PHYSICAL ACTIVITY PREVALENCE IN AUSTRALIAN CHILDREN AND ADOLESCENTS: WHY DO DIFFERENT SURVEYS PROVIDE SO DIFFERENT ESTIMATES, AND WHAT CAN WE DO ABOUT IT?

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Abstract:

To illustrate how the differences in measurement protocols affect physical activity (PA) monitoring among Australian children and adolescents aged ~5-17 years, this review aimed to summarize and critically assess the most recent findings from the national and state or territory health surveillance systems and population surveys. We compared methods and results of 21 population surveys identified in an extensive web-based search conducted using the entries 'Physical Activity', 'Surveillance', 'Monitoring', 'Survey', 'Australia' and the names of Australian states and territories as keywords. A large variability between PA prevalence rates from different Australian national- and state-level surveys was observed, both for self-reported and pedometer-based estimates. The prevalence estimates tended to be: [i] higher among children when compared with adolescents; [ii] higher for boys than for girls when assessed using self-reports; and [iii] higher for girls than for boys when assessed using pedometers. The true prevalence of compliance with PA guidelines among children and adolescents in Australia seems to be difficult to determine. To ensure comparability of prevalence estimates, key elements of data collection and processing protocols, such as PA questionnaires, survey administration modes, survey time frames, and definitions of a 'sufficient' PA level, should be standardised throughout all PA surveillance systems and population surveys in Australia.

Key words: *motor activity, sedentary lifestyle, child, adolescent, surveillance*

Introduction

Regular physical activity (PA) in childhood and adolescence is associated with a number of health benefits (Janssen & LeBlanc, 2010). It may lead to improvements in health status at a young age, and influence adult health either directly via long-term biological changes and adaptations, or indirectly due to behavioural carry-over into adulthood (Boreham & Riddoch, 2001; Hallal, Victora, Azevedo, & Wells, 2006; Hirvensalo & Lintunen, 2011). To gain these benefits, current Australian PA guidelines recommend children and adolescents aged 5-17 years to participate in at least 60 minutes of moderate-to-vigorous PA daily (Department of Health, 2014). Population-representative estimates of the prevalence of children and adolescents meeting the PA recommendations are essential for informing policy makers and public health stakeholders, monitoring populations at risk, and providing information on the impact of PA promotion strategies over the long term.

Collecting PA data using standardised and comparable measures is essential to population monitoring (World Health Organization, 2004). While there have been attempts to encourage a standardised PA assessment among Australian children and adolescents, this seems to have achieved little success (Australasian Child & Adolescent

Obesity Research Network, ACAORN, 2013; Dollman, et al., 2009). Subsequently, due to large differences in measurement protocols, the comparability of PA estimates from different health surveillance systems and population surveys is questionable. Inconsistencies in reporting against defined PA benchmarks may cause confusion in the general community and media, which has the potential to undermine the credibility of public health messages.

To illustrate how the differences in measurement protocols affect PA monitoring among children and adolescents aged ~5-17 years in Australia, in this review we aimed to summarize and critically assess the most recent findings from the national and state or territory health surveillance systems and population surveys.

Methods

As a starting point, we examined 11 Australian surveillance systems previously reviewed by Bauman, Chau, Van Der Ploeg, and Hardy (2010). This was followed by an extensive web-based search using the following keywords: 'Physical Activity'; 'Surveillance'; 'Monitoring'; 'Survey'; 'Australia'; 'Australian Capital Territory'; 'New South Wales'; 'Northern Territory'; 'Queensland'; 'South Australia'; 'Tasmania'; 'Victoria'; and 'Western Australia'. The search was primarily focused on the latest survey waves of health surveillance systems that regularly repeat their data collection. However, if no such system could be found for a state or territory, we selected their most recent population-representative survey. Our review relied on publicly available reports that can be found on the Internet, as they are the main source of information for public health stakeholders and general public. The search results were screened for relevance by two authors (AZ and ZP) independently and any disagreements were resolved in a discussion with a third investigator (AB).

Inconsistencies in questionnaire-based PA estimates from different surveys

We identified in total 21 population surveys conducted from 2004 to 2015 (Table 1). Australian national- and state-level data on PA among children and adolescents were collected using a variety of different self- or proxy- reports. Single-item questionnaires were the most commonly used measure. However, despite the well-known fact that even slight changes in the questionnaire design may affect data comparability, only few surveys used the same exact wording of the PA question. Furthermore, the most common data collection method was telephone interviews (40%), followed by paper-based questionnaires (30%), face-to-face interviews (15%), and different computer-based questionnaires (15%). It is important to note that each of these survey administration modes may bias participants' responses in a characteristic way (Bowling, 2005); hence potentially adding to the overall variability between PA estimates from different surveys. Furthermore, some of the reviewed surveys collected their data over a whole year, while other aimed at a specific season; e.g. winter and summer term in the *NSW Schools Physical Activity and Nutrition Survey, 2010* (Hardy, King, Espinel, Cosgrove, & Bauman, 2011). This difference in data collection time frames may also affect comparability of PA prevalence estimates across surveys, as PA levels may show seasonal patterns (Peiró-Velert, Devís-Devís, Beltrán-Carrillo, & Fox, 2008). The reviewed surveys also used very different criteria to assess whether participants met PA recommendations. In addition to the standard criterion of "≥60 minutes of moderate-to-vigorous PA on every day", the following definitions were also used: "≥5 PA sessions/week"; "≥60 minutes of any PA outside of school hours on every day"; "≥60 minutes of any PA (regardless of intensity) on every day"; and "≥7 sessions/week of moderate-to-vigorous PA with the duration longer than 60 minutes/session".

Consequently, large differences can be observed between PA prevalence estimates from different Australian national- and state-level surveys (Figure 1). In the *Australian Health Survey 2011/12*, the questionnaire-based prevalence estimates of children and adolescents meeting PA recommendations have shown relatively little variation between different states; ranging from 26.1% for New South Wales to 37.1% for the Northern Territory (Australian Bureau of Statistics, 2013b). By contrast, there was considerably greater variability in prevalence rates from independent state-level surveys, with estimates varying between 26.0% in the *Victorian Student Health and Wellbeing Survey, 2014* (Department of Education and Training, 2015a) and 63.0% in the *Northern Territory Child Health and Wellbeing Survey, 2004* (Carson, Guthridge, Li, & Measey, 2006). Moreover, even surveys from the same state reported vastly different prevalence estimates. For example, the percentage of ~5-7 year old girls meeting PA guidelines was estimated to be 6.3% in the *Healthy Kids Queensland Survey, 2006* (Abbott, et al., 2008) and 62.0% in the *Queensland Child Health Status survey, 2011* (Queensland Health, 2011). Similarly, the prevalence of ~15-17 year old boys meeting PA guidelines was estimated to be 17.9% in the *New South Wales School Students Health Behaviours Survey, 2014* (Centre for Epidemiology and Evidence, 2016b) and 68.2% in the *NSW Schools Physical Activity and Nutrition Survey, 2010* (summer term) (Hardy, et al., 2011).

To ensure the comparability of prevalence estimates, key elements of data collection and processing protocols, such as PA questionnaires, survey administration modes, survey time frames,

Table 1. Summary of Australian national- and state-level population surveys reporting prevalence of physical activity among children and adolescents

Source	Sample	Data collection method	PA measure	Definition of 'meeting PA recommendations'	% meeting PA recommendations
Australian Aboriginal and Torres Strait Islander Health Survey (AATSIHS), 2012-13 (Australian Bureau of Statistics, 2013a)	4,790 indigenous children and adolescents / age 2-17 years	face-to-face interview (age 2-8: proxy reports, age 9-14: personal interview assisted by proxy, age 15-17: personal interview / pedometer	In non-remote areas: Questionnaire 1: A set of questions about the time spent in specific types of moderate-to-vigorous physical activities and active transport over the last 3 days. Questionnaire 2: A single-item from the Health-Behaviour in School Children (HBSC) survey adapted from Prochaska et al. (2001) PA questionnaire Pedometers (G sensor accelerometer pedometer model 2026) worn at the waist for at least four days including a minimum of one week and one weekend day (no minimum threshold for wearing time/ day). In remote areas: A set of questions about the time spent in specific types of exercise, sports, household chores, walking, and other physical activity on the day before the interview.	For questionnaire-based estimates: In non-remote areas: Participation in ≥60 minutes of moderate-to-vigorous physical activity every day In remote areas: Participation in ≥60 minutes of moderate-to-vigorous physical activity on the day before the interview Thresholds for pedometer estimates: for girls ≥12,000 steps for boys ≥12,000 steps	Based on PA questionnaire 1: Age 5-17 years, living in non-remote areas F: 41.4%, M: 53.8%, All: 47.7% Age 5-8 years All: 63.9% Age 9-11 years All: 52.6% Age 12-14 years All: 42.9% Age 15-17 years All: 25.2% Age 5-17 years, living in remote areas F: 79.0%, M: 84.2%, All: 81.7% Age 5-8 years All: 86.0% Age 9-11 years All: 87.0% Age 12-14 years All: 83.8% Age 15-17 years All: 66.0% Based on pedometers: Age 5-17 years, living in non-remote areas All: 25.0%
Australian National Children's Nutrition and Physical Activity Survey (ANCNPAS), 2007 (Commonwealth Scientific Industrial Research Organisation (CSIRO), Preventative Health National Research Flagship, & & University of South Australia, 2008)	4,487 Australian children and adolescents / age 2-16 years	face-to-face interview / pedometer	Age 9-16 years: Multimedia Activity Recall for Children and Adolescents (Ridley, Olds, & Hill, 2006) (48 hours recall) Age 5-16 years: pedometers (New Lifestyles NL 1000) worn at mid-thigh for at least six days with <4 hours of non-wearing time during waking hours.	For questionnaire-based estimates: Participation in ≥60 minutes of moderate-to-vigorous physical activity every day For pedometer estimates: Threshold 1 (T1) for girls ≥11,000 steps for boys ≥13,000 steps Threshold 2 (T2) for girls ≥12,000 steps for boys ≥15,000 steps	Based on PA recalls: Age 9-13 years F: 33.0%, M: 46.0%, All: 40.0% Age 14-16 years F: 13.0%, M: 25.0%, All: 19.0% Based on pedometers: Age 5-8 years T1: F: 66.0%, M: 55.0% T2: F: 50.0%, M: 32.0% Age 9-13 years T1: F: 49.0%, M: 46.0% T2: F: 33.0%, M: 24.0% Age 14-16 years T1: F: 26.0%, M: 26.0% T2: F: 16.0%, M: 13.0%
ACT Year 6 Physical Activity and Nutrition Survey (ACTPANS), 2009 (Epidemiology Branch, Population Health Division, & Health Directorate, 2012)	1,374 Australian Capital Territory year 6 primary school students / age 10-13 years	written questionnaire (self-report)	PA items: 1) "Over the past 7 days on how many days were you physically active for a total of at least 60 minutes per day?" and 2) "Over a typical week on how many days are you physically active for a total of at least 60 minutes per day?"	Participation in ≥60 minutes of moderate-to-vigorous physical activity every day	Total sample F: 16.3%, M: 29.2%, All: 22.6%

Australian Health Survey / National Nutrition and Physical Activity Survey (NNPAS), 2011/12 (Australian Bureau of Statistics, 2013b, 2013c)	2,718 Australian children and adolescents / age 2-17 years	face-to-face interview (age 2-8: proxy reports, age 9-14: personal interview assisted by proxy, age 15-17: personal interview) / pedometer	Age 5-17 years: Questionnaire 1: A set of questions about the time spent in specific types of moderate-to-vigorous physical activities and active transport over the last 7 days Questionnaire 2: A single-item from the Health-Behaviour in School Children (HBSC) survey adapted from Prochaska et al. (2001) PA questionnaire Pedometers (G sensor accelerometer pedometer model 2026) worn at the waist for at least four days including a minimum of one week and one weekend day with no minimum threshold for wearing time/day (Threshold 1: for girls ≥11,000 steps; for boys ≥13,000 steps | Threshold 2: ≥12,000 steps for both sexes)	For questionnaire-based estimates: Participation in ≥60 minutes of moderate-to-vigorous physical activity every day For pedometer estimates: Threshold 1 (T1) for girls ≥11,000 steps for boys ≥13,000 steps Threshold 2 (T2) for girls ≥12,000 steps for boys ≥12,000 steps	Based on PA questionnaire 1: Total sample F: 28.3%, M: 31.0%, All: 29.7% Age 5-8 years F: 35.4%, M: 36.0%, All: 35.7% Age 9-11 years F: 19.8%, M: 22.3%, All: 21.1% Age 12-14 years F: 8.6%, M: 12.5%, All: 10.6% Age 15-17 years F: 6.2%, M: 5.4%, All: 5.8% All age groups – by state/territories NSW: 26.1%, VIC: 26.1%, QLD: 35.1%, SA: 35.4%, WA: 32.5%, TAS: 33.5%, NT: 37.1%, ACT: 31.2% Based on pedometers: Total sample T1: F: 17.2%, M: 18.6%, All: 17.9% T2: F: 8.4%, M: 24.5%, All: 16.5% Age 5-8 years T1: All: 28.5% T2: All: 21.7% Age 9-11 years T1: All: 25.4% T2: All: 24.4% Age 12-14 years T1: All: 13.2% T2: All: 12.6% Age 15-17 years T1: All: 4.8% T2: All: 7.1% All age groups – by state/territories (T1) NSW: 17.5%, VIC: 19.6%, QLD: 20.7%, SA: 11.0%, WA: 18.6%, TAS: 9.7%, NT: 18.2%, ACT: 17.4%
Child and Adolescent Physical Activity and Nutrition Survey (CAPANS), 2008 (Martin et al., 2008)	1,827 Western Australian primary and secondary school students / year levels 3, 5, 7, 8, 10 and 11	written questionnaire (self-report) / pedometer	A single-item adapted from Prochaska et al. (2001) questionnaire about the number of days in the last seven days with ≥60 minutes of PA Pedometers (Yamax Digiwalker SW-700 or SW 200) worn over the right hip for at least four days	For questionnaire-based estimates: Participation in ≥60 minutes of moderate-to-vigorous physical activity every day Thresholds for pedometer estimates: for girls ≥12,000 steps for boys ≥15,000 steps	Based on PA questionnaire: Age 5-12 years F: 27.4%, M: 41.2%, All: 34.6% Age 12-18 years F: 10.1%, M: 37.6%, All: 23.8% Based on pedometers: Age 5-12 years F: 43.9%, M: 31.7%, All: 37.7% Age 12-18 years F: 36.8%, M: 41.2%, All: 38.8%
Exercise, Recreation and Sport Survey (ERASS), 2010 (Australian Sports Commission, 2011, 2012)	3,306 Australian children and adolescents / age 5-14 years	telephone interview (proxy report)	10-item questionnaire about the participation in structured and unstructured physical activities outside school hours in a typical week	Daily participation in any physical activity for exercise, recreation or sport (regardless of intensity) in a 'typical week' in the previous school term	Total sample F: 56.8%, M: 66.5%, All: 61.8% Age 5-7 years F: 55.5%, M: 64.5%, All: 60.1% Age 8-10 years F: 61.4%, M: 71.3%, All: 66.4% Age 11-12 years F: 64.4%, M: 68.8%, All: 66.7% Age 13-14 years F: 44.4%, M: 59.9%, All: 52.4%

Healthy Kids Queensland Survey (HKQS), 2006 (Abbott et al., 2008)	3,691 Queensland primary and secondary school students / year levels 1, 5 and 10	written questionnaire (self-report) / pedometer	A single-item: "How many of the past 7 days did you participate in sport, physical activity or active play which raised your heart beat and/or made you huff and puff for a total of at least 60 minutes (each day)?" Participants were asked to wear pedometers on the waist for 5 consecutive days	For questionnaire-based estimates: Participation in ≥60 minutes of moderate-to-vigorous physical activity every day Thresholds for pedometer estimates: for girls ≥12,000 steps for boys ≥15,000 steps	Based on PA questionnaire: Year 1 F: 6.3%, M: 16.5% Year 5 F: 9.5%, M: 11.7% Year 10 F: 4.8%, M: 12.5% Based on pedometers: Year 1 F: 42.0%, M: 27.0% Year 5 F: 53.0%, M: 40.0%
National Aboriginal and Torres Strait Islander Social Survey (NATSISS), 2014/15 (Australian Bureau of Statistics, 2016)	4,156 indigenous children and adolescents / age 0-14 years	face-to-face interview (proxy report)	A single-item about the number of days in the last week with at least 60 minutes of moderate-to-vigorous physical activity	Participation in ≥60 minutes of moderate-to-vigorous physical activity every day	Age 4-14 years All: 75.8%
National Secondary Students Diet & Physical Activity Survey (NASSDA), 2009/10 (Cancer Council Australia, 2013)	12,188 Australian secondary school students / year levels 8 to 11	web-based survey (self-report)	A single-item: "Over the past 7 days, on how many days were you physically active for a total of 60 minutes or more per day?" (Prochaska et al., 2001)	Participation in ≥60 minutes of moderate-to-vigorous physical activity every day	Total sample F: 8.3%, M: 21.8%, All: 15.4% Year 8 F: 10.4%, M: 24.1%, All: 17.6% Year 9 F: 9.5%, M:22.1%, All: 16.3% Year 10 F: 7.1%, M: 22.0%, All: 15.0% Year 11 F: 5.9%, M: 18.7%, All: 12.6%
New South Wales School Students Health Behaviours Survey (SSHBS), 2014 (Centre for Epidemiology and Evidence, 2016b)	5,125 New South Wales secondary school students / age 12-17 years	written questionnaire (self-report)	A single-item: "On how many days in the past week have you done any vigorous or moderate physical activity for a total of at least 60 minutes? (this could be made up of different activities during the day like cycling or walking to and from school, playing sport at lunchtime or after school, doing an exercise class, doing housework etc)"	Participation in ≥60 minutes of moderate-to-vigorous physical activity every day	Total sample F: 16.7%, M: 25.0%, All: 21.0% Age 12-15 years F: 20.4%, M: 28.1%, All: 24.4% Age 16-17 years F: 8.6%, M: 17.9%, All: 13.3%
Northern Territory Child Health and Wellbeing Survey (NTCHWS), 2004 (Carson, Guthridge, Li, & Measey, 2006)	2,000 Northern Territory children and adolescents / age 0-12 years	telephone interview (proxy report)	PA items: 1) "On how many of the past 7 days did [child] participate in physical activity for at least 30 minutes that did not make them sweat or breathe hard, such as fast walking, slow bicycling, rollerblading or skate boarding?" and 2) "On how many of the past 7 days did [child] exercise or participate in physical activity for at least 20 minutes that made them sweat and breathe hard, such as basketball, soccer, football, running, swimming laps, fast bicycling or netball?"	For moderate-intensity exercise: Participation in ≥30 minutes of moderate-intensity exercise on 5-7 days a week For vigorous-intensity exercise: Participation in ≥20 minutes of vigorous-intensity exercise on 5-7 days a week For indigenous persons: Participation in physical activity five or more sessions a week	Moderate-intensity exercise* F: 63.2%, M: 62.8%, All: 63.0% Age 5-8 years All: 64.4% Age 9-12 years All: 60.4% Vigorous-intensity exercise F: 44.1%, M: 52.8%, All: 48.8% Age 5-8 years All: 47.5% Age 9-12 years All: 52.8% Indigenous persons† All: 56.4%

NSW Population Health Survey (SAPHaRI) – Child Health, 2014/15 (Centre for Epidemiology and Evidence, 2016a)	2,572 New South Wales children / age 5-15 years	telephone interview (proxy report)	PA items: 1) "On about how many days during the school week does child usually do physical activity outside of school hours?"; 2) "On those days, about how many hours does child usually do physical activity?"; 3) "On about how many weekend days does child usually do physical activity?"; and 4) "On a typical weekend day, about how many hours does child usually do physical activity?"	Participation in ≥60 minutes of any physical activity outside of school hours every day	Total sample All: 28.2% Age 5-8 years All: 35.6% Age 9-15 years All: 23.7%
NSW Schools Physical Activity and Nutrition Survey (SPANS), 2010 (Hardy, King, Espinel, Cosgrove, & A., 2011)	8,058 New South Wales primary and secondary school students / age 5-17 years	years 2 and 4: written questionnaire (proxy report) years 6, 8 and 10: written questionnaire (self-report)	Years K, 2 and 4: Questions from the NSW Population Health Survey about frequency and duration of participation in organised games, sports and dance, and in non-organised physical activities outside of school hours in a usual week Years 6, 8 and 10: Adolescent Physical Activity Recall Questionnaire (APARQ) (about participation in non-organised physical activities, organised sports, games and other activities in a usual week) (Booth, Okely, Chey, & Bauman, 2002)	For Years 2 and 4: Participation in ≥60 minutes of any physical activity (regardless of intensity) every day For years 6, 8 and 10: Participation in ≥60 minutes of moderate-to-vigorous physical activity every day	Year 2 F: 41.7%, M: 52.3%, All: 47.1% Year 4 F: 42.1%, M: 54.5%, All: 48.6% Year 6 – summer school term F: 55.9%, M: 60.5%, All: 58.3% Year 6 – winter school term F: 39.2%, M: 50.2%, All: 45.0% Year 8 – summer school term F: 60.2%, M: 67.6%, All: 64.1% Year 8 – winter school term F: 43.3%, M: 56.8%, All: 50.5% Year 10 – summer school term F: 56.9%, M: 68.2%, All: 62.8% Year 10 – winter school term F: 47.5%, M: 60.5%, All: 54.3%
Queensland Child Health Status (CHS), 2011 (Queensland Health, 2011)	2,484 Queensland children and adolescents / age 5-17 years	telephone interview (proxy report)	A single-item about the number of days in the past seven days with ≥60 minutes of physical activity	Data not publicly available	Total sample F: 38.5%, M: 49.1%, All: 44.0% Age 5-7 years F: 62.0%, M: 62.1%, All: 62.1% Age 8-11 years F: 49.0%, M: 55.5%, All: 52.3% Age 12-15 years F: 22.4%, M: 41.3%, All: 32.1% Age 16-17 years F: 17.4%, M: 34.8%, All: 26.4%
South Australian Monitoring and Surveillance System (SAMSS), 2014/15 (Population Research and Outcome Studies, 2016)	1,235 South Australian children and adolescents / age 5-17 years	telephone interview (proxy report)	A single-item: "How many days in the past week, have [you/child] done any vigorous or moderate physical activity for a total of at least 60 minutes (this could be made up of different activities during the day like cycling or walking to and from school, playing sport at lunchtime or after school, doing an exercise class, doing household chores etc)?"	Participation in ≥60 minutes of moderate-to-vigorous physical activity every day	Total sample F: 32.9%, M: 36.0%, All: 34.5% Age 5-7 years All: 50.6% Age 8-11 years All: 45.4% Age 12-15 years All: 27.9% Age 16-17 years All: 14.5%

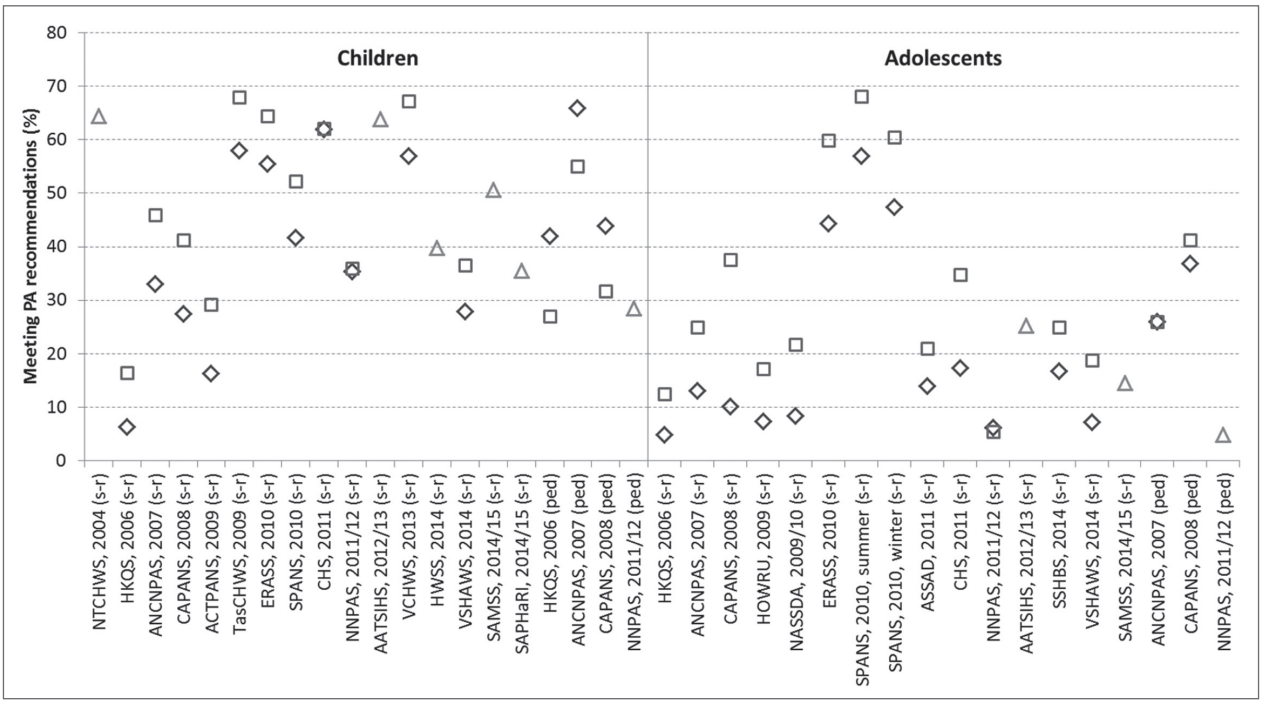
Tasmanian Child Health and Wellbeing Survey (TasCHWS), 2009 (The Social Research Centre, 2009)	770 Tasmanian children and adolescents / age 5-12 years	telephone interview (proxy report)	A single-item: "Over a typical week, on how many days is (child) physically active for a total of at least 60 minutes per day?"	Participation in ≥60 minutes of any physical activity (regardless of intensity) every day	Total sample F: 58.0%, M: 68.0%, All: 62.0% Age 5-10 years All: 67.0% Age 11-12 years All: 51.0%
Tasmanian component of the Australian Secondary Students' Alcohol and Drug Survey (ASSAD), 2011 (Skaczkowski, Bariola, & Balint, 2013)	1,779 Tasmanian secondary school students / age 12-17 years	written questionnaire (self-report)	A single-item: "How many days in the past week have you done any vigorous or moderate physical activity for a total of at least one hour?"	Participation in ≥60 minutes of moderate-to-vigorous physical activity every day	Total sample F: 14.0%, M: 21.0%, All: 17.0% Age 12-15 years F: 15.0%, M: 20.0%, All: 18.0% Age 16-17 years F: 10.0%, M: 23.0%, All: 17.0%
Victorian Adolescent Health and Wellbeing Survey (HOWRU), 2009 (Department of Education and Early Childhood Development, 2009)	10,000+ Victorian secondary school students / year levels 7, 9 and 11	computer-based survey (self-report)	Data not publicly available	Data not publicly available	Age 12-17 years F: 7.4%, M: 17.2%, All: 12.3%
Victorian Child Health and Wellbeing Survey (VCHWS), 2013 (Department of Education and Training, 2015b)	5,000+ Victorian children and adolescents / age 0-12 years	telephone interview (proxy report)	Data not publicly available	Data not publicly available	Age 5-12 years F: 57.0%, M: 67.2%, All: 62.2%
Victorian Student Health and Wellbeing Survey (VSHAWS), 2014 (Department of Education and Training, 2015a)	6,000 Victorian primary and secondary school students / year levels 5, 8 and 11	online survey (self-report)	Data not publicly available	Data not publicly available	Total sample F: 21.0%, M: 31.0%, All: 26.0% Year 5 F: 27.9%, M: 36.6%, All: 32.0% Year 8 F: 12.9%, M: 21.8%, All: 17.0% Year 11 F: 7.2%, M: 18.8%, All: 12.0%
WA Health & Wellbeing Surveillance System (HWSS), 2014 (Health Survey Unit – Epidemiology Branch, 2011; Tomlin, Radomiljac, & Kay, 2015)	657 Western Australian children and adolescents / age 0-15 years	telephone interview (proxy report)	PA questionnaire about the frequency and total duration of moderate and vigorous intensity physical activity in the past 7 days	Participation in 7 or more sessions a week of moderate-to-vigorous physical activity with the duration longer than 60 minutes per session	Age 5-15 years F: 40.3%, M: 39.8%, All: 40.1% Age 5-9 years All: 39.8% Age 10-15 years All: 40.3%

*Data available only for non-indigenous participants
†Data available only for indigenous participants

and definitions of a 'sufficient' PA level, should be standardised throughout all PA surveillance systems and population surveys in Australia.

Inconsistencies in pedometer-based PA estimates from different surveys

PA epidemiologists often advocate that motion sensors, such as accelerometers and pedometers, would facilitate standardisation of PA measurement. However, recent findings show that, due to a lack of standardised data collection and processing protocols, the use of such devices does not necessarily allow for useful between-study comparisons (Pedišić & Bauman, 2015). Moreover, high expense and administrative burden often preclude the use of motion sensors at a population level. Out of 21 reviewed Australian child and adolescent surveys, five (24%) used pedometers in addition to PA questionnaires. Pedometer measurement protocols, including [i] pedometer model, [ii] definitions of wear time, and [iii] placement of the device, differed between the surveys (Table 1). Previous studies have shown that these key components of pedometer measurement protocol may significantly affect



Legend: Children – primary school children (~5-12 years of age or the lowest age category where no overall data were available); Adolescents – secondary school children (~13-18 years of age or the highest age category where no overall data were available); diamond shape – girls; square shape – boys; triangle shape – both genders; s-r – self-report (or proxy); ped – pedometer-based estimate; AATSIHS – Australian Aboriginal and Torres Strait Islander Health Survey; ACTPANS – ACT Year 6 Physical Activity and Nutrition Survey; ANCNPAS – Australian National Children's Nutrition and Physical Activity Survey; ASSAD – Tasmanian component of the Australian Secondary Students' Alcohol and Drug Survey; CAPANS – Child and Adolescent Physical Activity and Nutrition Survey; CHS – Queensland Child Health Status; ERASS – Exercise, Recreation and Sport Survey; SPANS – NSW Schools Physical Activity and Nutrition Survey; HKQS – Healthy Kids Queensland Survey; HOWRU – Victorian Adolescent Health and Wellbeing Survey; HWSS – WA Health & Wellbeing Surveillance System; NASSDA – National Secondary Students Diet & Physical Activity Survey; NNPAS – Australian Health Survey / National Nutrition and Physical Activity Survey; NTCHWS – Northern Territory Child Health and Wellbeing Survey; SAMSS – South Australian Monitoring and Surveillance System; SAPHaRI – NSW Population Health Survey; SPANS – NSW Schools Physical Activity and Nutrition Survey; SSHBS – New South Wales School Students Health Behaviours Survey; TasCHWS – Tasmanian Child Health and Wellbeing Survey; VCHWS – Victorian Child Health and Wellbeing Survey; VSHAWS – Victorian Student Health and Wellbeing Survey

Figure 1. Prevalence rates of Australian children and adolescents meeting physical activity (PA) recommendations: results from the national- and state-level population surveys

accuracy of step counts (Laurson, Welk, & Eisenmann, 2015; Lee, Williams, Brown, & Laurson, 2015; Park, Lee, Ku, & Tanaka, 2014; Schneider, Crouter, Lukajic, & Bassett Jr., 2003). The definitions of 'recommended' step count also varied between different surveys, ranging from ≥11,000 to ≥12,000 steps/day for girls and from ≥12,000 to ≥15,000 steps/day for boys.

Relatively large differences between pedometer-based PA prevalence estimates were observed between different surveys. For example, the prevalence of 5-8 year-olds meeting the recommended step count (≥11,000 steps for girls; ≥13,000 steps for boys) was 66.0% for girls and 55% for boys in the 2007 *Australian National Children's Nutrition and Physical Activity Survey* (Commonwealth Scientific Industrial Research Organisation, CSIRO, et al., 2008) and 28.5% for both genders in the 2011/12 *Australian Health Survey / National Nutrition and Physical Activity Survey* (Australian Bureau of Statistics, 2013b). In this example, the difference in prevalence estimates between the two surveys may reflect a true change in PA over time or, more likely, a differences in measurement protocols. The latter study asked participants to wear G sensor accelerometer-pedometer model 2026 at their waist for at least four days including at least one weekday and one weekend day, whilst the former study required the New Lifestyles NL 1000 pedometers to be worn at mid-thigh for at least six days. These findings show that 'objective' PA estimates are not 'immune' to inconsistencies in methodology of data collection, and that, as with self-reports, standardised protocols should be introduced and maintained to assure comparability between different surveys.

Consistent findings across most surveys

Despite large variability in prevalence estimates, several common trends observed across most surveys lead to important conclusions. First, the prevalence rates of meeting PA recommendations tend to be higher among children when

compared with adolescents; a finding observed internationally in many studies (Jurakić & Pedišić, 2012). Second, questionnaire-based prevalence estimates tend to be higher for boys when compared with girls. This is in agreement with two recent reviews both indicating that boys are more likely to meet the PA recommendations than girls (Guinhouya, Samouda, & De Beaufort, 2013; Jurakić & Pedišić, 2012). Third, among children, pedometer-based estimates of meeting step-count recommendations tend to be higher among girls compared with boys. This is likely to be a consequence of the significantly lower recommended daily step-count thresholds for girls than for boys (≥11,000 steps vs. ≥13,000 steps; or ≥12,000 steps vs. ≥15,000 steps). Although this is a consistent finding, it adds to the overall ambiguity, because it contradicts the pattern obtained from self-reports. Finally, it seems that PA levels of primary and high school students are higher during the summer term, when compared with the winter term, which has also been reported previously (Carson & Spence, 2010).

Conclusions

The true prevalence of compliance with PA guidelines among children and adolescents in Australia seems to be difficult to determine. Estimates vary by the type of measure ('subjective' versus 'objective') and also within the same type of measure. A national standardised measurement method of PA among Australian children and adolescents is clearly a national priority to guide PA promotion campaigns, programs and policy. The recent *Australian Health Survey* (Australian Bureau of Statistics, 2013b) employed a simple validated measure of guideline compliance adapted from Prochaska, Sallis, and Long (2001) questionnaire (Ridgers, Timperio, Crawford, & Salmon, 2012) that has also been used internationally (Currie, et al., 2009) which will enable international benchmarking with other countries. Once there is jurisdictional acceptance of this new metric, advocated by child PA experts in Australia, we will have better confidence in estimates of PA levels among Australian children and adolescents.

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