



## Article

# Racial discrimination and the health and wellbeing of Aboriginal and Torres Strait Islander children: Does the timing of first exposure matter?



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## ABSTRACT

Racial discrimination has been observed to negatively impact on the health of Aboriginal and Torres Strait Islander children, although evidence surrounding periods of greater vulnerability to the stressor of racism have not yet been explored in this population. We compared first exposure to interpersonal racism at either ages 4–5 years or 7 years with no exposure to examine the influence of sensitive periods of racism exposure on mental health and physiological outcomes during middle childhood (7–12 years).

The study cohort comprised 1,759 Aboriginal and Torres Strait Islander children aged 4–12 years from waves 2–8 (2009–2015) of the Footprints in Time: The Longitudinal Study of Indigenous Children (LSIC) dataset. Multilevel logistic regression was used in all analysis.

We observed a larger effect (OR: 2.8; 95% CI: 1.4–5.4) for negative mental health with first exposure at 4–5 years compared to 7 years (OR: 2.1; 95% CI: 1.2–3.6), referenced to children with no exposure. Effect sizes were similar in both exposure groups for the significantly increased risk of sleep difficulties, while a stronger adverse effect on behavioural issues was found at 7 years (OR: 2.2; 95% CI: 1.3–4.0) relative to 4–5 years (OR: 1.7; 95% CI: 0.8–3.7). No significant associations were found with general health, obesity or being underweight.

This study generates new evidence surrounding sensitive periods of exposure to racism in Aboriginal and Torres Strait Islander children. A pattern of consistently greater adverse effects on mental and physiological health was not observed with first exposure at 4–5 compared to 7 years, although initial evidence indicates that first exposure to racism at these ages increases the likelihood of negative mental health relative to children without racism exposure. Longitudinal data extending from earlier to later developmental periods will allow further investigations into the presence of sensitive periods of exposure to racism in these children.

## Introduction

Racism is a modifiable and direct determinant of negative health outcomes which contributes to population health disparities (Braveman, Egerter, & Williams, 2011; Braveman et al., 2017; Brondolo, Gallo, & Myers, 2009; Gee, Walsemann, & Brondolo, 2012; Krieger, Jahn, & Waterman, 2017; Sanders-Phillips, Settles-Reaves, Walker, & Brownlow, 2009; Williams & Mohammed, 2009), including those observed between Indigenous and non-Indigenous populations worldwide (King, Smith, & Gracey, 2009; Paradies, 2018; Paradies, Harris, & Anderson, 2008). Despite this, developing effective public health responses to racism remains an ongoing challenge (Came & Griffith, 2018; Ford &

Airhihenbuwa, 2010; Thomas, Quinn, Butler, Fryer, & Garza, 2011). Targeted responses are particularly vital during childhood as the early years are understood to present a critical period of health vulnerability resulting from adversity and stress (Maggi, Irwin, Siddiqi, & Hertzman, 2010; McEwen & Gianaros, 2010; Shonkoff, Boyce, & McEwen, 2009). The stressor of racial discrimination has been shown to generate greater adverse effects on health during this early developmental period compared with exposure during adolescence or adulthood (Benner et al., 2018; Lee & Ahn, 2013; Schmitt, Branscombe, Postmes, & Garcia, 2014). While interventions to reduce prejudice in early childhood have shown some promise, effective strategies to address this complex issue remain elusive (Aboud et al., 2012). Examining developmental trends in the

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health risk of racism among Indigenous children can potentially inform the content and timing of important public health initiatives to address this critical stressor in vulnerable population groups.

The aetiological pathways between racism and health outcomes have been closely examined, although predominantly in cross-sectional studies of adult populations (Ben, Cormack, Harris, & Paradies, 2017; Paradies et al., 2015). Interpersonal racism is known to have a significantly negative impact on myriad health outcomes, with stronger and more consistent effects reported for mental health as opposed to physical health (Krieger, 2014; Pachter & Coll, 2009; Paradies, 2006; Paradies et al., 2015; Pascoe & Richman, 2009; Priest et al., 2013; Schmitt et al., 2014; Williams & Mohammed, 2009). Racism impacts health and wellbeing through initiating physiological dysregulation, maladaptive psychological responses or changes in health behaviour such as disturbed sleep patterns or substance use (Paradies, 2006; Paradies et al., 2015; Priest et al., 2013). Longitudinal studies have shown weaker associations between racism and negative mental health outcomes compared with cross-sectional studies, suggesting that the impact of racism on negative mental health may attenuate over time (Paradies et al., 2015; Schmitt et al., 2014). While this provides perspective on the duration of racism's impact, it does not account for the age of study populations or the relative impact of racism exposure during different developmental periods. Studies that examine how this association may differ according to the age of first exposure to racism in a longitudinal cohort of children have not yet taken place.

Children have demonstrated the ability to conceptualise and perpetuate racial prejudice, recognising discriminatory behaviour from age 5 years (Brown & Bigler, 2005) and enacting prejudice from ages 2–4 years, with a peak in middle childhood (5–7 years) (Raabe & Beelmann, 2011). More specifically, in the context of Australian Aboriginal and Torres Strait Islander (hereafter after referred to as 'Aboriginal') groups, children aged 8–12 years have demonstrated an awareness of racist acts and described the onward impact of these acts on their health and wellbeing (Priest, Thompson, Mackean, Baker, & Waters, 2016). The occurrence of racism in the lives of Aboriginal children is well documented (Bodkin-Andrews et al., 2017; Priest, King, Becares, & Kavanagh, 2016; Priest, Paradies, Stevens, & Bailie, 2010; Priest, Paradies, Stewart, & Luke, 2011; Shepherd, Li, Cooper, Hopkins, & Farrant, 2017; Zubrick et al., 2005) and evidence has begun to be generated on the negative impact of racism on Aboriginal child health and wellbeing outcomes (Shepherd et al., 2017). Despite this, no studies have yet examined whether sensitive periods of exposure to racism are present for Aboriginal children – that is, whether these children are more vulnerable to the adverse health effects of racism exposure during certain developmental periods. This is partly due to the paucity of datasets able to examine the timing of exposures and outcomes across childhood, including prospective cohort studies.

This study undertakes one of the first examinations of the impact of timing of exposure to racial discrimination (Adam et al., 2015; Benner & Kim, 2009; Cuevas et al., 2019; Ford, Hurd, Jagers, & Sellers, 2013; Hou, Kim, Wang, Shen, & Orozco-Lapray, 2015), using a prospective national longitudinal cohort study of Aboriginal children aged 4–12 years. We expected that Aboriginal children first exposed to direct racial discrimination at an early age (4–5 years) would have an increased risk of negative physical and mental health outcomes relative to both those first exposed during middle childhood (7 years) and those never exposed.

## Methods

Footprints in Time: The Longitudinal Study of Indigenous Children (LSIC) is a prospective national longitudinal cohort survey of Aboriginal and Torres Strait Islander children designed to track their development in the context of their sociodemographic background (Thurber, Banks, & Banwell, 2015). LSIC used a multi-stage clustered sampling method across 11 sites to recruit a non-representative national sample of

Aboriginal children across two age cohorts. LSIC aimed to recruit 5–10% of the total Australian population of Aboriginal children aged 0.5–2 years in the 'younger cohort' and 3.5–5 years in the 'older cohort' at baseline (2008). The survey conducts annual face-to-face interviews with the study child and their primary caregiver. The sample came to 1671 children at baseline, with a further 88 children recruited at wave 2 culminating in a total sample of up to 1759 children. Full details of the rationale, sampling, recruitment, and data collection have been reported elsewhere (Australian Government Department of Social Services, 2018).

## Participants

Study participants include children aged 6 months to 12 years from the first 8 waves of LSIC. From a total sample of 1,759, 1255 children remained by wave 8 (75% retention). The sample is broken into a younger and older cohort, with 1010 respondents in the younger cohort and 749 in the older cohort.

## Measures

### Predictor variable

Throughout waves 2–7 of LSIC, primary carers were asked whether the study child had been bullied or treated unfairly at preschool or school by children or adults because they are Aboriginal. This direct racism measure was coded as a binary variable for analysis ('Yes, bullied [kids being mean to him/her]', 'Yes, treated unfairly [adult being mean to him/her]' or 'Yes, both bullied and treated unfairly' compared with 'No'). In wave 8 the structure of the question was changed slightly so that the primary carer was first asked whether the study child had been bullied or treated unfairly at school and if they responded positively to this question (study child was bullied, treated unfairly or both), they were then prompted to indicate whether this was because the study child is Aboriginal or Torres Strait Islander. Carer responses of 'always for this reason' or 'sometimes for this reason' were categorised as a child that had been bullied or unfairly treated due to being Aboriginal or Torres Strait Islander. The mean age of children at each wave in each cohort was then used to assign an age at which the direct racism measure was first responded to. First exposure was recorded at 4, 5 and 7 years; this was then collapsed into two exposure age categories, 4–5 years and 7 years. First exposure was limited to 4–7 years to ensure minimal overlap with the age range at which outcome variables were assessed (7–12 years). First exposure was recorded for children whose primary carer reported direct racism exposure at each age, excluding those who reported racism exposure at any previous age.

### Outcome variables

Health outcomes included within this analysis were categorised as either mental health and behavioural issues or physical health. All outcomes were categorised into binary variables for analysis. All outcomes were taken from wave 8 except sleep difficulties which was last asked in wave 7.

**Mental health and behavioural issues.** Mental health and behavioural outcomes included measures of child mental health, sleep difficulties and behavioural issues at school. Child mental health status was determined by primary carer responses to the Strengths and Difficulties Questionnaire (SDQ), a measure of emotional and behavioural difficulties in children aged 4–17 years which provides a score ranging from 0 to 40. Total difficulty scores were categorised into abnormal (17–40), borderline (14–16) and normal (0–13) based on cut-off scores derived from community-based samples of children (Goodman, 1997). In this study, scores of 14–40 (combining borderline and abnormal) were used to indicate an increased risk of mental health problems. Study children were considered to be experiencing sleep difficulties when the primary

carer reported they usually had trouble getting to sleep or staying asleep over the past month. Study children were deemed to have behavioural issues at school where primary carers reported that the school had contacted them because their child had behaved badly at school in the last twelve months.

**Physical health.** Physical health outcomes included indicators of general health, obesity and being underweight. General health was coded as positive if the study child's health was indicated to be 'excellent', 'very good' or 'good' by the primary carer and coded as negative where their health was indicated to be 'fair' or 'poor'. Children's height and weight were translated into Body Mass Index (BMI)-for-age z-scores and then classified as obese or underweight based on WHO guidelines. Underweight was indicated by BMI-for-age z-scores below 2. Obesity was indicated by BMI-for-age z-scores above 2 (Australian Government Department of Social Services, 2018).

#### Covariates

**Community variables.** The Level of Relative Isolation (LORI) measure was used as an index for remoteness levels within Australia. LORI uses five categories of isolation; none (e.g. metropolitan areas), low, moderate, high and extreme (e.g. remote communities). Within LSIC, respondents in the 'high' and 'extreme' categories have been collapsed into one item – 'high/extreme isolation' – due to small sample size. The Index of Relative Indigenous Socioeconomic Outcomes (IRISEO) was used as an indicator of community level socio-economic outcomes. IRISEO is a ranked scale based on the employment, education, income and housing characteristics of Aboriginal peoples from Indigenous Areas across Australia (Biddle, 2009). IRISEO data from wave 1 of LSIC has been refined into quintiles for this analysis.

**Primary carer variables.** LSIC primary carers were asked to indicate the highest qualification they had completed. This measure was coded into a four-item variable including university-level education, certificate or post-school qualifications, completion of Year 11 to Year 12 or equivalent, and Year 10 completion or less. A six-item subjective rating of the family financial situation was collapsed into a three-item variable for analysis ('We run out of money before payday/We are spending more money than we get', 'We have just enough money to get us through to the next pay day/There's some money left over each week but we just spend it' and 'We can save a bit every now and then/We can save a lot'). Prior experience/s of homelessness were recorded from all primary carers in wave 3 based on whether there had been any times in the last five years when they did not have a place to live; homelessness was indicated for those that responded 'Yes, many times', 'Yes, a few times' or 'Yes, once'.

**Child variables.** Primary carers reported the study child's age and gender at each wave. Child age at wave 8 was collapsed into three categories: 7–8, 9–10 and 11–12 years.

#### Data analysis

Ordinal logistic regression was used to determine independent associations between the covariates and age of first exposure to racism. Two logistic regression models were then defined and fitted using the generalised linear mixed modelling (GLMM) framework to determine associations between age of first exposure to racism and health outcomes: the first model adjusted for child age and gender (model 1); the fully adjusted model (model 2) included child age and gender, geographic remoteness, area-level socioeconomic status and family-level socioeconomic status (primary carer reported highest education completed, financial difficulty and prior homelessness). A randomised cluster variable was developed within LSIC to identify respondents

living in close geographic proximity and to overcome bias introduced by the sampling method (Australian Government Department of Social Services, 2018). This variable was used as the grouping variable in random effects modelling. Models were fitted using PROC GLIMMIX in SAS (version 9.4, SAS Institute Inc., Cary, NC, USA, 2002-12) using compound symmetry as the covariance structure. Adaptive Gaussian quadrature methods were chosen as they have been shown to perform well with minimal bias when estimating the fixed effects of a GLMM for binary outcome clustered data where there are sufficient numbers of observations per random effect (Capanu, Gönen, & Begg, 2013).

#### Missing data

The predictor, outcome and covariate variables all contained a proportion of non-responses (missing data). Multiple imputation was used as a sensitivity analysis to determine the influence of missing data on parameter estimates. Cohort (younger or older) and number of major events experienced in the last year were used as auxiliary variables to assist with the prediction of missing data. Multilevel multivariate normal imputation with joint modelling was then conducted, generating 100 imputed datasets. Adaptive rounding was pursued on imputed datasets because model variables were either binary or categorical, although this did not return realistic data in all cases. Linear mixed effects models were then run on unrounded imputed data and pooled parameter estimates were compared against estimates from complete case analysis (see Appendix A). These analyses were conducted using the 'mitml' package (Grund, Robitzsch, & Luedtke, 2018) in R studio (Version February 1, 1335 - © 2009–2019).

#### Ethics

Ethics approval for the LSIC was provided by the Australian Commonwealth Department of Health Departmental Ethics Committee and from state and territory Ethics Committees. The current analysis was approved by the Western Australian Aboriginal Health Ethics Committee and the University of Western Australia Human Research Ethics Committee.

#### Results

In the full sample the mean age of respondents was 2.4 years (SD: 1.6; age range: 0–6 years) at wave 1 and 9.3 years (SD: 1.5; age range: 7–12 years) by wave 8. Overall, 887 (50.4%) study children were male and 872 (49.6%) were female, 1534 (87.2%) study children were Aboriginal, 117 (6.7%) were Torres Strait Islander and 108 (6.1%) were both Aboriginal and Torres Strait Islander. First exposure to racial discrimination at 4–5 years was reported for 6.9% of our in-scope study sample and first exposure at 7 years was reported for 8.3% of children. By 7–12 years, 17% of study children were reported to have negative mental health or behavioural issues at school, 18% of children were obese, 4% were underweight and 3% of children were identified as having fair or poor general health. At 6–11 years, 21% of children were reported to have experienced difficulty sleeping.

After adjustment for all covariates, having a primary carer experience homelessness in the previous five years increased the odds of being first exposed to racism at age 7 by 1.9 times compared with being first exposed at age 4–5 and never being exposed (OR: 1.9; 95% CI: 1.1–3.2) (Table 1). No other sociodemographic factors increased the odds of first exposure to racial discrimination.

Overall, first exposure to racial discrimination at 4–5 years did not consistently increase the risk of mental and physical health outcomes relative to children first exposed to racism at age 7 (Table 2). Positive associations were observed between first exposure to direct racial discrimination at 4–5 and 7 years and each outcome related to mental health. In the fully adjusted model, statistically significant effects for negative mental health and sleep difficulties were seen in study children

**Table 1**  
Distribution and multivariate associations between age of first exposure to direct racial discrimination and selected socio-demographic characteristics in Aboriginal children.

Variables	Age of first exposure to bullying or unfair treatment due to child being Indigenous			
	4–5 years % (n)	7 years % (n)	No exposure % (n)	Adjusted OR (95% CI)
<b>Gender of child</b>				
Male	45.2 (47)	48.4 (61)	51.3 (657)	Ref
Female	54.8 (57)	51.6 (65)	48.8 (625)	1.11 (0.79–1.57)
<b>Age of child (years)</b>				
7–8	41.4 (43)	54.8 (69)	37.7 (483)	-
9–10	10.6 (11)	16.7 (21)	13.9 (178)	-
11–12	48.1 (50)	28.6 (36)	48.4 (621)	-
<b>Level of relative isolation</b>				
None	25.6 (23)	38.0 (46)	26.7 (325)	Ref
Low	35.6 (32)	40.5 (49)	50.8 (619)	0.79 (0.50–1.26)
Moderate	25.6 (23)	9.9 (12)	13.5 (165)	1.08 (0.56–2.06)
High	13.3 (12)	11.6 (14)	9.0 (110)	1.04 (0.49–2.18)
<b>Index of relative Indigenous socioeconomic outcomes</b>				
Quintile 5 – most advantaged	16.5 (15)	21.3 (26)	14.3 (175)	Ref
Quintile 4	14.3 (13)	13.1 (16)	16.0 (195)	0.71 (0.39–1.30)
Quintile 3	28.6 (26)	36.9 (45)	42.0 (513)	0.74 (0.41–1.31)
Quintile 2	15.4 (14)	15.6 (19)	16.1 (197)	0.90 (0.47–1.72)
Quintile 1 – most disadvantaged	25.3 (23)	13.1 (16)	11.6 (142)	1.56 (0.74–3.30)
<b>Primary carer highest education completed</b>				
Never attended school to Year 10	33.3 (33)	42.5 (51)	43.5 (504)	Ref
Year 11/12	43.4 (43)	31.7 (38)	32.2 (374)	1.32 (0.89–1.96)
Diploma or Certificate	17.2 (17)	22.5 (27)	18.0 (209)	1.39 (0.87–2.22)
University	6.1 (6)	3.3 (4)	6.3 (73)	0.87 (0.37–2.06)
<b>Financial difficulty</b>				
Save a lot/save a bit every now and then	31.8 (28)	29.7 (35)	36.5 (429)	Ref
Some money left/just enough to get through	39.8 (35)	50.0 (59)	46.1 (541)	1.19 (0.81–1.76)
Spending more than we get/run out of money	28.4 (25)	20.3 (24)	17.4 (204)	1.34 (0.83–2.18)
<b>Primary carer experienced homelessness</b>				
No	86.8 (72)	85.6 (95)	92.6 (1011)	Ref
Yes	13.3 (11)	14.4 (16)	7.4 (81)	1.87 (1.10–3.18)

Odds ratios are adjusted for all variables that appear in the table excluding child age.

with first exposure to direct racism at 4–5 years and 7 years compared with those not exposed to racism. Risk for negative mental health was higher for children exposed at 4–5 years (OR: 2.8; 95% CI: 1.4–5.4) compared with those exposed for the first time at 7 years (OR: 2.1; 95% CI: 1.2–3.6). Study children were found to be at similar risk of sleep difficulties at 6–11 years when exposed to racism at 4–5 years (OR: 2.1; 95% CI: 1.1–4.3) and 7 years (OR: 2.2; 95% CI: 1.4–3.7) compared to those not exposed to racism. Study children with first exposure to direct racism at 7 years had 2.2 times the risk of behaviour issues at school (95% CI: 1.3–4.0; fully adjusted model) when compared with those not

**Table 2**  
Multivariate models examining association between age of first exposure to direct racial discrimination and mental and physical health outcomes in Aboriginal children.

	Model 1		Model 2	
	β	Adjusted OR (95% CI)	β	Adjusted OR (95% CI)
<b>Mental health</b>				
No exposure	Ref		Ref	
First exposure age 4–5 years	0.54	1.72 (0.96–3.08)	1.01	2.76 (1.42–5.40)
First exposure age 7 years	0.57	1.77 (1.08–2.89)	0.75	2.11 (1.23–3.62)
<b>Sleep difficulties</b>				
No exposure	Ref		Ref	
First exposure age 4–5 years	0.35	1.43 (0.77–2.65)	0.75	2.13 (1.06–4.25)
First exposure age 7 years	0.74	2.09 (1.31–3.32)	0.79	2.20 (1.33–3.66)
<b>Behaviour issues at school</b>				
No exposure	Ref		Ref	
First exposure age 4–5 years	0.46	1.58 (0.84–2.96)	0.52	1.68 (0.77–3.67)
First exposure age 7 years	0.56	1.74 (1.04–2.92)	0.80	2.22 (1.25–3.95)
<b>General health</b>				
No exposure	Ref		Ref	
First exposure age 4–5 years	0.003	1.00 (0.23–4.36)	0.18	1.20 (0.26–5.59)
First exposure age 7 years	-0.25	0.78 (0.18–3.37)	-0.07	0.94 (0.21–4.17)
<b>Underweight</b>				
No exposure	Ref		Ref	
First exposure age 4–5 years	0.78	2.19 (0.73–6.54)	0.92	2.50 (0.67–9.31)
First exposure age 7 years	1.07	2.91 (1.12–7.57)	0.78	2.18 (0.66–7.22)
<b>Obesity</b>				
No exposure	Ref		Ref	
First exposure age 4–5 years	0.31	1.36 (0.71–2.61)	0.21	1.23 (0.55–2.74)
First exposure age 7 years	0.74	2.10 (1.21–3.63)	0.57	1.76 (0.96–3.22)

exposed; while a smaller effect was seen for first exposure at 4–5 years for this outcome (OR: 1.7; 95% CI: 0.8–3.7). A reparameterization of the model indicated that children with first exposure at 7 years had 1.3 times the risk of behavioural issues relative to those first exposed at 4–5 years (95% CI: 0.5–3.3).

No discernible effects were evident for general health in either the basic or fully adjusted model. We observed significant effects for being underweight (OR: 2.9; 95% CI: 1.1–7.6) and obesity (OR: 2.1; 95% CI: 1.2–3.6) in children with first exposure at age 7 in the model adjusted for child age and gender, although these effects were attenuated in the fully adjusted model. In this model, we continued to observe an increased risk for children being underweight in both those first exposed to racism at 4–5 years (OR: 2.5; 95% CI: 0.7–9.3) and 7 years (OR: 2.2; 95% CI: 0.7–7.2) compared with those not exposed, although these estimates were imprecise. Smaller effects were also observed for obesity, with imprecise estimates seen for those first exposed at 4–5 years (OR: 1.2; 95% CI: 0.6–2.7) and marginally significant effects seen for those first exposed at 7 years (OR: 1.8; 95% CI: 1.0–3.2) compared with those without racism exposure.

Analysis using imputed datasets resulted in pooled estimates for each outcome that were similar to estimates from complete case analysis. Pooled estimates fell within confidence intervals from complete case analysis and confidence intervals from both analyses overlapped considerably. All significant associations between racial discrimination and health outcomes found in complete case analysis were also found in analysis of imputed datasets.

## Discussion

This study investigated whether the effect on health outcomes at 7–12 years differed by the age of first exposure to direct racism at school, thereby offering a novel method to understand how sensitive periods of exposure to racism influence later mental and physical health outcomes. We found limited evidence to support our expectation that first exposure to direct racial discrimination at a younger age (4–5 years) would pose an increased risk of later negative mental and physical health outcomes compared to first exposure at an older age (7 years). An increased risk of negative mental health was observed for first exposure at 4–5 years relative to 7 years, after adjustment for all covariates, though this relationship was not seen across other outcomes.

Overall, children with a first exposure to racism at either 4–5 or 7 years had a moderately increased likelihood of experiencing the negative mental health and weight-related outcomes under examination relative to children who were not exposed to racism. However, the effect estimates were imprecise for weight-related outcomes and behaviour issues at school with first exposure at 4–5 years in the fully adjusted model. The negative impact of racism on health in both international and Australian Indigenous populations is well established (King et al., 2009; Paradies, 2018; Paradies et al., 2008). Our study confirms that this impact is apparent early (ages 7–12) when first exposure to racism occurs at 4–5 and 7 years of age. Evidence supporting the heightened physiological and psychological vulnerability to adverse environments during early development is indisputable (Bagby, Martin, Chung, & Rajapakse, 2019; Fleming et al., 2018; Hanson & Gluckman, 2014; Heim & Binder, 2012). Similar patterns of increased vulnerability have been found with exposure to interpersonal racism as a stressor, though these are based on broad comparisons between child and adolescent or adult periods of exposure (Benner et al., 2018; Lee & Ahn, 2013; Schmitt et al., 2014). While the more granular periods of exposure examined within our study allowed closer investigation of the impact of first exposure to racism during childhood, we did not find evidence for differential effects on health from racism exposure earlier in childhood. This may be due in part to the small proportion of children with first exposure at these young ages. While children can recognise and enact discriminatory behaviour based on racial prejudice from age 5, awareness of this discrimination increases as children age, becoming more consistently detected by 8–10 years (Brown & Bigler, 2005). Concomitantly, the children in this study were 7 years or less at the time of collecting information on racial discrimination and may have had a lesser capacity or inclination to articulate and/or disclose their experiences. These factors, collectively, may have contributed to the small proportions reporting exposure and the resulting imprecision of estimates observed for some outcomes. Differences in the duration and frequency of racism exposure at each age also likely influence the impact of racism on health, though these aspects of racism exposure were unmeasured in this study. Larger longitudinal datasets incorporating time-limited measures of racism (e.g. exposure within previous 12 months) which capture the duration, frequency and context of racism exposure throughout childhood will allow for analysis that can more accurately confirm the presence of sensitive periods of exposure to racial discrimination during early development.

We observed an increased risk of negative mental health in children with first exposure to direct racism at 4–5 years compared with those first exposed at 7 years. Our findings align with the strong associations found between racism and negative mental health outcomes in adult and adolescent populations, and provide a unique insight into the impact of racism exposure during childhood (Benner et al., 2018; Paradies, 2006; Priest et al., 2013; Schmitt et al., 2014). Environmental stressors are understood to increase the risk of negative mental health via the disturbance of neurobiological systems implicated in stress responses and emotional regulation (Heim & Binder, 2012; McEwen & Gianaros, 2010). Exposure to stress early in life can reduce neurological adaptability to later difficulties, resulting in patterns of behaviour that

characterise a range of mental health disorders (Heim & Binder, 2012). It is likely that changes in neural plasticity throughout development lead to differential vulnerability to negative mental health from external stressors and that the nature and severity of the stressor also influences this vulnerability. However, sensitive periods of exposure to racial discrimination as a stressor are currently underexamined, particularly during childhood. Where the strength of this association has been compared across adolescent developmental periods, the positive association between emotional and behavioural difficulties and racial discrimination has been shown to be stronger in early rather than late adolescence (Benner et al., 2018). Although our study found a similar pattern during childhood, it is clear that complex intersections between the neurological, environmental and genetic factors which influence associations between racism and mental health outcomes must still be addressed. It is also important to note that resilience to racism as an early life stressor is among the potential outcomes of exposure. Integrating psychometric and neurobiological outcome data within the context of broader environmental and genetic factors may better identify sensitive periods of exposure to the negative mental health effects of racism.

In contrast to findings for the association between early exposure to racial discrimination and mental health, we saw that children first exposed to direct racism at a later age (7 years) were at an increased risk of behavioural issues at school and that there was minimal difference in the effect size of associations with sleep difficulties by age of first exposure. Emotional and behavioural difficulties are known to co-develop throughout childhood (Keiley, Bates, Dodge, & Pettit, 2000) and racial discrimination has been found to have a strong and consistent association with behavioural issues during childhood and adolescence, equal to the association with negative mental health outcomes (Priest et al., 2013). Our preliminary evidence for a stronger adverse effect at 7 years adds to these earlier findings, although a lack of statistical precision meant that we did not find a significant difference in the likelihood of behavioural issues for those first exposed at 7 years relative to 4–5 years. The stronger adverse effect at an older age may be due in part to the later expression of behavioural issues at school after an earlier experience of negative mental health, particularly as the measure under investigation captured only behavioural issues severe enough to result in the school contacting a parent or carer. In contrast, children with first exposure to racial discrimination during the earliest years of school were at significantly increased risk of sleep difficulties and there was minimal difference in the effect size of these associations with age. This may be explained in part by the links between sleep difficulties and both emotional and behavioural difficulties in children (Gregory & Sadeh, 2012), leading to strong associations at both younger and older ages. Overall, the contrast between these two observations may reflect different mechanisms underlying the association between racism and behavioural compared to mental health outcomes, particularly given the early developmental period under investigation. This finding strengthens the need to examine the longitudinal association between behavioural and mental health outcomes and racial discrimination in children as they move from early to late childhood and into adolescence.

We provide tacit evidence that first exposure to racism at either 4–5 or 7 years poses an increased likelihood of being underweight or experiencing obesity, although our expectation that first exposure at 4–5 years would increase the risk of later obesity or underweight status compared to first exposure at age 7 was not supported in this cohort of Aboriginal children. Estimates for obesity in this study reflect those observed between obesity and racial discrimination exposure in Aboriginal children aged between 5–10 years (Shepherd et al., 2017). Weight-related outcomes may be more consistently influenced by the timing of exposure to racial discrimination during later childhood (8–11 years) or by repeated exposures throughout childhood. In the current study, age of first exposure to racism was limited to 4–7 years to reduce overlap with the ages at which outcome measures were recorded (7–12 years). However, longitudinal data which captures data from

respondents across a broader age range (incorporating adolescence) would allow sensitive periods of exposure to racism to be examined more fully.

This study contributes to examinations of the impact of racial discrimination on the health of Aboriginal children by developing a novel exposure variable – age of first exposure – to explore sensitive periods of exposure to racism. To our knowledge, no other published study has examined age of first exposure to racism in Aboriginal children or characterised the health impacts of first exposure at different ages. As a prospective cohort study, the LSIC allows for an examination of temporal exposure variables which would not be possible within a cross-sectional study design. Alongside these strengths, a number of limitations should also be considered when interpreting our findings – principally related to the racism exposure variable. The exposure variable for racism in this study was based on the perceptions of primary carers, not the study children themselves. While primary carers were asked to report on the experiences of study children, these reports may not reflect the perceptions of racism in study children. There was a risk of respondent bias where primary carers also provided reports of outcome variables (i.e. mental health [SDQ], sleep difficulties and general health). In these cases, carers' assessments of racism and mental or physical health outcomes in children may have tended towards being uniformly positive or negative, whether consciously or not. The racism exposure variable was not time-limited and did not account for the frequency or severity of racism exposure. These factors reduce the sensitivity of this exposure as children with an array of experiences with racism were unable to be differentiated. Finally, despite the strength of the LSIC as a prospective cohort study, the sampling design was non-random due to practical and logistic considerations in site selection. As a result, the sample of study children in LSIC is not nationally representative of the population of Aboriginal children across Australia, although the sites selected for the study were intended to reflect the geographic distribution of Aboriginal children within Australia and the varied environments in which these children live (Australian Government Department of Social Services, 2018).

## Conclusion

This study generates new evidence surrounding the impact of age of

## Appendix B. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2019.100492>.

## Appendix A

### *Multiple imputation and adapting rounding*

Multiple imputation using mixed effects models is a relatively novel procedure and best practice recommendations are currently limited. Based on this limited literature, adaptive rounding of ordinal and binary variables returned from linear models using the 'mitml' package in R Studio was originally pursued in this analysis. First, ordinal variables were recoded into a series of dummy variables, these were then entered into linear mixed effects models for each health outcome. Adaptive rounding based on Bernaards et al. calculation for a cut-off score based on normal approximation to the binomial distribution was then applied to all variables (Bernaards, Belin, & Schafer, 2007). Ordinal variables were then recreated based on the dummy variables originally derived from each variable. However, due to the rounding procedure, cases would occasionally be returned where all levels of the ordinal variable were rounded to zero or more than one level of the variable was rounded to 1. This led to unrealistic cases where, for example, individuals were not allocated to any remoteness level or were allocated into multiple remoteness levels at once. Resolving this required implementing alternate or multiple rounding procedures, such as naïve rounding, to ensure that each case was allocated into a single category within ordinal variables. This process would likely lead to biased estimates and so we chose not to pursue any rounding procedure. Although the strategy of no rounding meant that continuous data was used in analysis, not the binomial data originally used with complete-case analysis, we preferred to treat both sets of data as continuous rather than introduce bias through rounding. To ensure estimates were comparable we contrasted the pooled estimates from linear models run on the imputed continuous data with linear models run on the complete-cases data.

*Comparison of estimates from imputation and complete case analysis*

first exposure to racism on mental and physical health outcomes in Aboriginal children. We provide further evidence that racial discrimination places Aboriginal children at a moderately increased risk of negative mental and physical health outcomes, with no evidence to suggest that these risks are consistently higher for first exposure at 4–5 years than 7 years across all the health outcomes under investigation. Although we did not observe consistently differential health vulnerability to racism with exposure at 4–5 and 7 years, exposure during this period of childhood may still be heightened compared to exposure in older childhood and adolescence. Examining longitudinal data which also captures these later developmental periods will assist in determining the presence and timing of sensitive periods of exposure to racism. Additionally, study designs and analytic models should integrate validated psychometric and biological outcomes alongside psychosocial covariates including cultural identity, social support and resilience where possible to ensure that the complex intersections between racism, health and environment are accounted for. Ultimately, this work can inform the timing of important public health initiatives to address the critical stressor of racism in vulnerable population groups.

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## Declaration of competing interest

None.

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	Imputation <sup>a</sup>	Complete cases
	$\beta$ (SE)	$\beta$ (SE)
Negative mental health		
No exposure	Ref	Ref
First exposure age 4–5/7	<b>-0.05 (0.02)</b>	<b>-0.08 (0.02)</b>
Sleep difficulties		
No exposure	Ref	Ref
First exposure age 4–5/7	<b>-0.05 (0.02)</b>	<b>-0.07 (0.02)</b>
Behaviour issues at school		
No exposure	Ref	Ref
First exposure age 4–5/7	<b>-0.04 (0.02)</b>	<b>-0.05 (0.02)</b>
General health		
No exposure	Ref	Ref
First exposure age 4–5/7	0.002 (0.01)	-0.001 (0.01)
Underweight		
No exposure	Ref	Ref
First exposure age 4–5/7	0.02 (0.01)	-0.02 (0.01)
Obesity		
No exposure	Ref	Ref
First exposure age 4–5/7	<b>-0.05 (0.02)</b>	-0.02 (0.03)

<sup>a</sup> Models adjusted for child age and gender, geographic remoteness, area-level socioeconomic status and family-level socioeconomic status (primary carer reported highest education completed, financial difficulty and prior homelessness).

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