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# Screen time among kindergarten children in the Australian Capital Territory (including a comparison of First Nations and non-Indigenous children)

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## Abstract

**Background** Australian First Nations children have poorer outcomes across a range of health measures. High levels of screen time are associated with a range of adverse health outcomes. Gaps remain in our knowledge on the association between screen time and health outcomes for different demographic groups, including First Nations children. We aimed to describe the screen time behaviours of First Nations and non-Indigenous kindergarten children in the Australian Capital Territory (ACT) and identify any associated disparities in key health outcomes.

**Methods** 5,516 children participated in the cross-sectional population-based ACT Kindergarten Health Check (KHC) survey, including 146 First Nations children. The association between screen time of more than two hours per day and health outcomes (body mass index, respiratory health, development and wellbeing) was assessed for both First Nations and non-Indigenous cohorts using comparative statistics.

**Results** Non-Indigenous children who had an average of more than two hours of screen time per day were 1.5 (95% CI, 1.3–1.7) times more likely to be overweight/obese, 1.2 (95% CI, 1.0–1.4) times more likely to have had a wheeze/whistle in their chest in the 12 months before the KHC, 1.5 (95% CI, 1.3–1.7) times more likely to have developmental concerns and 1.5 (95% CI, 1.3–1.8) times more likely to have reduced wellbeing measures compared to non-Indigenous children with screen time of two hours or less per day. None of these associations were statistically significant amongst First Nations children.

**Conclusions** Screen time of more than two hours per day is associated adverse health outcomes in non-Indigenous children, including overweight/obesity, respiratory problems, developmental concerns, and reduced wellbeing. Further analysis is required to enable a more robust assessment of the effect of screen time on health outcomes for First Nations children.

**Keywords** Child health, Indigenous peoples, Sedentary behaviour, Screen time, Social determinants of health

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## Background

Management of screen time is one of the key challenges in childhood health for parents, educators, and policy-makers alike [1, 2]. The *Australian 24-Hour Movement Guidelines for Children and Young People* ('the 24-hour movement guidelines') were developed to support healthy physical activity and sleep habits across the day [3]. These guidelines recommend children aged 5–17 years have no more than two hours of recreational sedentary screen time per day. However, evidence suggests that most Australian children exceed these limits [4].

High levels of screen time in children are associated with a wide range of poor physical and psychosocial health outcomes. These include: overweight/obesity [5–7], poorer diet [7], poorer psychological health [7, 8], developmental delays [9] and respiratory problems [10]. Despite these 'knowns', there are gaps in the body of evidence regarding children's screen time habits and outcomes for different demographic groups, including First Nations children [11]. For example, a longitudinal study of First Nations children in Australia found that family screen time was inversely related to children's physical activity, however this did not report on the screen time of the children directly [12].

First Nations children have poorer health outcomes across many of the measures associated with high levels of screen time, including overweight/obesity, wellbeing and respiratory disease [13]. Health disparities are heterogeneous across Australia, however even within the Australian Capital Territory (ACT), an area of relative socioeconomic advantage, First Nations children experience disadvantage, and are a core focus area for the ACT Aboriginal and Torres Strait Islander Agreement 2019–2028 [14].

Considering these disparities and the link between screen time and health outcomes, we sought to describe the screen time behaviours of First Nations children and non-Indigenous children in the ACT, identify differences in health outcomes between these cohorts and explore whether screen time was a risk factor for these outcomes.

## Methods

### Data source

The ACT Kindergarten Health Check (KHC) is an annual cross-sectional population-based survey conducted as a part of the ACT Health Child, Youth and Women's Health program. The KHC captures health measures for children in their first year of full-time primary education (i.e., kindergarten). All children enrolled in kindergarten in ACT public and private schools are invited to participate in the survey. In 2019, the KHC introduced questions exploring children's recreational screen time habits. We used this 2019 dataset as the basis for our study.

The KHC is comprised of two components: a questionnaire and a physical health screen [15]. In the first month of the school year, parents/guardians completed a questionnaire collecting demographic data, parent-reported physical activity and screen time behaviours, and child development and wellbeing (Supplement 1). Through the school year, an opt-in nurse-led health screen collected physical measures including height and weight. Of the 5,531 children for whom a questionnaire was completed, 93% participated in the physical health screen.

### Socioeconomic position

To assess socioeconomic position, we linked KHC data with the Australian Curriculum, Assessment and Reporting Authority (ACARA) Index of Community and Socioeducational Advantage (ICSEA). The ICSEA is a school-level measure that compares the average level of socio-educational advantage of a school's student population to those of other schools, with a prescribed national median of 1000, where a higher score indicates higher socio-educational advantage [16]. The ICSEA model is derived from factors including parental occupation and education, and school factors such as remoteness. We created quintiles of socio-educational advantage by ranking ICSEA scores and dividing them into five equal groups, with the top quintile representing children at schools with relatively higher socio-educational advantage compared to their peers. These quintiles are specific to the 2019 ACT KHC cohort and differ from national ICSEA quintiles.

### Physical activity

Physical activity was derived from parent-reported number of days per week their child was physically active for a total of at least 60 min per day (Supplement 1).

### Screen time

Screen time was reported as average hours per day (at home) for the specified number of days during the school week and on weekends. Time watching TV, videos or DVDs was reported separately to time using a computer, tablet or mobile phone (excluding school-related work). Screen time in excess of 16 h per day (comprised of no more than 8 h of TV/video and 8 h of computer/video games) was excluded from the analysis. We computed the total number of hours of screen time by weekday, weekend day and averaged across the week.

Composite measures of weekday and weekend screen time were created by adding the average hours per day of each type of screen time together.

A sensitivity analysis was conducted, comparing mean screen time use, where reported time was set at a cap of 8 h, 16 h, and 24 h in data cleaning (Supplement 3). This

showed no significant impact on the analysis of screen time use.

### Body mass index

Body mass index (BMI) was calculated from measured height and weight, and classified into weight categories based on Cole & Lobstein's age- and sex-specific cutoffs [17].

### Respiratory problems

Respiratory health information was collected using core questions from the International Study of Asthma and Allergies in Childhood Questionnaire (ISAAC) [18].

### Development and wellbeing

The KHC includes the Parents' Evaluation of Developmental Status (PEDS) questionnaire and the Strengths and Difficulties Questionnaire (SDQ). The PEDS questionnaire identifies children with clinically significant (Pathways A–B) and non-predictive (Pathway C–D) developmental concerns, as well as children with no developmental concerns (Pathway E). The PEDS is described in more detail at [19]. The SDQ categorises wellbeing scores as 'close to average', 'slightly raised' or 'high risk' of clinically significant concerns. The SDQ is described in more detail in Supplement 2.

### Statistical analyses

The study population included all children enrolled in kindergarten in the ACT in 2019. We excluded non-responses/missing data from analyses, thereby using implicit imputation.

We produced descriptive statistics for children stratified by Indigenous identification. Measures included demographic information (age, gender and socio-educational advantage), physical activity and screen time, and health outcomes (BMI, respiratory health, development and wellbeing).

Confidence intervals for proportions were calculated using binomial sampling methods.

We calculated comparative statistics for the relationship between screen time of more than two hours per day with children's BMI, respiratory problems, developmental concerns and wellbeing. Chi-squared tests comparing total average screen time against health risk factors were

conducted, and odds ratios (OR) calculated, separately for First Nations and non-Indigenous cohorts.

To explore the impact of covariate factors, we conducted a logistic regression for the dependent variable screen time of more than two hours per day against independent variables gender, Indigenous identification, ICSEA score, BMI, PEDS pathway, and total difficulties, and wheeze/whistle in the chest in the past 12 months. Interaction terms were included for gender, Indigenous identification and ICSEA score, by PEDS pathway and total difficulties (previous studies having found a link between these [19, 20]). Stepwise selection (0.05 significance level for entry/removal) was used to identify variables for inclusion. Models were run with ICSEA and BMI in both continuous and categorical form. Physical activity was included as a class variable, as it was not normally distributed.

Multiple imputation techniques were used to test the impact of missing data. SAS procedures MI and MIANALYZE were executed to facilitate the three steps of multiple imputation inference: filling in missing data  $m$  times to generate  $m$  complete datasets; analysis of the  $m$  datasets; combined inference derived from the analysis of the  $m$  datasets. We created  $m = 12$  datasets. Imputed values for discrete data were rounded to valid values. Logistic regression was run with all variables included for contribution to the combined parameter estimates.

Statistical analyses were conducted in IBM SPSS version 26 and SAS version 9.4.

## Results

### Demographics

Table 1 presents demographics of the study cohort. First Nations children accounted for 2.6% ( $n = 146$ ) of 2019 KHC participants for whom Indigenous identification was reported ( $n = 5,516$ ). Children were an average of 5 years 9 months at the time of the health screen. There was no significant difference in the gender profile of First Nations and non-Indigenous children.

The mean ICSEA score for First Nations and non-Indigenous children was above the national median of 1000, at 1054 (SD, 50) and 1089 (SD, 48) respectively. Significantly more First Nations than non-Indigenous children were in the least socio-educationally advantaged ICSEA quintile (42.5%, 95% CI, 34.7–50.6% ( $n = 62$ ) compared to

**Table 1** 2019 KHC respondent characteristics by indigenous identification

Demographics	Missing data	First Nations children		Non-Indigenous children	
		Mean (SD)	Proportion of cohort % (95% CI)	Mean (SD)	Proportion of cohort % (95% CI)
Age in months at time of KHC health screen	$n = 15$	69.0 (4.7)		69.5 (4.1)	
Gender	Male		50.7 (42.6–58.7), $n = 74$		51.0 (49.7–52.3), $n = 2,739$
	Female	$n = 15$	49.3 (41.3–57.4), $n = 72$		49.0 (47.7–50.3), $n = 2,631$

17.5%, 95% CI, 16.5–18.5% ( $n=940$ )) (Fig. 1). Similarly, a smaller proportion of First Nations children were in the most socio-educationally advantaged quintile compared to non-Indigenous children (8.2%, 95% CI, 4.6–13.5% ( $n=12$ ) compared to 23.0%, 95% CI, 21.9–24.1% ( $n=1235$ )).

#### Physical activity and screen time measures

Both First Nations and non-Indigenous children were physically active for at least 60 min on most days of the week (Table 2). A higher proportion of First Nations children were physically active at this level on every day of the week compared to non-Indigenous children.

Averaged across the week, daily screen time was 2.2 and 1.9 h respectively for First Nations and non-Indigenous children. Weekend screen time averaged 3.1 h for First Nation children and 2.7 h for non-Indigenous children compared to 1.9 and 1.6 h respectively on weekdays.

#### Health outcomes

Table 3 sets out health and development outcomes by Indigenous identification. Three quarters of children were in the healthy weight range in both the First Nations and non-Indigenous cohorts.

More than one-third of First Nations children had ever had a wheeze/whistle in the chest compared to less than one quarter of non-Indigenous children. Likewise, a significantly higher proportion of First Nations children had

respiratory problems in the 12-month period preceding the KHC.

The proportion of children with developmental concerns was not significantly different for either cohort. However, only 36 per cent of First Nations children were identified as having no developmental concerns compared to more than half of non-Indigenous children.

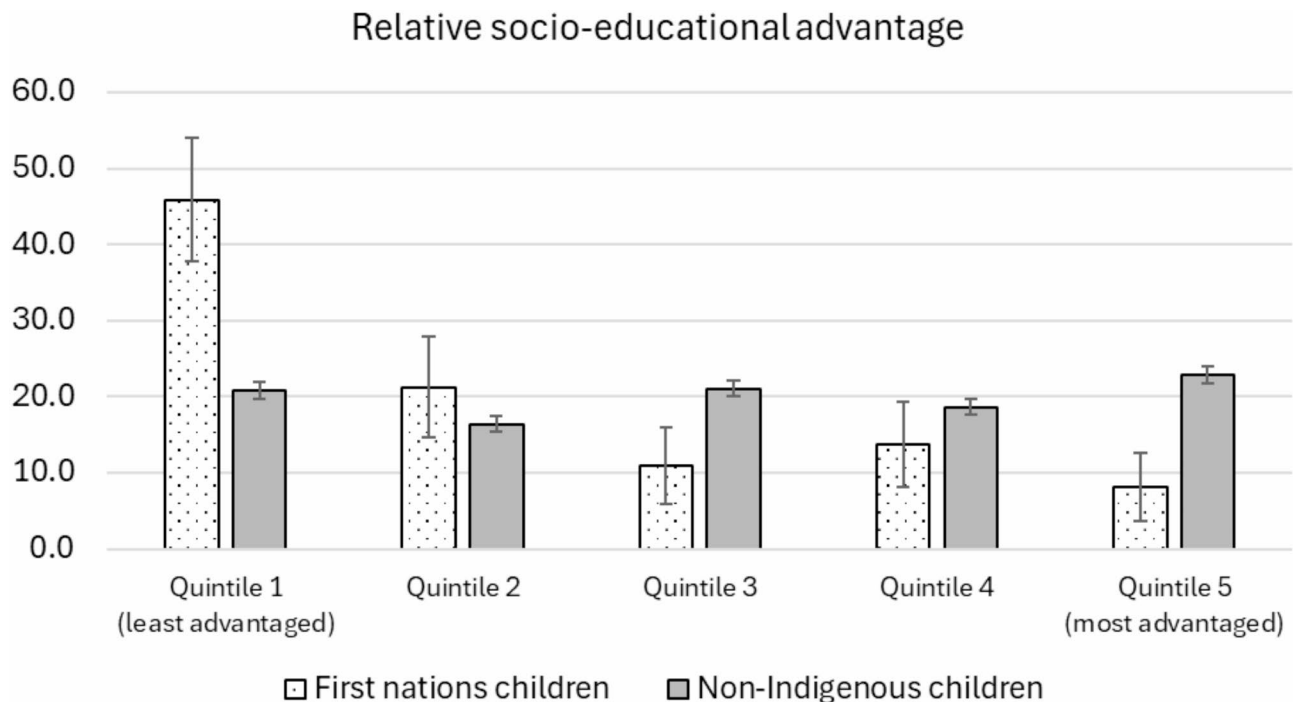
Table 4 sets out SDQ 'total difficulties' and 'high-risk subscale' wellbeing scores, all of which were within the expected range for both cohorts of children.

#### Health outcome associations with screen time

Exposure to more than two hours of screen time per day was associated with a range of unfavourable health outcomes in non-Indigenous children; screen time was not significantly associated with any of the health outcomes examined through this study for First Nations children (Table 5).

Non-Indigenous children who had an average of more than two hours of screen time per day were 1.5 times more likely to be overweight/obese, have at least one clinically significant developmental concern, or to have wellbeing measures outside of the 'close to average' range. They were also 1.2 times more likely to have had a wheeze/whistle in the chest in the 12 months before the KHC than children who had two hours or less daily screen time.

Logistic regression found gender, BMI, physical activity, PEDS pathways, and ICSEA score all to be significantly



**Fig. 1** 2019 KHC respondent socio-educational advantage<sup>†</sup> by Indigenous identification. <sup>†</sup>Quintile 1: ICSEA < 1042; Quintile 2: ICSEA 1042 to 1071; Quintile 3: ICSEA 1072 to 1106; Quintile 4: ICSEA 1107 to 1129; Quintile 5: ICSEA ≥ 1130. Missing:  $n=15$

**Table 2** 2019 KHC respondent modifiable risk factors by indigenous identification

Risk factor	Missing data	First Nations children		Non-Indigenous children	
		Mean (SD)	Proportion of cohort % (95% CI)	Mean (SD)	Proportion of cohort % (95% CI)
Physical activity					
Days in typical week with $\geq 60$ min $\geq 60$ min every day in typical week	$n=86$	6.0 (1.4)	56.6 (48.5–64.8), $n=81$	5.6 (1.6)	44.3 (43.0–45.7), $n=2,351$
Screen time					
Weekdays					
Total screen time per day (h)	$n=178$	1.9 (1.3)		1.6 (1.2)	
Mean daily screen time $> 2$ h			30.5 (23.4–38.4), $n=43$		23.7 (22.6–24.9), $n=1,237$
Weekends					
Total screen time per day (h)	$n=186$	3.1 (1.9)		2.7 (1.7)	
Mean daily screen time $> 2$ h			60.4 (52.2–68.3), $n=84$		55.0 (53.6–56.4), $n=2,863$
All days					
Total screen time per day (h)	$n=279$	2.2 (1.3)		1.9 (1.2)	
Mean daily screen time $> 2$ h			41.9 (33.9–50.3), $n=57$		36.2 (34.9–37.6), $n=1,851$

**Table 3** 2019 KHC respondent health and development outcomes by indigenous identification

Health outcome	Missing data	First Nations children	Non-Indigenous children
		Proportion of cohort % (95% CI)	Proportion of cohort % (95% CI)
BMI category †			
Healthy weight	$n=384$	74.6 (66.7–81.5), $n=97$	77.4 (76.2–78.5), $n=3,882$
Overweight		15.4 (10.0–22.3), $n=20$	12.4 (11.5–13.3), $n=621$
Obese		9.2 (5.1–15.1), $n=12$	7.5 (6.8–8.3), $n=377$
Respiratory problems			
Chest wheeze/whistle (ever)	$n=79$	36.1 (28.6–44.2), $n=52$	23.2 (22.0–24.3), $n=1,229$
Chest wheeze/whistle (in past 12 months)	$n=81$	24.5 (18.0–32.0), $n=35$	13.0 (12.1–13.9), $n=689$
Parents' Evaluation of Developmental Status (PEDS) pathway scores			
Pathway A	$n=39$	15.1 (10.0–21.5), $n=22$	11.8 (10.9–12.7), $n=629$
Pathway B		25.3 (18.8–32.8), $n=37$	22.1 (21.0–23.2), $n=1,179$
Pathway C–D (non-predictive concerns)		23.3 (17.0–30.6), $n=34$	16.1 (15.1–17.1), $n=858$
Pathway E (no concerns)		36.3 (28.8–44.3), $n=53$	50.1 (48.8–51.4), $n=2,678$

†Underweight excluded from table due to small numbers preventing adequate de-identification of data (included in analysis)

**Table 4** 2019 KHC respondent strengths and development questionnaire (SDQ) wellbeing scores by indigenous identification

SDQ measure	Missing data	Expected range <sup>†</sup>	First Nations children	Non-Indigenous children
			Mean (SD)	Mean (SD)
Total difficulties	$n=53$	0–13	10.5 (6.7)	7.6 (5.0)
Emotional difficulties	$n=52$	0–3	2.4 (2.3)	1.7 (1.8)
Conduct problems	$n=50$	0–2	1.8 (1.7)	1.4 (1.4)
Hyperactivity and inattention	$n=51$	0–5	4.5 (2.7)	3.3 (2.4)
Peer problems	$n=51$	0–2	1.8 (1.9)	1.3 (1.6)
Prosocial	$n=52$	6–10	8.1 (1.7)	8.2 (1.7)

†Close to average risk

**Table 5** Association between screen time over two hours per day (across all days of the week) and health outcomes for First Nations children, and non-indigenous children

Health measures	Outcome	Comparison	Odds Ratio (95% CI)	
			First Nations children	Non-Indigenous children
BMI†	Overweight/obese	Healthy weight	1.4 (0.6–3.1)	1.5 (1.3–1.7)
Respiratory	Chest wheeze/whistle (in past 12 months)	No chest wheeze/whistle (in past 12 months)	1.0 (0.5–2.4)	1.2 (1.0–1.4)
Development	PEDS predictive concerns (any number)	No PEDS predictive concerns	1.0 (0.5–2.1)	1.5 (1.3–1.7)
Wellbeing	'High-risk' or 'slightly raised' range SDQ Total difficulties score	'Close to average risk' SDQ Total difficulties score	1.1 (0.5–2.3)	1.5 (1.3–1.8)

†Underweight children were excluded from OR analysis due to the small proportion in this BMI category within each cohort

**Table 6** Associations with screen time use of < or ≥ 2 h per day

Variable	X <sup>2</sup> (df)	Pr > X <sup>2</sup>	Adjusted odds ratio (95% CI)	
ICSEA	154.59 (4)	< 0.001	Quintile 2 vs. 1	0.73 (0.60–0.88)
			Quintile 3 vs. 1	0.60 (0.50–0.72)
			Quintile 4 vs. 1	0.48 (0.40–0.58)
			Quintile 5 vs. 1	0.35 (0.29–0.42)
PA typical	69.30 (7)	< 0.001	0 days vs. 7	3.13 (1.27–7.73)
			1 day vs. 7	1.98 (1.18–3.33)
			2 days vs. 7	2.25 (1.34–3.11)
			3 days vs. 7	1.36 (1.06–1.74)
			4 days vs. 7	1.48 (1.19–1.85)
			5 days vs. 7	1.50 (1.26–1.77)
			6 days vs. 7	1.03 (0.86–1.22)
PEDS	40.12 (3)	< 0.001	Pathway A vs. E	1.75 (1.44–2.13)
			Pathway B vs. E	1.28 (1.09–1.49)
			Pathway C/D vs. E	1.17 (0.99–1.40)
BMI	17.94 (3)	< 0.001	Obese vs. healthy weight	1.56 (1.24–1.96)
			Overweight vs. healthy weight	1.23 (1.03–1.48)
			Underweight vs. healthy weight	0.92 (0.63–1.35)
gender	4.85 (1)	0.028	male vs. female	1.15 (1.02–1.30)

Reference categories: ICSEA quintile 1, physical activity 7 days per week, PEDS pathway E, BMI healthy weight, male

**Table 7** Associations with screen time use of < or ≥ 2 h per day — multiple imputation model

Variable	Parameter Estimate	95% CI	Pr >  t  <sup>(a)</sup>
ICSEA	-0.958	(-1.142, -0.774)	< 0.001
gender	0.063	(0.004, 0.123)	0.037

(a) Testing the null hypothesis

associated with screen time of more than 2 h per day (Table 6). A gradient was seen for each relative socio-educational advantage, PEDS, typical physical activity, and BMI. Indigenous identification was not statistically significant in the models.

#### Multiple imputation model

Parameter estimates derived from the model estimates for the 12 imputation datasets found only gender and ICSEA score to be significantly associated with screen time of more than 2 h per day (Table 7).

## Discussion

### Screen time behaviours

Our analysis of the 2019 KHC showed that the screen time habits of most ACT kindergarten children were consistent with the 24-hour movement guidelines, regardless of Indigenous identification. Multivariate analysis found that gender, BMI, physical activity, developmental measures, and relative socio-educational advantage were all significantly associated with overall screen time, with only gender and relative socio-education advantage remaining significant in multiple imputation analysis.

Time spent using screens was higher on weekend days compared to weekdays for both First Nations and

non-Indigenous children; this is comforting as evidence suggests that high levels of weekday screen time may be disproportionately detrimental to child health and development outcomes [4]. However, almost one-third of First Nations children and one-quarter of non-Indigenous children still reported more than two hours of recreational screen time per weekday—concerning statistics given the body of evidence highlighting the association between high levels of weekday screen time and adverse health outcomes [5]. Alongside this evidence, positive associations with screen time have been found, and this is likely to be context dependent [21–23]. Sanders et al. found that while more screen time was associated with poorer outcomes in children, some of this may be mitigated by the type of screen time [24].

### Health outcomes and their association with screen time

#### *Overweight and obesity*

Overweight and obesity are nationally significant health concerns for all ages. Nearly one-quarter of First Nations children and one-fifth of non-Indigenous children in the 2019 KHC survey were overweight/obese. Of note, these proportions are higher than an analysis of KHC data from 2004 to 2008, which found that 18% of First Nations children and 14% of non-Indigenous children were overweight/obese [25]. This echoes a broader national trend of increasing adiposity among Australian children [26].

For non-Indigenous children, high BMI was associated with high levels of screen time. In this cohort, children with an average of more than two hours of screen time per day were 1.5 times more likely to be overweight/obese than peers with two hours or less daily screen time. Our data reinforces the established association between screen time and overweight/obesity in non-Indigenous children [5, 6]. While this was not demonstrated for First Nations children, it is important to note that the confidence interval around the OR estimate was wide (OR 1.4, 95% CI 0.6–3.1); while a statistically significant result was not demonstrated, this may have been due to a small sample size, rather than lack of relationships.

#### *Respiratory problems*

Respiratory diseases result in significantly greater burden in First Nations communities than among non-Indigenous children [12]. Our analysis confirmed this disparity, with 36% of First Nations children reporting ever having had wheeze/whistle in their chest compared to 23% of non-Indigenous children.

International studies have suggested that children with respiratory conditions are more likely to engage in excessive use of screens than children with good respiratory function [9]. While our study cannot demonstrate causality, we found that non-Indigenous children were 1.2 times more likely (OR 95% CI 1.0–1.4) to have respiratory

problems if they had high levels of screen time. The association between screen time and respiratory problems for First Nations children was not statistically significant, with the OR point estimate 1.0.

#### *Developmental concerns and wellbeing*

High levels of screen time have been linked with developmental delay in young children [9]. Similarly, a broad evidence base supports the association between high levels of screen time and reduced wellbeing, including anxiety, depression and peer problems [8]. Our analysis found that non-Indigenous children were 1.5 times more likely to have clinically significant developmental concerns or adverse wellbeing measures (OR 95% CI 1.3–1.7 and 1.3–1.8 respectively) if they had more than two hours of screen time per day compared to lower levels. There was no comparable significant relationship between screen time and either developmental concerns or wellbeing for First Nations children despite a similar prevalence of clinically significant concerns in both cohorts. Again, it is important to note that due to small numbers, the confidence intervals were wide (or 95% CI 0.5–2.1 for development, and 0.5–2.3 for wellbeing).

#### *The role of demographics and physical activity*

##### *Socio-educational advantage*

The ACT is a well-off area, with a mean level of socio-educational advantage significantly above the national median of 1000 [27]. At a macro level, our data appears to support this stereotype for both First Nations and non-Indigenous children, with a mean ICSEA of 1054 and 1089 respectively (a lower score indicating lower socio-educational advantage). However, a growing body of evidence has highlighted the ‘hidden disadvantage’ of certain sub-groups in the ACT [19, 28] and the importance of considering disadvantage as a relative measure, considering family level variation in access to resources [29]. Our study found that First Nations children were significantly more likely than non-Indigenous children to be in the quintile of least socio-educational advantage relative to their peers (46% of First Nations children vs. 21% of non-Indigenous children). While we cannot infer causality from our analysis, relative socio-educational disadvantage is a known risk factor for a range of health outcomes, including overweight/obesity [6], respiratory health [30], child development [31] and wellbeing [32].

##### *Physical activity*

Physical activity promotes healthy growth and development [5] and has a protective effect on wellbeing [33]. For these reasons, the 24-hour movement guidelines recommend children do at least 60 min of physical activity per day [3]. Our study confirmed the trend highlighted in an analysis of 2014–2016 KHC data, which showed that

First Nations children are more physically active than their non-Indigenous peers [20]. In 2019, 57% of First Nations KHC participants were active for at least 60 min every day compared to 44% of non-Indigenous participants. Free play and exercise are culturally important to First Nations Australians [12, 34]. While we cannot infer causality from our study, the higher level of physical activity amongst First Nations children compared to non-Indigenous children may have masked any deleterious associations observed for non-Indigenous children between screen time and BMI, respiratory problems, developmental concerns and wellbeing.

#### Limitations and opportunities for future study

The KHC provides a unique opportunity to identify population-level outcomes and risk factors for kindergarten children in the ACT. With excellent response rates and well-validated questions, the KHC is a complete enumeration survey that provides a large representative sample for analysis and to inform evidence-based health policy design. The 2019 survey was the first iteration of the KHC to address children's screen-time behaviours. These data will serve as a sound basis to build longitudinal data on this important health risk factor in later years.

The screen time questions in the KHC instrument are based on parent report and recollection. Self- or parent-reported data are cost effective and more straightforward to collect than measured data. However, that these data may be impacted by difficulties with recall, or indeed moderating answers in a way to be deemed more 'acceptable'. The small population of First Nations children in our study meant that many of our findings were not statistically significant with large confidence intervals. There may be a small over-representation of non-Indigenous children in our sample, however our results are robust compared to other equivalent studies. Estimates from the Australian Bureau of Statistics (ABS) reported 645 Aboriginal and Torres Strait Islander people aged 4–6 years living in the ACT in 2019 [35]; 3.7% of the total 4-6-year-old population of 17,514 [36]. While the proportion of First Nations children is higher in these official statistics compared to our sample (3.7% versus 2.6%), the ABS figures are based on back-casting updates from the 2021 Census. Prior to the 2021 Census, the projected estimated resident population of Aboriginal and Torres Strait Islander children aged 4–6 years in the ACT was 531, just 3.0% [37]. A comparable study to the KHC is the state of Victoria conducts the School Entrant Health Questionnaire [38]. In 2019, they reported 1.8% of children beginning school as being of Aboriginal and/or Torres Strait Islander origin. This compares to ABS estimates of 3.6–4.5% of children aged 4–6 years living in Victoria identifying as Aboriginal and Torres Strait Islander. Thus, our results appear comparatively representative.

Missing data were excluded from the main analyses; if the characteristics of these missing data differ from those children with complete data this has the potential to introduce bias. Table S3 outlines in detail the characteristics of children with missing data. While there are some differences between First Nations children and non-Indigenous children, numbers are small and so may not be of significance. The impact of missing data was further explored using multiple imputation methods. Combined parameter estimates arising from the multiple imputation modelling were only statistically significant for gender and ICSEA score. As the set of significant parameters differed between the main analysis and multiple imputation analyses, it is likely that data were not wholly missing at random.

Repeating our analyses when multiple years of data are available would provide more reliable findings and help to minimise potential bias.

#### COVID-19 pandemic

At the time of conducting our study, 2019 data were the most recent available. The 2019 KHC was completed prior to school and community closures related to the COVID-19 pandemic and the ACT's transition to intermittent periods of online learning. Both 2020 and 2021 were characterised by significant disruptions to normal schooling in Australia, including pandemic lockdowns. Early research suggests that children's use of recreational screen time markedly increased over the intervening period as a result of such closures [26]. It will be of interest to repeat the study analyses on later KHC data to gain insight into changes in children's screen time behaviour in the wake of the COVID-19 pandemic and effects on associated health outcomes. A series of cross-sectional studies of children (average age 10 years) in the Netherlands from 2016 to 17 to 2021–22 found that there was an increase in screen time during the pandemic, which then decreased, but not to pre-pandemic levels [39].

#### Conclusions

Indigenous identification was not found to be associated with recreational screen time use in our study. A high proportion of First Nations and non-Indigenous children had screen time habits consistent with the 24-hour movement guidelines. Factors associated with the likelihood of exceeding screen time recommendations showed a graded relationship with BMI, exercise, PEDS, and relative socio-educational advantage.

Interventions to support healthy levels of discretionary screen-time use may support childhood health at a population level. This includes promoting healthy body weight, age-appropriate development and enhanced wellbeing amongst children. Policymakers, health professionals, educators and parents, can all promote moderation

of screen time through support, education and role modelling, particularly in light of those factors showing positive and negative associations with discretionary screen time.

Exploring risk factors for health, particularly those that disproportionately impacting First Nations Australians remains important to help overcome the lasting impacts of intergenerational trauma and help 'close the gap'.

### Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-025-21611-z>.

Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

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### Author contributions

All authors were involved in the design of the study. Data were extracted by KC. Data analysis was done by KOB and CB. CB and KOB wrote the manuscript, with contributions from KD and KC. Figures and tables were prepared by CB and KOB. All authors had final approval of the final manuscript.

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No funding was received.

### Data availability

Data may be obtained from a third party and are not publicly available. The Kindergarten Health Check is an ACT health database. Access can be applied for by emailing: [KindyHealthAUGP@act.gov.au](mailto:KindyHealthAUGP@act.gov.au).

### Declarations

#### Ethics approval and consent to participate

Ethics approval for our study, secondary analysis of the KHC, was granted by the ACT Health Human Research Ethics Committee (HREC; 2020/ETH02679). The data collection and consent process for the KHC has been granted ethics approval through the ACT HREC (ETHLR.13.316). This includes informed consent from the parent/guardian for de-identified information collected in the KHC to be provided to researchers who have approval granted from the ACT HREC. The KHC was conducted in accordance with the National Statement on Ethical Conduct in Human Research (National Health and Medical Research Council, Australian Research Council, Universities Australia), and in accordance with the declaration of Helsinki.

#### Consent for publication

Not applicable.

#### Competing interests

The authors declare no competing interests.

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