Journal of Science and Medicine in Sport 22 (2019) 1119–1124

Contents lists available at ScienceDirect

Journal of Science and Medicine in Sport

journal homepage: www.elsevier.com/locate/jsams

Original research

Is sport enough? Contribution of sport to overall moderate- to vigorous-intensity physical activity among adolescents

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ARTICLE INFO

Article history:
Received 6 November 2018
Received in revised form 6 May 2019
Accepted 21 June 2019
Available online 27 June 2019

Keywords:
Accelerometer
Youth
Organised sport
Recreation
Exercise
Schools

ABSTRACT

Objectives: This study examined the contribution of sports participation to overall moderate-to-vigorous physical activity (MVPA) among adolescents, and explored potential moderators.
Design: Cross-sectional observational study using survey and accelerometry data drawn from the NEighbourhood Activity in Youth (NEArbY) study.
Methods: Adolescents (n = 358) were recruited from secondary schools in Melbourne, Australia. Average min/day in MVPA was assessed using accelerometry. Participants self-reported sports participation (number of teams, type, frequency, and months of participation). Regression models determined the percent variance in MVPA explained by the sport variables, adjusted for wear time, age and sex, and accounting for clustering at the school level. Additional analyses tested if age, sex, body mass index (BMI), and socioeconomic status (SES) moderated relationships between sport variables and MVPA.
Results: Participants (mean 15.3 years, 59% female) spent a mean (SD) of 68.6 (27.4) min/day in MVPA and 50% reported participating in any sport. Those who participated in sport did so 3.4 times/week on average and accumulated 7 min/day of MVPA more than those who did no sport. For each additional sport participated in, on average, there were approximately 5 additional min/day of MVPA. The number and frequency of sports participation explained 3.2% and 3.8% of the variance in MVPA respectively. Participation in field hockey and gymnastics explained 2.2% and 3.6% of the variance in MVPA, respectively. There were no moderating effects.
Conclusions: Sport appears to make a very small contribution to adolescents' average daily physical activity. Effectiveness of approaches to increasing youth population levels of physical activity via sports participation needs to be tested.

Practical implications

- The number of sports and frequency of participation explained just 3.2% and 3.8%, respectively, of the variance in MVPA min/day.
- Adolescents who participated in sport accumulated 7 min/day of MVPA more than those who did no sport. For each additional sport participated in, on average, there were approximately 5 additional min/day of MVPA.
- There were no moderating effects of age, sex, BMI or SES on the contribution of sports participation to adolescent MVPA.
- Targeting sports participation as a way to promote adolescent physical activity may lead to only small increases in population levels of time spent in MVPA and needs to be tested within experimental designs.

1. Introduction

Australia has one of the highest rates internationally of organised sports participation (defined as a sport or physical activity organised by a club, business, school or other organisation[1]) among children and young people.[2] National data (2012–13) indicated that 64% of 5–17 year olds participated in organised sport or physical activity at least once per week.[3] The Australian government has had a sustained commitment to investing in and promoting sports participation among children and adolescents; since 2015, approximately $160 million has been invested into funding the Sporting Schools Initiative.[4] The 2036 'aspiration for Australian sport' aims to reverse rates of physical inactivity, overweight and obesity.[5] To achieve this goal, it is anticipated that local, state and Commonwealth government investment will increase incrementally by a total of $400–600 million annually.[5]

Despite considerable investment and the relatively high rate of sports participation among youth, Australia is one of the most

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https://doi.org/10.1016/j.jsams.2019.06.009
1440-2440/

physically inactive countries in the Global Matrix of 38 countries.[2] Physical activity incorporates not just sport, but also play, active transport, physical education, and recreation at moderate-to-vigorous intensities. In 2016, Australia received the second lowest score[2] for the proportion of children and young people meeting the physical activity guidelines (at least 60 min of daily moderate-to vigorous-intensity physical activity [MVPA][2]). Only 29% of Australian children (5–11 years) and 8% of adolescents (12–17 years) meet current guidelines for physical activity.[3]

The many psychological, social and physical health benefits of sports participation during childhood and adolescence, such as improved mental health, social functioning, physical functioning and general health and wellbeing, are well recognized.[6] Participation in specific types of sport, such as recreational dance, have also shown cardiovascular fitness and adiposity benefits.[7] However, studies examining links between overall organised sports participation, body composition, weight status and BMI generally show no or weak associations with overweight and obesity (e.g.[8]).

Sports programs may also fail to reach those adolescents at greatest risk of adverse health outcomes from inactivity. Adolescents from higher socioeconomic areas are more likely to participate in sports and sports teams/physical activities outside of school hours, and less likely to be obese.[9] Of those who do participate in organised sports, participation alone does not ensure adherence to the physical activity guidelines. A study that assessed MVPA among 7–14 year olds whilst participating in organised sports programs showed that less than one-quarter of participants met physical activity guidelines as a direct result of sport.[10] Structured physical activities (e.g. organised sport programs, after-school clubs) have been shown to contribute very little to daily MVPA among adolescents, compared to unstructured physical activity (e.g. outdoor play).[11] There is less evidence that sports,[12] including school-based sports,[13] make a significant contribution to increasing population physical activity.

The aims of this study were to determine the contribution of participation in organised sports/physical activities (hereafter referred to only as 'sports participation') to overall MVPA among adolescents, based on the total number, intensity and frequency of sports participated in. Secondary aims were to explore the moderating effects of age, sex, BMI and SES on the contribution of sports participation and time spent in MVPA.

2. Methods

Data for the current study were drawn from the NEighbourhood Activity in Youth (NEArbY) study. Participants completed an online survey and were asked to wear an accelerometer. Ethical approval was received from the Deakin University Human Ethics Advisory Group (HEAG-H 152_2013), the Department of Education and Training (2013_002182) and the Catholic Education Office (Project ID #1950).

Schools from across Melbourne, Australia (n = 137) were selected from statistical areas of Melbourne that varied by area-level income and objectively-assessed walkability. A more detailed description has been published previously.[14] Of the 137 schools approached, 18 took part in the study (response rate 13%). Each school selected year levels to be involved in the study and these students were invited to attend a short presentation at their school. Interested students were given a recruitment pack, which included study information and a consent form for both parent/guardian and child to sign. Overall, 528 students returned a signed consent form. Data were collected from schools across all school terms over an 18 month period, the majority of data were collected in spring and autumn. Due to study withdrawal or absence on the day of data collection (n = 55), the final sample included 473 participants, of whom 468 provided both survey and accelerometer data.

2.1. Objectively measured physical activity

Accelerometer data from the ActiGraph (model GT3X+, Pensacola, FL) were used to determine average min/day of MVPA. Participants were asked to wear the accelerometer attached via an elastic belt at the right hip for eight consecutive days, excluding during sleep and water-based activities. Data were downloaded in 15-s epochs using ActiLife software (version 6.11.5; ActiGraph LLC, Pensacola, FL). The accelerometer data files were processed using a specifically developed excel macro and Stata code (StataSE 14). Wear time was calculated by subtracting non-wear periods of $\geq$20 min of consecutive zeros from each day.[15] Adolescents with $\geq$8 h wear time on $\geq$3 weekdays, and $\geq$7 h on at least one weekend day were included in analyses.[15] Average MVPA (min/day) was computed using data from valid days only. Objectively-measured adherence to the physical activity guidelines was calculated based on >60 min of MVPA on each valid day. Adolescents recorded daily instances of, and reasons for, accelerometer non-wear within a log book. Reasons for non-wear were later coded to indicate removal for 'sports participation' or 'other' (e.g. showering).

2.2. Self-reported organised sport and physical activity

Survey questions were modified from the Minnesota Leisure Time Physical Activity Questionnaire (MLTPAQ)[16] and the Adolescent Physical Activity Recall Questionnaire (APARQ).[17] Adolescents self-reported their participation in organised sports teams and physical activity classes, including sports training and games/competitions, outside of school hours over the previous year. Sport during school hours was not included in this measure. Participants were asked to list sports teams/physical activity classes they undertook, and for each indicate the months the activity was undertaken and how frequently.

For these analyses, data on sports participation were extracted only for the month corresponding to the month in which the accelerometer was worn. Sports participation was assumed to be zero for participants who did not report participation in any sport during the month of accelerometer wear. The total number of sports participated in was calculated based on the sum of sports listed in that month. Each sport/activity was classified as light- (<3 METs), moderate- (>3–<6 METs) or vigorous-intensity (>6 METs) physical activity.[18] Each activity in the compendium was allocated a "light", "moderate" and "hard effort" option. Effort did not necessary relate to intensity. For example, a "light effort" in basketball was allocated a vigorous-intensity MET value of 7.2, "moderate effort" was 8.2, and "hard effort" was 10.1. Because this level of detail was not available from the APARQ questionnaire, we selected the "moderate effort" option for all activities. Participation in any sports classified as moderate and as vigorous, respectively, was computed. The frequency/wk of all sports classified as moderate- and as vigorous-intensity, respectively, were also summed. Subjectively measured adherence to the physical activity guidelines in a typical week was assessed by a single item requesting the number of days participants were physically active for a total of at least 60 min/day.[19]

2.3. Covariates and moderators

Participant age and sex were obtained from the survey. BMI (kg/m^2) was calculated through objectively measured height and weight by trained research staff. Socioeconomic status (SES) was derived from baseline participant postcodes and data from the 2011 Australian Census of Population and Housing: Socio-Economic

Indexes for Areas[20] (Australian Bureau of Statistics [ABS] Index of Relative Advantage and Disadvantage [IRSAD]).

Separate random-intercept linear models, with students nested within schools, were used to determine the percentage of variance in MVPA explained by the total number of sports, intensity of the sports, the frequency of sports participation, and the type of sports participated in, respectively. Model 1 included only three explanatory variables (wear time, age and sex [covariates]). Individual models were run for each of the sport variables (referred to as 'Model 2'). As such, the variance in MVPA explained by each sport variable, after adjustment for the covariates, is expressed as a percentage of the variance remaining unexplained by the covariates. Interaction terms were added to assess whether age, sex, BMI or SES moderated the relationship between sports participation (total number, intensity and frequency of sport) and time spent in MVPA. Descriptive data were reported for the whole sample and by sex. Analyses were conducted for the whole sample and repeated for only those who participated in sport. As a sensitivity analysis, the results were re-run excluding those participants who in log books reported removing their accelerometer for sports. Participants were excluded if they reported sports participation as a reason for non-wear on at least one occasion during the measurement period (n = 70). All analyses were performed using Stata version 14 (StataCorp, TX).

3. Results

Valid accelerometry data were obtained from 380 adolescents, of which 358 also had valid survey data. Participants excluded were older (15.8 ± 1.6 versus 15.3 ± 1.5 years; $p = 0.004$) and on average had higher levels of MVPA (85.8 ± 90.9 versus 68.6 ± 27.4 min/day; $p = 0.009$). Excluded and non-excluded participants differed significantly in terms of sports participation ($p < 0.0005$). Of those adolescents excluded, only 29% participated in sport during the month the accelerometer was worn compared to 50% of participants included in the study. Table 1 presents descriptive characteristics of participants.

Table 2 presents the number of sports participated in and the frequency of sports participation per week. All reported sports were classified as at least moderate-intensity, with vigorous-intensity sports being most common. Half of the participants participated in at least one sport during the month in which they wore the accelerometer. Participants who participated in any sport did so approximately 3.4 times/week. Basketball and netball were the most popular sports (Supplementary File 1).

Table 3 shows over a third of the variance in MVPA was explained by sex, age and wear-time (Model 1). Of those who participated in sport at least once during the month of measurement accumulated an additional 7 min/day of MVPA than non-participants ($b = 6.79$; 95% CI, 2.18–11.41; $p = 0.004$). The number of sports and frequency of participation were also significantly positively associated with MVPA. Each additional sport was associated with approximately 5 additional min/day of MVPA. Among adolescents who participated in sport, compared to Model 1, the number and frequency of sports participation explained 3.2% and 3.8% (Model 2), respectively, of the remaining variance in MVPA (Note: this 'remaining' percentage variance explained is expressed as a proportion of the variance left unexplained by the covariates). Intensity of sports participation explained up 0.6% of the remaining variance in MVPA compared to Model 1, whereas the frequency of moderate- or vigorous-intensity sports participation explained up to 2.6%. Participation in field hockey and gymnastics were significantly associated with MVPA, explaining 2.2% and 3.6% of the remaining variance respectively (Supplementary Files 2 and 3). All other types of sports explained up to 1%.

Results of the sensitivity analysis were broadly consistent with the primary analyses. However, among those participants who reported removing their accelerometer for sport, the frequency of sports participation explained 1.9% ($p = 0.04$) of the remaining variance in MVPA, which is a slight reduction from 3.8% ($p = 0.003$) in the main analyses. The percent of the remaining variance explained by moderate-intensity sports and frequency of moderate- or vigorous-intensity sports also increased slightly to 2.9% ($p = 0.04$) and 6.6% ($p = 0.002$), respectively. Field hockey was no longer significantly associated with MVPA, explaining only 1.9% of the variance compared to 3.6% in the main analyses, and gymnastics remained significantly associated with MVPA but increased to explaining 4.6% of the variance compared to 2.2% in the main analyses. There were no moderating effects of age, sex, BMI or SES on the association between sports participation and duration of MVPA.

4. Discussion

Australian, and other governments, invest heavily into promoting sports participation as a strategy to increase population physical activity, yet there are surprisingly few studies that have examined the contribution of sports participation to overall physical activity among adolescents. Understanding this relationship is important for informing government policy and investment into initiatives to increase population physical activity. To our knowledge, this is the first study to investigate the contribution of multiple aspects of adolescent's sports participation to objectively-assessed MVPA. Notwithstanding the range of known benefits of sports participation,[6] with just 50% of adolescents participating in any sport and the small contribution of sport frequency to overall MVPA (<4%), our findings challenge youth sport as a primary government strategy to increase population levels of youth physical activity and adherence to the physical activity guidelines. This is consistent with research from the UK, which demonstrated no empirical evidence to support UK government investment in sports as a public health intervention to increase physical activity among the less and least active.[21]

The survey and accelerometer-derived data in this study showed a smaller proportion of adolescents in the analytical sample met the physical activity guidelines compared to national population surveys.[3] Further, although time spent in MVPA increased with the number and frequency of sports participated in, sports participation explained between 0.3–3.8% of the variance in daily MVPA, irrespective of age and sex, in all models (including the number, intensity, frequency or type of sports undertaken). Studies show that between one-third and one half of youth's sports practice time is spent in MVPA,[10,22] with the remaining time spent in sedentary or light-intensity physical activities. Sport programs provide beneficial access and resources for recreational physical activity, however, they may not provide sufficient intensity to warrant health benefits, nor increase overall population levels of MVPA. For example, increasing the time spent active during sports practices could include designing training sessions to minimise waiting/standing and session management time. The absence of any moderating effects of age, sex, BMI or SES suggests that the contribution of sport to adolescent MVPA is similar across socio-demographic groups. If governments are to achieve significant impacts on youth physical activity levels via organised sports programs, it would likely require a substantial increase in overall participation and retention rates, including frequency of participation, and increased duration of time spent in MVPA within each session.

Government-funded sports programs often target out-of-school hours (during weekends and after school). However, strategies in the school setting have been shown to increase physical activity among children and adolescents during school hours,[23]

Table 1
Participant characteristics, sport participation and percentage meeting the physical activity (PA) guidelines.

Demographic characteristics	Overall (n = 358)	Boys (n = 146)	Girls (n = 212)	p
Age (years) (Mean, SD)	15.3 (1.5)	15.2 (1.7)	15.4 (1.5)	0.27
BMI (kg m^{-2}) (Mean, SD), N = 289	21.8 (4.3)	21.2 (3.9)	22.2 (4.4)	0.22
Accelerometer-derived PA				
MVPA min/day (Mean, SD)	68.6 (27.4)	79.4 (28)	61.1 (24.3)	<0.0005
Proportion of valid days met guidelines (Mean, SD)	0.53 (0.3)	0.63 (0.3)	0.46 (0.3)	<0.0005
Met PA guidelines on all valid days (%)	9.8	15.1	6.1	0.005
Self-reported PA				
Days met PA guidelines (Mean, SD)	3.4 (1.8)	3.6 (1.7)	3.2 (1.8)	0.04
Days met PA guidelines (%)				0.08
0 days	4.2	1.4	6.1	
1 day	11.7	9.6	13.2	
2 days	19.0	17.8	19.8	
3 days	22.0	23.3	20.8	
4 days	15.1	18.5	12.7	
5 days	14.5	12.3	16.0	
6 days	8.7	12.3	6.1	
7 days	5.0	4.8	5.2	

PA – physical activity. Meeting PA guidelines defined as >60 min/day MVPA. T-tests were used for continuous data & chi-square for categorical.

Table 2
Frequency and number of sports participated in per week, outside of school hours.

Sports participation (per month)	Overall (n = 358)	Adolescents participating in sport (n = 179)[a]
Any sport (%)	50	100
Frequency/wk of sport (Mean, SD)	1.75 (2.28)	3.43 (2.16)
Number of sports		
1 sport (%)	34.6	69.3
2 sports (%)	12.9	25.7
3 sports (%)	2.2	4.5
4 sports (%)	0.3	0.6
Total number of sports (Mean, SD)	0.68 (0.8)	1.36 (0.60)
Vigorous intensity sports		
Any vigorous-intensity sport (%)	37.4	74.9
Frequency/wk of vigorous-intensity sport (Mean, SD)	1.33 (2.09)	2.67 (2.27)
Moderate intensity sports		
Any moderate-intensity sport (%)	13.1	26.3
Frequency/wk of moderate-intensity sport (Mean, SD)	0.44 (1.40)	0.88 (1.88)

[a] These analyses included only those adolescents participating in at least one sport.

Table 3
Contribution of sports participation to adolescent's minutes of MVPA per day.

	Overall sample (n = 358) [Variance explained in Model 1[a] = 34.2%]				Adolescents participating in sport (n = 179)[d] [Variance explained in Model 1[a] = 36.9%]			
	Unstandardized coefficient[b] (95% CI)	p	Variance explained by confounders & sport variable (%)[b]	Remaining variance explained by sport variable (%)[c]	Unstandardized coefficient[b] (95% CI)	p	Variance explained by confounders & sport variable (%)[b]	Remaining variance explained by sport variable (%)[c]
Any sport (Y/N)	6.79 (2.18, 11.41)	0.004	35.7	2.4	–	–	–	–
Frequency any sport (times/week)	2.06 (1.08, 3.04)	<0.0005	37.0	4.3	2.06 (0.71, 3.42)	0.003	39.2	3.8
Number of sports	5.14 (2.32, 7.96)	<0.0005	36.7	3.9	5.50 (0.50, 10.51)	0.03	38.9	3.2
Vigorous intensity sports								
Vigorous-intensity sports (Y/N)	5.90 (1.25, 10.54)	0.01	35.4	1.9	2.07 (-4.83, 8.97)	0.56	37.0	0.3
Vigorous-intensity sport/week	1.71 (0.63, 2.78)	0.002	35.9	2.7	1.33 (0.02, 2.63)	0.05	37.8	1.6
Moderate intensity sports								
Moderate-intensity sports (Y/N)	6.90 (0.31, 13.48)	0.04	35.0	1.2	3.53 (-3.19, 10.23)	0.30	37.3	0.6
Moderate-intensity sport/week	2.18 (0.61, 3.76)	0.007	35.7	2.3	1.66 (0.11, 3.21)	0.03	38.5	2.6

[a] Model 1 includes wear time, age and sex.
[b] Model 2 includes the same as Model 1 plus each single sport variable.
[c] Proportion of variance left unexplained by confounders (in Model 1) that is explained by the sport variable (in Model 2). % remaining variance explained based on 100 × (% variance explained in Model 2 – % variance explained in Model 1)/(100 – % variance explained in Model 1).
[d] These analyses included only those adolescents participating in at least one sport.

subsequent out-of-school physical activity,[24] and overall physical activity levels.[24] Compared to unstructured physical activity (e.g. indoor or outdoor play), structured physical activities (e.g. organised sport programs, after-school clubs) contribute very little to daily MVPA, and adolescents tended to accumulate the majority of their total daily MVPA during school and unstructured leisure-time activities.[11] For example, objectively-assessed activity accumulated during school recess and lunchtime has been shown to contribute approximately 11% and 7% towards adolescent's daily moderate-intensity and vigorous-intensity physical activity, respectively.[25] Furthermore, adolescents who frequently engaged in active school transport accumulated an additional 13 and 14 min of MVPA on weekdays and weekend days, respectively.[26] In the current study, each additional sport adolescents reported was associated with an additional 5 min/day of MVPA. However, only 2% of the overall sample participated in more than two sports so the additional MVPA attributed to sports participation was small.

Only 50% of our sample participated in sport during the month the accelerometer was worn, thus organised sports programs may not appeal to this age group. Unorganised, individual activities (e.g. walking, jogging, stationary exercises e.g. a stationary bike), as opposed to club- and team-based sports, may have greater appeal to this population.[27] Strategies to enhance the urban environment via infrastructure changes (e.g. installation of bike lanes and paths) and street-scale urban redesign (e.g. improving aesthetics and perceived safety) can also be effective at supporting physical activity across all ages.[28] Australia is one of several countries facing a national physical inactivity epidemic, but lacks a national physical activity action plan. Government leadership and sustained commitment to physical activity promotion and funding, including upstream policy and environmental infrastructure approaches to improving population level physical activity is needed.

The relatively large sample size and objective quantification of MVPA are key strengths of this study. However, the study was cross-sectional and data were limited to the type and frequency of sports participation only. Stronger contributions of sport may have been found if total volume of sports participation were examined. It is also possible that sports participation was over-reported in this study and there was a potential lack of alignment between the survey measure and accelerometry, where adolescents may not have participated in organised sport during the period of accelerometer wear. In addition, seasonality may have also influenced participation rates.[29] Our measure of sports participation also included only sports outside of school and this may under-represent total participation for some participants. Accelerometer output accuracy may vary by activity type[30] and therefore the contribution of sports to accelerometer determined MVPA may have been underestimated for some sports compared to others. For example, swimming and cycling may be underestimated, however these were only reported by 15 and 4 adolescents, respectively, and therefore the impact on results would be minimal (Supplementary File 1). Assessment of physical activity guideline adherence by accelerometry was also limited to the number of days on which criteria for 'valid' data were met; only 5% of the sample had 7 valid days of accelerometer data. However, irrespective of self-reported device non-wear during sport, the results of this study remained broadly consistent. Future research could use more specific questions or diaries to assess sport, tailored to the specific week of monitoring, or could extract accelerometry data during periods of known sports participation.

5. Conclusion

This study found a minimal contribution of organised sports participation to overall MVPA among adolescents, irrespective of whether the number, intensity, frequency and type of sport was considered. Policies focused only on sport may have a minimal impact on population physical activity levels. National strategies to increase physical activity among youth may need to have a greater focus on active living, such as active transport policies and environmental infrastructure that is conducive to recreational and incidental physical activity, in addition to sport.

Author contributions

HK led writing of the manuscript and conducted the analyses with **GA**. **JS** and **AT** conceptualised the study. All authors critically revised the manuscript for intellectual content, and read and approved the final draft.

Acknowledgements

The authors wish to thank all participants and research staff involved in the NEArbY study. The NEArbY study was funded by the National Institutes of Health (NIH) R01 HL111378. **AT** was supported by a Future Leader Fellowship from the National Heart Foundation of Australia (Award 100046) during the NEArbY study. **LA** is supported by an Alfred Deakin Postdoctoral Research Fellowship. **KP** is supported by a Deakin University Postgraduate Research Scholarship. The authors have no competing interests.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.jsams.2019.06.009.

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