggests that, compared to non-Aboriginal children, Aboriginal children report poorer sleep quality and duration.[47,48] The Longitudinal Study of Indigenous Children found that 'late sleepers' were significantly more likely to have increases in BMI over time compared to children with earlier bedtimes.[49] This suggests that promoting adequate sleep, in addition to healthy eating and physical activity, may be an important strategy to consider in future programs to protect children from unhealthy weight gain. Evaluating the dimensions of sleep hygiene (duration, quality, timing, efficiency) is an important area for future childhood obesity research.[50]

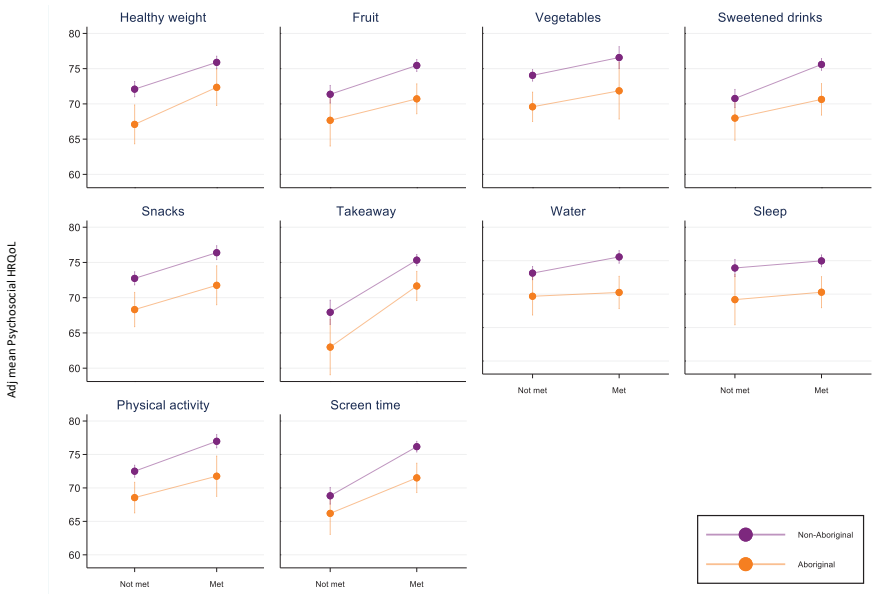
While we adopted a strengths-based approach wherever possible, we also wanted to identify priority areas that require attention.[12] We believe this is the case for HRQoL. Non-Aboriginal children in our sample had significantly higher average HRQoL scores compared to Aboriginal children and the differences between groups is clinically important.[51] Although these findings are concerning, we also found that regardless of Aboriginality, meeting the guidelines for healthy weight and selected health behaviours was associated with higher HRQoL. This is consistent with Australian and international evidence,[31,52] that childhood overweight and obesity is associated with lower HRQoL. This finding is highly relevant in the context of the holistic approach to Aboriginal health.[10] Our findings suggest promoting healthy eating and physical activity as part of this holistic approach may have significant impacts on children's HRQoL. These recommendations are important as our

analysis shows meeting one guideline infers a 5-10% improvement in HRQoL.

This is the first study to report on the prevalence of healthy weight, diet, physical activity, sedentary behaviour, sleep and HRQoL among Victorian Aboriginal children. Although not directly comparable due to the different age groups sampled, our findings extend those of the NATSIHS by providing data on more variables and for a more specific age group. The use of measured height, weight and accelerometry strengthened the objectivity of data reported. A key strength of this study was the involvement of Aboriginal researchers and practitioners on the research team and our partnership with VACCHO to maximise utility for the sector. Aboriginal team members were based in both urban and regional Victoria and their leadership ensured adherence with the strengths-based approach and contextualisation of findings with regard to broader cultural determinants of health and Indigenous worldviews.

It is important to note that this study has some limitations. First, the participants in this study are unlikely to be representative of all Aboriginal and non-Aboriginal children in Victoria. Secondly, it is important to acknowledge that BMI is only a proxy for percentage body fat and that its validity in Aboriginal populations has been debated.[53] It has been suggested that BMI z-scores may underestimate chronic disease risk in Aboriginal children thus our findings may therefore reflect even greater differences in adiposity-related risks between Aboriginal and non-Aboriginal children.[54] Furthermore, the questionnaires used, including the PedsQL inventory, have not been validated for use with Aboriginal children; which is strongly recommended as a future area of research. Some specific tools have been developed to measure social and emotional wellbeing among Aboriginal adults,[55] however, there were no validated tools for measuring HRQoL in Aboriginal children at the time this study was undertaken. The recently developed First Nations-Child Quality of Life scale is a promising development which may help fill this important gap.[56] Third, the reliance on self-reported dietary data is a further limitation that is common to population nutrition surveys. Our analyses of discretionary food intake are limited by the lack of data collected on the total number of serves consumed each day. This precluded analyses according to the Australian Dietary Guidelines as we have done with fruit and vegetables. However, our categories of 'high' and 'low' intakes of individual discretionary food types are still useful as an indicator of dietary quality. Finally, as this is a cross-sectional study, a causal relationship between weight, healthy behaviours and HRQoL cannot be inferred. Despite this limitation, promoting healthy nutrition, physical activity and sleep patterns is likely to benefit all children.

Figure 3: Psychosocial H HRQoL among Aboriginal and non-Aboriginal children, and associations with healthy weight and meeting behavioural recommendations.



Note:

** separate models for each exposure - all were mixed linear models with school as random effect, including exp#Aboriginality interaction and adjusted for gender, grade, study, condition, school rurality, school type, and ICSEA tertile. Note that lines joining dots are included for ease of interpretation, and do not indicate repeated measures.*

The study fills an important gap in knowledge about the health and wellbeing of Victorian Aboriginal children and provides evidence to inform holistic health promotion at the local level. Plain language and culturally relevant communication tools have also been developed so that VACCHO can communicate the findings of this study to its member ACCHOs. ACCHOs can use this data for service planning, to advocate for continued funding of successful programs, or for development of new Aboriginal-specific health promotion programs in Victorian Aboriginal communities.

Conclusion

The majority of Aboriginal children in this study were meeting the guidelines for fruit consumption, physical activity, screen time and sleep, and reported consuming take-away foods less than once per week. Children meeting these recommendations had significantly higher HRQoL. This paper presents the most comprehensive health data collected for Aboriginal children in Victoria to date. Our results suggest that promoting healthy body weight, vegetable intake, and reducing unhealthy snack food consumption is likely to benefit Aboriginal and non-Aboriginal children in Victoria. Further, culturally and context-specific interventions targeting these behaviours are likely to impact HRQoL.

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Supporting Information

Additional supporting information may be found in the online version of this article:

Supplementary Table 1: Participant responses to Aboriginality question.

Supplementary Table 2: Prevalence of healthy weight and health-promoting behaviours by study location and Aboriginal status.

Supplementary Table 3: Differences in mean Global HRQoL according to the meeting of healthy weight and behavioural recommendations, and Aboriginal status.

Supplementary Table 4: Differences in mean Physical HRQoL according to the meeting of healthy weight and behavioural recommendations, and Aboriginal status.

Supplementary Table 5: Differences in mean Psychosocial HRQoL according to the meeting of healthy weight and behavioural recommendations, and Aboriginal status.