



Australian children are not meeting recommended physical activity levels at school: Analysis of objectively measured physical activity data from a cross sectional study

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ABSTRACT

This study aimed to quantify, and examine grade level (Grade Kindergarten-2 vs. 3–6) and sex differences in the daily minutes of moderate-to-vigorous physical activity (MVPA) of primary school children, and the proportion of children meeting MVPA recommendations, across the school day and in break times. Consenting children in Kindergarten to Grade 6 from 12 Catholic primary schools within the Hunter region of New South Wales, Australia (February–April 2017) wore accelerometers during school hours (approx. 9am–3 pm) for five school days. Differences in student physical activity by Grade (Kindergarten-2; Grade 3–6) and sex were analysed using regression mixed modelling for the whole school day, during class time and break time. Valid data was available for 1862 students. Mean (SD) minutes of MVPA were consistently higher for Grade K-2 compared to Grade 3–6 students respectively, 37.02 (12.4) and 32.6 (12.2) across the school day; 20.4 (8.4) and 15.3 (7.6) minutes within breaks. Over the whole school day 69.7% of Grade K-2 and 54.1% of Grade 3–6 met the recommended 30 min of MVPA. Boys had higher MVPA than girls and a higher proportion of boys met MVPA recommendations than girls with 68.9% and 52.4% over whole school day and 6.43% and 0.98% respectively during break times. A large percentage of Australian children are not meeting physical activity guidelines whilst at school, with declining levels of physical activity from Grade K-2 to Grade 3–6 especially evident in girls.

1. Introduction

Children's participation in regular physical activity is essential for children's healthy growth and development (Australian Government Department of Health. *Australia's Physical Activity and Sedentary Behaviour Guidelines*, 2017). Physical activity has also been found to improve children's social, cognitive and psychological health (2010; 2017). Despite this, many primary school (aged 5–12) children are not sufficiently active (Telford et al., 2016; Schranz et al., 2014). For example, the 2018 physical activity report card from 49 countries estimated that only 27–33% of children were meeting the World Health Organization (WHO) physical activity guidelines of 60 min of moderate to vigorous physical activity each day (Aubert et al., 2018). Evidence also suggests the decline of physical activity may begin as young as

seven (Farooq et al., 2018). Thus, improving children's physical activity levels is regarded as an international priority (Tremblay et al., 2014; Broom et al., 2017).

Schools are a key setting to address children's physical activity as they provide access to almost all children for extensive periods of time (Fox et al., 2004). School specific recommendations have been developed by the Institute of Medicine and countries such as the United States of America and Canada which recommend that children accumulate at least 30 min of moderate-to-vigorous physical activity (MVPA) across the whole school day (Kohl and Cook, 2013; Education BMo, 2008; CDC. *CfDCaP*, 2011), and spend at least 40% of break times, that is recess and lunch times, in MVPA (Ridgers et al., 2005). Schools provide numerous opportunities for children to accumulate MVPA, including; class time via physical education (PE) (Fox et al., 2004), short activity

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breaks such as energizers (Watson et al., 2017), and during break times via organised activities or access to sports equipment (Erwin et al., 2012).

However, evidence based on objective accelerometer-measured physical activity demonstrates that primary school aged children are not engaging in the recommended levels of MVPA while at school (Weaver et al., 2016; Bailey et al., 2012; Taylor et al., 2017; Nettlefold et al., 2011). For example, a 2016 U.S.A study of 453 Grade 3–5 children from 13 schools, found that only 8% of children met the recommended 30 min of MVPA across the whole school day, with an average of 18.1 min of MVPA accumulated (Hubbard et al., 2016). Similarly, a 2016 study of children from Grades 1–3 from the US and Finland found children accumulated a mean of 20 and 24.1 min of MVPA across the whole school day, respectively (Yli-Piipari et al., 2016). In Australia, a 2015 study with 568 children in Grades 3–6 found children averaged 32 min of MVPA across the school day. However, neither of these studies reported the proportion of children meeting the recommended 30 min. Children's physical activity in school break times is also low. For example, a 2016 systematic review of MVPA during break time (24 studies, 5778 primary school children) revealed a weighted mean of 12 min of MVPA during school break time (Reilly et al., 2016). A study published after the review found children averaged only 4.5 min of MVPA during the recess and lunch breaks (Sutherland et al., 2017).

Of concern, this gap between physical activity recommendations and children's actual engagement in MVPA at school, may be more pronounced for girls compared to boys, especially as they approach adolescence. (Telford et al., 2016; Baquet et al., 2014; Grao-Cruces et al., 2019). For example, a 2016 U.S study with 323 Grade 1–3 children reported an average of 27.3 min and 23.5 min of MVPA accumulated across the school day for boys and girls respectively, with only 36.5% of boys and 16.3% of girls meeting the 30 min of MVPA per day guideline (Weaver et al., 2016). A 2017 study with 186 primary school children aged nine to ten years from seven schools in England, found that average school day MVPA was 20.9 min for boys and 14.3 min for girls (Taylor et al., 2017). In school break times, a 2013 study of 76 children aged 6–11 across six schools in the Netherlands found that 43% of boys and only 11% of girls met the break time MVPA guideline (Dessing et al., 2013).

While these studies provide insight into children's physical activity levels at primary school, we could not locate any studies that objectively measure activity levels of all primary school children (i.e., K-Grade 6) across the whole school day, and also include activity within break time and class time segments, by student sex. Such assessment would allow a more complete exploration of school day physical activity patterns of all children as well as exploration of the potential decline in school day MVPA as age increases.

Identifying the segments of the school day where opportunity exists to increase the amount or intensity of children's physical activity may assist schools to prioritise programs for implementation. Furthermore, identifying if children's activity in these segments differs by Grade or sex may help identify how future interventions could be tailored to support those at higher risk of reduced MVPA. Therefore, this study aimed to quantify, and examine grade level (Grade Kindergarten-2 vs. 3–6) and sex differences in the daily minutes of moderate-to-vigorous physical activity (MVPA) of primary school children, and the proportion of children meeting MVPA recommendations, across the school day and in break times.

2. Methods

2.1. Ethics

Approval to conduct this study was obtained from the Hunter New England (HNE) Human Research Ethics Committee (no. 06/07/26/4.04), Maitland-Newcastle Catholic Schools' Office (approved 31st October 2016) and University of Newcastle (no. H-2008-0343) Human

Research Ethics Committees.

2.2. Design and setting

This study is secondary data analysis of baseline data collected during a cluster randomized controlled trial (Nathan et al., 2020). The trial included students in Kindergarten (K) to Grade 6, from 12 Catholic schools located in the HNE region of New South Wales (NSW), Australia. Baseline data collection occurred from February to April 2017.

2.3. Participants and recruitment

All Catholic primary schools (catering for children aged 5–12 years) located in the HNE region were identified from the Catholic schools office. Schools were ineligible to participate if they were: central schools (catering for children aged 5–18 years), special purpose schools (catering for children with special needs) or participating in another physical activity intervention, resulting in 20 schools being invited to participate. Principals of all eligible schools were mailed an information letter overviewing the purpose of the study and asked to provide written consent to participate. Following principal consent all students in Grades K-6 were provided a parent information pack explaining the purpose of the study, data collection procedures and included a consent form, which parents were asked to return to their school for collection by the research team.

2.4. Data collection and measures

Child and school demographics- Parents were asked to report their child's sex, age, Grade and postcode via the consent form.

Children's in-school hours physical activity - Student's school day physical activity was assessed via wrist-worn accelerometer (Actigraph GT3X + and GT9X), which they wore for five school days during school hours only (generally between 9am and 3 pm). Details on the procedures used to administer and score the accelerometers are outlined elsewhere (Nathan et al., 2020). Valid student data was classified as at least 3 days wear time at 80% per day. Raw accelerometer counts were processed and Chandler cut-point applied to categorize the levels of physical activity intensity (Crouter et al., 2015). Student levels of MVPA were calculated by summing together moderate and vigorous intensities. The Chandler cut points have been recommended in children for use on the non-dominant wrist (Migueles et al., 2017). Three school day segments were recorded based on school bell times: whole school day (i.e. first and last bell of the day), class time (whole school day minus break time) and break time (i.e. lunch and recess breaks).

2.5. Data analysis

Analyses were performed in SAS version 9.3 (SAS Institute Inc., Cary, NC). School postcode was used to classify schools as 'urban' (major cities) or 'rural' (inner/outer regional/remote) using the Australian Statistical Geography Standard (ASGS) (Statistics AB. [Frequently Asked Questions](#), 2010). The NSW median disadvantage score, from the Socio-Economic Indexes for Australia (SEIFA), was used to dichotomise school postcodes into 'higher' (upper 50%) and 'lower' (lower 50%) socio-economic regions in NSW (Statistics AB, 2016). Descriptive statistics, including means and standard deviations (SD) for continuous variables, and frequencies and percentages for categorical variables, were used to describe study outcomes by Grade and sex, for MVPA across the whole school day, during class time and break time.

Linear mixed regression analyses were used to compare minutes of MVPA spent in each of the school day segments (i.e., whole day, class time and break time) between students in Grade K-2 to Grade 3–6. Results are presented as mean difference with 95% CIs and corresponding p-values. Generalised linear mixed models, with a binomial distribution and a logit link function, was used to compare the proportion of Grade K-

2 vs. Grade 3–6 students meeting physical activity guidelines, that is > 30 min of MVPA at school and > 40% of recess and lunch time in MVPA. The percentage of time students engaged in MVPA during the school day and during break times was determined by dividing the average time spent in MVPA for each segment by total available time per school day. Results from these models are expressed as an odds ratio with 95% Confidence Intervals (CI) and corresponding *p*-values. All models included a random intercept for school, and a random intercept for student nested within school to account for the multiple days (up to 5) of accelerometer data taken on students, as all available data (i.e. day-by-day) were included in the analysis. All models were adjusted for SEIFA and rurality. A grade by sex interaction term was included in all models as a fixed effect to assess the differential effects by sex, and the estimate statement used to calculate differences by sex and grade. As this was an exploratory descriptive study we did not rely on statistical significance to determine whether results were presented, but instead presented all results from this analysis. Observations with missing data on the specified covariates were excluded via listwise deletion. Results were considered statistically significant when *P* < 0.05.

3. Results

3.1. Participant characteristics

Of 3772 eligible students, 2142 (56.8%) had parental consent to participate and wore an accelerometer. Of these, 1862 (86.9% of consenting students) provided valid accelerometer data and were included in the analysis (Table 1). Of these, 909 (49.5%) students were female, and the mean age was 8 (2.04) years. A total of 814 students were in Kindergarten to Grade 2, including 421 males and 377 females; and 1048 (56.3%) were in Grade 3 to Grade 6, including 508 males and 532 females. (Table 1). The characteristics of students with and without valid data are shown in Table 1, illustrating a similar demographic profile between the two groups, except for rurality, with a larger percentage of students without valid data from rural areas compared to those with valid data. The average minutes of class time and break time equates to 290 min and 70 min per day respectively.

3.2. Mean minutes of MVPA accumulated across the whole school day

Overall, students spent 34.54 (SD 12.5) minutes of the school day in MVPA. On average students in Grade K-2 spent 4.33 min (95% CI: 3.36; 5.30, *p* < 0.001) more in MVPA than Grade 3–6 students (Table 2). Males on average, spent 5.29 min (95% CI: 4.34; 6.25, *p* = 0.001) more

Table 1
Student demographic characteristics.

Student demographic characteristics Characteristic	Total (n) students with valid data	Total (n) students without valid data
Total students	<i>n</i> = 1862	<i>n</i> = 286
Age, mean (sd)	8 (2.04)	8.02 (2.03)
Sex, n (%) female	909 (49.5%)*	147 (52.3%) ^a
School category, n (%)		
Grade K-2 (ages 5–8)	814 (43.7%)	117 (40.9%)
Grade 3–6 (ages 8–12)	1048 (56.3%)	169 (59%)
Rurality, n (%)		
Rural	344 (18.5%)	98 (34.3%)
Urban	1518 (81.5%)	188 (65.7%)
Socio-Economic Indexes for Areas (SEIFA), n (%)		
Lower (50% most disadvantaged postcodes in NSW [ABS 2016])	579 (31.1%)	86 (30.1%)
Upper (50% least disadvantaged postcodes in NSW [ABS 2016])		

*24 students had missing sex data

^a 5 students had missing sex data

time in MVPA than females (Table 3). Grade K-2 males spent more time in MVPA across the school day than Grade K-2 females; as did males in Grade 3–6 (Table 3).

3.3. Proportion of students meeting the recommended MVPA guidelines across the whole school day

Sixty-one percent of all students met the recommended 30 min of MVPA during the school day. By Grade level, 69.7% of Grade K-2 students met these guidelines compared to 54.1% of Grade 3–6 students, with the odds of K-2 students meeting these guidelines 2.15 times (95% CI: 1.81; 2.55, *p* < 0.001) higher than Grade 3–6 students (Table 2). When stratified by sex 68.9 of males met these guidelines compared to 52.4% of females, with males having 1.95 times (95% CI: 1.38; 2.74, *p* = 0.001) the odds of meeting these guidelines than females (Table 2). Grade K-2 males had higher odds of meeting the recommended guidelines than Grade 3–6 males. Similarly, Grade K-2 females were more likely to meet the recommended guidelines than Grade 3–6 females (Table 2). Males reported higher odds of meeting the recommended 30 min of MVPA across the school day compared to females for students in both Grades K-2 and Grades 3–6 (Table 3).

3.4. Mean minutes of MVPA per day accumulated during class time

When examining class time only, students spent on average 18.7 (8.2) minutes in MVPA. Grade K-2 students spent significantly more time in MVPA than Grade 3–6 students (3.10 min, 95% CI: 2.51; 3.69, *p* < 0.001) (Table 2). Males in Grade K-2 had higher mean MVPA levels during class time than males in Grade 3–6. Grade K-2 females spent longer in MVPA during class time than Grade 3–6 females. Additionally, a non-significant difference was observed between Grade K-2 male and Grade K-2 female class time MVPA (Table 3). However, Grade 3–6 males spent significantly more time in MVPA during class time than Grade 3–6 females.

3.5. Mean minutes of MVPA accumulated during break time

Overall, students accumulated 15.88 (7.4) minutes of MVPA during break times. Grade K-2 and Grade 3–6 students accumulated 16.6 min (7.12) and 15.3 min (7.57) of MVPA respectively during school break time (*p* < 0.001). (Table 2). When stratified by sex, females in Grade K-2 had higher mean MVPA levels during breaks than females in Grade 3–6 (*p* < 0.001), but for males there was no significant difference between Grade K-2 and Grade 3–6 (Table 2). Grade K-2 males spent more time in MVPA during break time than Grade K-2 females; as did males in Grade 3–6 (Table 3).

3.6. Proportion of students meeting the recommended MVPA guidelines during break time

Collectively, 3.8% of students met break time guidelines, spending at least 40% of break time in MVPA. By grade, 4.24% of Grade K-2 s and 3.52% of Grade 3–6 students met the 40% MVPA break time guidelines, with the odds of Grade K-2 students meeting the guidelines not significantly higher than Grade 3–6 students overall, for males or females (Table 2). By sex, 6.43% of males and 0.98% of females met these guidelines, with the odds of males meeting these guidelines 6.11 times (95% CI: 4.01; 9.30, *p* < 0.001) higher than females. (Table 3) Male students in Grade K-2 had higher odds of meeting these guidelines than female students in Grade K-2. Consistently, the odds of males in Grade 3–6 meeting the break time guidelines were higher than Grade 3–6 females (Table 3).

4. Discussion

To our knowledge this is the largest study to objectively measure

Table 2
Differences in physical activity across the school day between Grade K-2 s and Grade 3–6 students.

Monitoring period	Physical activity intensity or guideline ^a	Sex ^b	Grade K-2 mean minutes (SD)	Grade 3–6 mean minutes (SD)	Mean difference or odds ratio (95%CI)*	p-value	Differential effect or odds ratio (95%CI)*	p-value
Whole school day	MVPA	Males	38.5 (12.99) N = 421	35.9 (12.63) N = 508	-2.58 [-3.89;-1.27]	0.001	3.04	0.004
		Females	35.2 (11.3) N = 377	29.4 (10.85) N = 532	-5.62 [-6.96;-4.29]	<0.001	[1.17 ; 4.92]	
		Total	37.02 (12.39) N = 814	32.6 (12.19) N = 1048	4.33 [3.36;5.30]	<0.001		
	% meeting 30 min guidelines	Males	72.9%	65.6%	OR:0.67 [0.53;0.86]	0.004	OR:1.95	0.001
		Females	65.6%	43.1%	OR:0.35 [0.27;0.44]	<0.001	[1.38 ; 2.74]	
		Total	69.7%	54.1%	OR:2.15 [1.81;2.55]	<0.001		
Class time	MVPA	Males	20.4 (8.73)	18.4 (8.24)	-2.06 [-2.88;-1.23]	<0.001	1.96	0.004
		Females	20.3 (8.01)	16.3 (7.27)	-4.01 [-4.86;-3.17]	<0.001	[0.78 ; 3.14]	
		Total	20.4 (8.38)	17.3 (7.84)	3.10 [2.51;3.69]	<0.001		
Break time	MVPA	Males	18.1 (7.64)	17.6 (8.03)	-0.53 [-1.27;0.22]	0.15	1.08	0.045
		Females	14.8 (5.99)	13.1 (6.40)	-1.61 [-2.37;-0.86]	<0.001	[0.03 ; 2.14]	
		Total	16.6 (7.12)	15.3 (7.57)	1.23 [0.67;1.80]	<0.001		
	% meeting 40% guidelines	Males	6.77%	6.17%	OR:0.86 [0.59;1.25]	0.39	OR: 0.78	0.53
		Females	0.89%	1.04%	OR:1.10 [0.51;2.39]	0.79	[0.33 ; 1.83]	
		Total	4.24%	3.52%	OR:1.22 [0.05;0.78]	0.19		

*Differences between Grade K-2 and Grade 3–6 students expressed as either mean difference or odds ratio (95%CI).

^a Time spent in physical activity for Grade K-2 and Grade 3–6 students is listed as means (SD); students meeting guidelines expressed as %.

^b There were 24 students of which sex could not be determined.

Table 3
Differences in MVPA across the school day between males and females.

Monitoring period	Physical activity intensity or guideline ^a	School stage	Males ^b	Females ^b	Mean difference or odds ratio (95%CI)*	p-value
Whole school day	MVPA	Grade K-2	38.5 (12.99)	35.2 (11.30)	3.43 [2.02;4.85]	<0.001
		Grade 3–6	35.9 (12.63)	29.4 (10.85)	6.48 [5.25;7.71]	<0.001
		All	37.1 (12.85)	31.8 (11.39)	5.29 [4.34;6.25]	<0.001
	% meeting 30 min guidelines	Grade K-2	72.9%	65.6%	OR:1.51 [1.16;1.96]	0.005
		Grade 3–6	65.6%	43.1%	OR:2.93 [2.35;3.66]	<0.001
		All	68.9%	52.4%	OR:2.28 [1.92;2.70]	<0.001
Class time	MVPA	Grade K-2	20.4 (8.73)	20.3 (8.01)	0.18 [-0.72;1.07]	0.67
		Grade 3–6	18.4 (8.24)	16.3 (7.27)	2.13 [1.36;2.91]	<0.001
		All	19.3 (8.52)	17.9 (7.84)	1.40 [0.79;2.01]	<0.001
Break time	MVPA	Grade K-2	18.1 (7.64)	14.8 (5.99)	3.25 [2.45;4.05]	<0.001
		Grade 3–6	17.6 (8.03)	13.1 (6.40)	4.34 [3.64;5.03]	<0.001
		All	17.8 (7.86)	13.8 (6.29)	3.89 [3.36;4.42]	<0.001
	% meeting 40% guidelines	Grade K-2	6.77%	0.89%	OR:7.09 [3.65;13.78]	<0.001
		Grade 3–6	6.17%	1.04%	OR 5.51 [3.19;9.52]	<0.001
		All	6.43%	0.98%	OR 6.11 [4.01;9.30]	<0.001

Note: the differential effect, odds ratios and corresponding p-values within [Table 3](#) are identical to those mentioned in [Table 2](#) therefore are only reported in the previous table..

*Differences between male and female students expressed as either mean difference or odds ratio (95%CI).

^a Time spent in physical activity for males and females is listed as means (SD); students meeting guidelines expressed as %.

^b There were 24 students of which sex could not be determined.

student MVPA across a range of segments of the school day and across all Grade levels of primary school. The study found a significant decline in mean minutes of MVPA across the school day from Grade K-2 to Grade 3–6 across all children and for both sexes. Mean activity levels in girls were consistently lower than in boys across all the whole school-day and within class time and break time segments for Grades 3–6, while for Grades K-2 girls were less active across the whole day and within breaks, but not within class time.

Our study found a substantial proportion of children were not meeting the recommended guidelines of 30 min of MVPA during the school day. This is consistent with other studies that have explored school day MVPA ([Weaver et al., 2016](#); [Taylor et al., 2017](#); [Hubbard](#)

[et al., 2016](#); [Grao-Cruces et al., 2019](#); [Cohen et al., 2015](#)). Our result of declining school day activity with age is also aligned with previous studies, which show declines in whole day physical activity from the age of eight ([Telford et al., 2016](#)) or even earlier ([Cooper et al., 2015](#)) ([Farooq et al., 2018](#)). The Australian Institute of Health and Welfare reports Australian children meeting daily recommended guidelines of 60 min per day declines from 61% of 2–5 year olds to 26% of 5–12 year olds to 7.9% of 13–17 year olds ([Welfare, 0000](#)). These findings suggest that strategies to prevent this decline may need to be implemented in the earlier years. Whilst our study showed a decline in both boys and girls MVPA between Grade K-2 and Grade 3–6, the decline for girls was larger by approximately 3 min. Given physical activity patterns track into

adulthood such results suggest efforts need to be directed to engage not only older children, but particularly upper primary school girls in more physical activity across the school day if we are to prevent this steady decline. Teachers may need to consider activities that are particularly appealing to girls and implement strategies that have been shown to give girls autonomy in their activity selections (Nathan et al., 2020).

Sport and Physical Education (PE) are considered major contributors to school day physical activity. On average children in this study spent between 16.3 min (Grade 3–6 girls), and 20.4 min (Grade K-2 boys and girls) in MVPA during class time. While our study did not assess whether the school day included sport or PE, systematic review evidence suggests that even on days when PE occurs, the total student physical activity still doesn't reflect the recommended 30 min guidelines per day (Lonsdale et al., 2013). Physical Education in the Grade 3–6 school setting is often deprioritised and time devoted to this key learning area is declining (Telford et al., 2013; Marshall and Hardman, 2000). This is perhaps due to barriers to teaching PE and sport, including insufficient time, limited skills and poor availability of equipment (Nathan et al., 2018). The development of additional physical activity options that are implemented as well as PE and sport, that are easy for teachers and appropriate for both sexes could contribute to increases in school day physical activity. One idea is the use of classroom energisers, short physically active breaks from learning, which can potentially contribute to overall physical activity levels while at school for both sexes and across Grades K-6 equally (Calvert et al., 2018) whilst also overcoming the known teacher barriers to teaching PE and sport (Nathan et al., 2018).

Consistent with previous research (Taylor et al., 2017; Reilly et al., 2016; Sutherland et al., 2017; Dessing et al., 2013) our study found that children are not accumulating enough physical activity during break times, with only 4% of all children meeting the recommended guideline of 40% MVPA. There was not a significant decline between Grades K-2 and Grades 3–6 in the proportion of either boys or girls meeting this recommendation, with consistently very low proportions among Grades K-2, Grades 3–6 and both sexes. However, there were significant differences in mean minutes of break time MVPA by sex. Boys had higher mean minutes of break time MVPA than girls within Grades K-2 and Grades 3–6 and the differential decline between sexes was significant. The differences found in this study between boys and girls are also consistent with previous findings, with a 2012 systematic review confirming that boys are more active than girls during break time (Ridgers et al., 2012). Whilst systematic reviews have found that schools' implementation of simple initiatives such as playground markings or the provision of sports equipment can significantly increase children's MVPA during recess and lunch (Ridgers et al., 2012), evidence suggests that such strategies are already occurring at schools (Nathan et al., 2015). Therefore supporting schools to implement additional low cost, scalable strategies during break times where children have the opportunity to be active may be needed. On average, a school may have 70–80 min allocated to break times throughout the school day, however Grade 3–6 girls in particular only record an average of 13 min of MVPA during combined break times and <1% of these girls are meeting the break time guidelines. The differential levels of activity for boys and girls during break times suggests that other initiatives may need to be considered for girls. There is emerging evidence to suggest that girls' uniforms, which require them to wear tunics or skirts, may contribute to their inactivity at school. Having the opportunity to wear an activity friendly uniform every day may encourage increased participation in physical activity throughout the day (Watson et al., 2015; Norrish et al., 2012).

The findings should be considered in the context of some limitations. The generalisability of the results maybe limited as the trial was only conducted in one region of NSW Australia and only in Catholic schools. Furthermore, estimates of MVPA may only be comparable to studies using similar accelerometer cut-points, as research suggests that use of different cut points can yield different estimates of physical activity (Guinhouya et al., 2006). We Selected Chandler cut points based on their widely recommended use in this age group and therefore any form of

bias would be similar across the full data set (Migueles et al., 2017). Wrist worn accelerometers were chosen due to the high compliance rate with children (Scott et al., 2017) however it is important to note that wrist worn accelerometers have potential to over report physical activity levels compared to hip worn (Tudor-Locke et al., 2015). The study also has a number of strengths, including its large sample size, the inclusion of children across the seven years of primary school in Australia (K-6), and the objective measure of physical activity. The study also has a comprehensive analysis of whole school day, class time and break time segments to allow a complete picture of activity at school.

5. Conclusion

This study highlights that a large percentage of students are not meeting physical activity guidelines whilst at primary school. It also suggests a decline in physical activity from Grade K-2 to Grade 3–6, especially in girls. Results reinforcing the need for policy and practice initiatives to prevent the decline in class time and break time MVPA, especially in girls is needed.

Conflict of interest and funding

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CRediT authorship contribution statement

Nicole McCarthy: Conceptualization, Methodology, Writing - review & editing. **Alix Hall:** Writing - review & editing, Data curation. **Adam Shoosmith:** Writing - review & editing. **Rachel Sutherland:** Writing - review & editing. **Rebecca Hodder:** Writing - review & editing. **Elizabeth Campbell:** Writing - review & editing. **Nicole Nathan:** Conceptualization, Methodology, Writing - review & editing.

Declaration of Competing Interest

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

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