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Review

Longitudinal changes in domains of physical activity during childhood and adolescence: A systematic review

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ABSTRACT

Objectives: Physical activity (PA) participation is prone to decline during adolescence. An understanding of the domains of PA that are susceptible to decline may support a more targeted approach to PA and health promotion. The aim of this study was to review longitudinal trends in participation in four PA domains during childhood and adolescence: organized PA, non-organized PA, active transport and active chores.
Design: Systematic review.
Methods: 5517 research articles were sourced from five electronic databases (covering January 1997–April 2018). Eligibility criteria included repeated measurements of at least one PA domain among the same participants (5–18 years of age).
Results: 23 studies were included, cumulatively reporting data from 27,231 participants. Few studies had a low risk of bias (n = 6). Most studies of active transport reported an increase in participation during childhood, no change in the transition to adolescence, and no change or decline during adolescence. Most studies of organized PA reported an increase during childhood, an increasing or stable pattern in the transition to adolescence, and no change or decline during adolescence. Non-organized PA participation tended to remain stable among adolescent girls and decline among adolescent boys. Active chores increased during the transition to adolescence and then stabilized.
Conclusions: Potential strategies for PA promotion among youth may include targeting non-organized PA among adolescent boys or organized PA among late adolescent boys and girls. However, there is a continuing need for high-quality, longitudinal studies of participation in PA domains, particularly non-organized PA and active chores.
PROSPERO Registration: CRD42017076888.

Practical implications

- Most studies of active transport reported an increase during childhood (n = 3/6), a plateau in the transition to adolescence (n = 5/8) and no change (n = 1/2) or decline (n = 1/2) during adolescence.
- Most studies of organized PA reported an increase during childhood (n = 3/5), an increasing (n = 2/4) or stable (n = 2/4) pattern in the transition to adolescence, and no change (n = 2/3) or decline (n = 2/3) during adolescence.
- Non-organized PA participation tended to vary by sex — remaining stable among adolescent girls (n = 2/2) and declining among adolescent boys (n = 1/2).
- Active chores increased during the transition to adolescence (n = 1/1) and then stabilized (n = 1/1).

1. Introduction

Regular physical activity (PA) is associated with a number of health benefits for children and youth.[1] However, the results of global analyses suggest that youth are generally not meeting PA recommendations.[2,3] PA participation declines over the life course[4] and this decline is particularly steep during adolescence at around 7% per year.[5] However, the reasons for this intra-individual decline

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in PA participation are still not fully understood, particularly in the transition from childhood to adolescence.[6]

One area of emerging research interest is the context in which PA occurs, known as the domain[6] or mode[7] of PA. Domains of PA during childhood and adolescence can include organized PA (e.g. organized sport), non-organized PA (e.g. active play or non-organized sport), active transport (e.g. walking to school)[8] and active chores/work (e.g. lawn mowing, shoveling).[9,10] Analysis of domains of PA may provide a more nuanced understanding of behavior that is potentially lost in studies reporting more general outcomes such as moderate-to-vigorous intensity physical activity (MVPA).[11] While studies reporting overall PA are useful in determining whether youth are sufficiently active, a better understanding of longitudinal changes in domains of PA may provide more specific behavioral targets for intervention. Previous narrative reviews have noted trends such as a decline in non-organized sport participation during adolescence[4] or an increase in organized sport participation in early adolescence followed by drop-out a few years later.[12] Although such findings may seem axiomatic, it is worth noting that these review papers are more than 10 years-old and did not systematically review the evidence base.

Therefore, the aim of this study was to review longitudinal (intra-individual) changes in the frequency and duration of participation in four PA domains during childhood and adolescence (5–18 years): organized PA, non-organized PA, active transport and active chores/work. These findings may be used to develop differentiated PA promotion strategies[11] for youth focussing on PA domains that are either resistant[4,9] or prone[4] to decline (e.g. targeted social marketing campaigns or after-school sports programs).

2. Methods

This systematic review was conducted in accordance with recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement.[13] A study protocol was registered on PROSPERO, the international prospective register of systematic reviews, prior to commencement (CRD42017076888).

A systematic literature search was conducted using five electronic databases (MEDLINE, PsycINFO, SCOPUS, SPORTDiscus and Web of Science Core Collection). In some contexts, PA participation has been found to be prone to secular as well as longitudinal changes,[14] so the present review was limited to full-text journal articles published during January 1997–April 2018. The search strategy is provided in Appendix A (Supplementary material). Search results were imported into an Endnote X7 library (Clarivate Analytics 2017). Additional papers were sourced from the reference lists of included studies. Database searches were conducted up to 30 April 2018. Two authors (BK and KHC) independently screened all search results for inclusion based on titles/abstracts and then full-text articles if further detail was required. Reviewers agreed in their initial assessment of full-text articles in almost 80% of cases (153/193 articles). Discrepancies were resolved by discussion between the two reviewers. If consensus could not be reached a third researcher (AM or DC) reviewed the article and made a determination.

The review included longitudinal, observational studies that measured the domains of organized PA, non-organized PA, active transport or active chores/work on at least two time-points during childhood and/or adolescence. Childhood was defined as starting at 5 years and ending before 13 years of age. Adolescence was defined as spanning 13–18 years of age. The mean age of participants was used to determine eligibility where studies included participants of various ages (e.g. 10–15 years old at baseline). Where studies only reported the age range without reporting the mean, the middle point in the range was used to classify studies. Papers were included if they were written in English and published or accepted/in-press in a peer-reviewed journal article at the time of review. Books and book chapters, conference abstracts, study protocols, dissertations and non-scholarly sources were excluded.

Studies were excluded if participant groups were selected on the basis of PA status (e.g. sufficiently active or inactive), PA ability (e.g. motor coordination) or a pre-existing health condition or disability (including overweight or obesity). Studies that stratified data by the above variables without providing a total for the whole sample were also excluded. In addition, studies were excluded if the data was not reported for the same participants over time or if the interval between baseline and final follow-up measurement was less than 12 months. Intervention studies and qualitative studies were also excluded.

Studies were excluded if they only measured participation in specific sports or activities (e.g. tennis or swimming). Active transport to school was included because it generally comprises a substantial proportion of overall active transport.[15,16] Objective measurement of PA was not required for inclusion in the present study. It was expected that most studies in the review would utilize self-reported data because objective methods such as accelerometry cannot easily determine the context in which PA occurs.[17]

Duplicate publications were identified and excluded based on the author(s), article title and journal name. To avoid double-counting, publications were also considered as duplicate if they reported data for the same cohort and PA domain at the same time points (regardless of the lead author or article title). Such publications were identified based on the study name, place and year of data collection, age of respondents, sample sizes and/or outcomes. In the event of overlapping publications, the article with the largest analytic sample size was included in the review.

A piloted form was used to extract information from in-scope studies by one researcher (BK) and this was checked by a second researcher (KHC). During the preliminary testing phase of the review, it was observed that not all studies adhered to a uniform definition of each PA domain. Therefore, the PA domains of included studies were classified according to a set of predetermined definitions (see Supplementary Appendix B).

The risk of bias (ROB) assessment for the present review was developed in accordance with PRISMA guidelines. Three domains were used to assess ROB, adapted from Cliff et al.[18]: (1) were the participants likely to be representative of the target population? (selection bias); (2) did an adequate proportion ($\geq$70%)[19] of participants have complete data? (attrition bias); and (3) did the study demonstrate adequate reliability and/or validity of the PA outcome(s)? (intraclass correlation coefficient $\geq$0.4; Cohen's kappa $\geq$0.4; correlation coefficient $\geq$0.5)[20] (detection bias). Each of these items were independently coded by two reviewers (BK and KHC) as 'low', 'unclear' or 'high' ROB for each study. An overall rating of 'low' ROB was applied if at least 2/3 items were classified as 'low' ROB. The reviewers demonstrated 84% agreement based on initial criterion assessments (63 out of 75 items) which represented significant inter-rater agreement ($\kappa = 0.76$, $p < 0.001$). Any discrepancies were then resolved in a discussion between the two reviewers. If consensus could not be reached, a third researcher (AM or DC) made a determination. Studies were not excluded from the present review based on ROB.

Aggregate data analysis was not considered appropriate for this review due to the degree of heterogeneity among the included studies. Differences across studies included the details of PA measurement (e.g. reference period, data type), number of follow-up measurements and the follow-up interval. A descriptive synthesis was instead developed by grouping studies according to PA domain and the age span of participants (within-childhood/between childhood and adolescence/within adolescence). Longitudinal changes

Table 1
Characteristics of included studies.

Study characteristic	Number of studies (%)[a]	References
Year of publication		
1997–2007	2 (9%)	25,38
2008–2012	5 (22%)	29,33,40–42
2013–2017	16 (70%)	7,9,10,22–24,26,27,30–32,34–37,39
Continent of data collection		
Europe	14 (61%)	9,22–25,29,30,32,34–39
Australia	5 (22%)	7,26,27,33,40
Asia	2 (9%)	41,42
North America	1 (4%)	10
South America	1 (4%)	31
Sample size for paired analysis		
Less than 100	1 (4%)	25
100–399	11 (48%)	7,9,27,29,33,36–38,40–42
400–699	5 (22%)	22,32,34,35,39
700–999	1 (4%)	24
Over 1000	5 (22%)	10,23,26,30,31
Age span measured[b]		
Within childhood (5–12 years)	10 (43%)	22,24,26,32,33,36,39–42
Transition from childhood to adolescence	13 (57%)	7,9,23,25,27,29–31,33–37
Within adolescence (13–18 years)	6 (26%)	7,10,25,30,38,40
Domain of PA measured[b]		
Active transport	13 (57%)	22–24,27,29–31,33–35,40–42
Organized PA	9 (39%)	7,25,26,32,36–39,41
Non-organized PA	3 (13%)	7,37,38
Active chores	2 (9%)	9,10

[a] Some percentages will add to more than 100% due to rounding.
[b] Results for these items will add to more than 100% because some studies measured more than one age period and/or domain of PA.

were categorized as an 'increase' or 'decline' if the change was statistically significant ($p < 0.05$); otherwise studies were categorized as 'no change'. Statistical significance was taken as reported by journal articles, although many articles (n = 15) did not state the statistical significance of the data of interest. In these cases it was possible to manually calculate the significance of changes. McNemar's Test[21] was used to determine the significance of data from seven studies[9,22–27] and confidence intervals for paired proportions were calculated as detailed by Twisk[28] for six studies.[7,10,29–32] Independent-samples t-tests were performed on mean data provided by two studies[33,34] because paired data were not available. Further details about manual calculations are provided in Supplementary Appendix C.

3. Results

Of the 5517 studies identified, 193 full-text articles were retrieved and 23 articles were included in the review (Fig. 1). Table 1 describes the characteristics of the included studies. The analytic sample sizes of included studies ranged from 97[25] to 7418[23] respondents. Overall, the included studies cumulatively reported data from 27,231 participants. Most studies were conducted in Europe (n = 14)[9,22–25,29,30,32,34–39] but others were conducted in Australia (n = 5),[7,26,27,33,40] Asia (n = 2),[41,42] North America (n = 1)[10] and South America (n = 1).[31] Most studies reported longitudinal data that spanned the transition from childhood to adolescence (n = 13),[7,9,23,25,27,29–31,33–37] although some reported trends within childhood (n = 10)[22,24,26,32,33,36,39–42] or within adolescence (n = 6).[7,10,25,30,38,40] Most studies collected data at two in-scope time-points (n = 17)[9,10,22–24,26,27,29,31,32,34,35,37,39–42] but some had collected data at three (n = 5)[7,25,30,33,36] or four (n = 1)[38] in-scope time-points. The average interval between time-points was 2.5 years (range: 1–6 years). Most studies only measured one domain of PA (n = 19)[9,10,22–27,29–36,39,40,42] but some studies measured two domains (n = 4).[7,37,38,41] No studies measured more than two domains of PA, although one study included a third category of 'other PA' which was not classifiable in this review[38]. All studies collected data using a questionnaire or interview. Few studies had a low risk of bias (n = 6).[23,26,33,34,37,40]

The majority of studies that reported longitudinal data for the active transport domain reported a significant increase in participation during childhood (n = 3/6)[24,40,41] followed by a plateau during the transition to adolescence (n = 5/8)[27,29,30,33,35] and no change (n = 1/2)[40] or decline (n = 1/2)[30] during adolescence. Only one study reported a significant decline in participation during childhood, although this study was restricted to participants who adhered to the same travel mode (active/passive) on the journey to and from school.[22] In addition, one study reported a significant decline in active transport within adolescence (from 14 to 16 years of age).[30] This study had measured active transport as a categorical variable (usual mode of transport),[30] whereas the study that reported a stable trend had measured active transport as a continuous variable (number of active trips[40] per week). In addition, the study that reported a decline had measured school transport only,[30] whereas the study that reported a stable trend was not limited to school transport.[40] There did not appear to be any substantial sex differences in active transport participation during childhood and adolescence. The full details of all studies in the active transport domain can be found in Supplementary Appendix D.

Only four studies of active transport were deemed to have a low ROB.[23,33,34,40] In terms of attrition bias, four studies were coded as low ROB.[23,31,40,42] The other studies had more than 30% of data missing (high ROB).[22,24,27,29,30,33–35,41] Four studies were coded as having a low risk of detection bias.[27,33,34,40] Detection bias was rated as unclear for the other studies, as validity and reliability information was either not reported at all (n = 5/13),[22,24,31,41,42] based on a measure with a different reference period (n = 2/13),[29,30] based on an adult sample (n = 1/13)[35] or reported for overall PA but not for the specific domain (n = 1/13).[23] In terms of selection bias, six studies were coded as low ROB.[23,24,33,34,40,41] Five studies were deemed to have a high risk of bias, due to the exclusion of population segments (e.g. rural areas) (n = 3/13),[22,27,29] the use of purposive/convenience sampling (n = 1/13),[42] or an inadequate sampling frame (n = 1/13).[30] Two studies were considered to have an unclear risk of selection bias because inadequate information was provided in the article.[31,35] When longitudinal results are limited to studies with a low ROB, most studies reported an increasing (n = 1/2)[40] or stable (n = 1/2)[33] pattern in childhood, an increasing (n = 2/3)[33,34] pattern in the transition to adolescence, and no change during adolescence (n = 1/1).[40] ROB ratings for all included studies are provided in Supplementary Appendix E.

The studies that reported longitudinal data for the organized PA domain had measured participation in organized sports activities (n = 5/9)[7,26,32,38,41] and/or sports club PA (n = 5/9).[7,25,36,37,39] As shown in Table 2, most studies of this domain reported a significant increase during childhood (n = 3/5),[32,39,41] followed by an increasing (n = 2/4)[7,37] or stable pattern (n = 2/4)[7,36] in the transition to adolescence, and no change (n = 2/3)[7,38] or decline (n = 2/3)[7,25] during adolescence. Significant declines were more common during late-adolescence, as two studies that reported declines had a final follow-up at approximately 18 years.[7,25] One study only sampled girls and reported participation in organized non-competitive activities (e.g. aerobics) and sports club membership.[7] Participation in non-competitive activities increased in the transition to adolescence and remained stable thereafter, whereas sports club membership remained stable in the transition to adolescence and

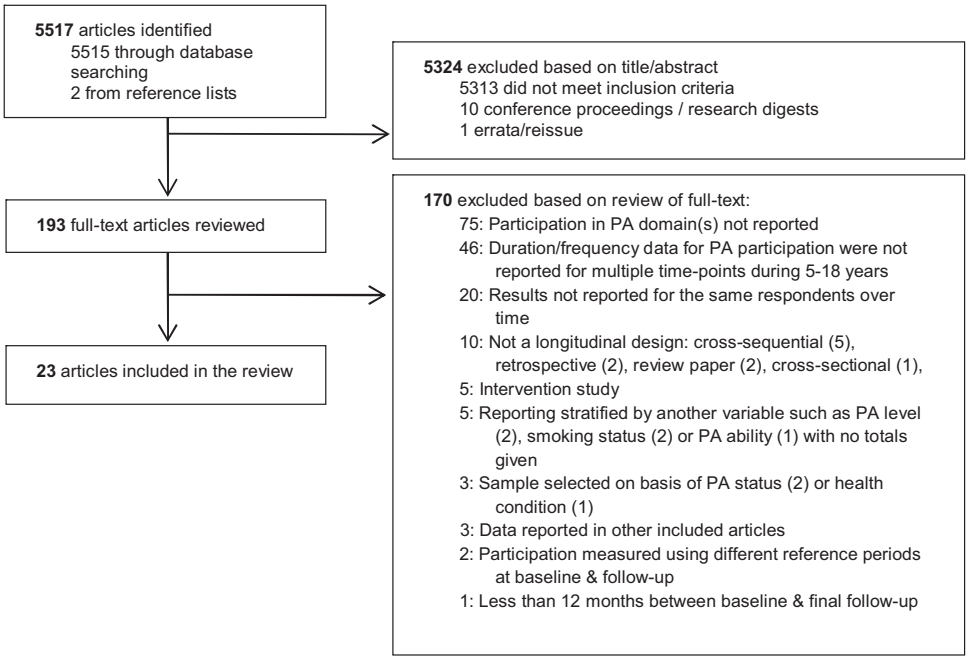

Fig. 1. Flowchart of search results and selection process.

Table 2
Summary of longitudinal changes in domains of PA, by age period.

Domain	Trend in participation	Number of studies		
		References		
		Within childhood (5–12 years)	Transition from childhood to adolescence	Within adolescence (13–18 years)
Active transport	**Number of studies in category**	**6**	**8**	**2**
	Significant increase	3 [24,40,41]	2 [33,a,b,34]	–
	No significant change	2 [33,42]	5 [27,29,30,33,a,c,35]	1 [40]
	Significant decline	1 [22]	2 [23,31]	1 [30]
Organized PA	**Number of studies in category**	**5**	**4**	**3**
	Significant increase	3 [32,39,41]	2 [7,c,d,e,37,f]	–
	No significant change	2 [26,36b]	2 [7,c,d,g,36,b]	2 [7,c,d,e,38,h]
	Significant decline	–	1 [25]	2 [7,c,d,g,25]
Non-organized PA	**Number of studies in category**	**0**	**2**	**2**
	Significant increase	–	–	–
	No significant change	–	1 [7,c]	2 [7,c,38 a,c,h]
	Significant decline	–	1 [37,f]	1 [38,a,b,h]
Active chores	**Number of studies in category**	**0**	**1**	**1**
	Significant increase	–	1 [9h]	–
	No significant change	–	–	1 [10]
	Significant decline	–	–	–

[a] Study is counted twice in this category due to differing results for boys and girls (no total provided).
[b] Boys only.
[c] Girls only.
[d] Eime et al.[7] is counted twice in this category due to differing results for competitive and non-competitive organized PA (no total provided).
[e] Non-competitive organized PA.
[f] 'Young cohort' only.
[g] Sports club membership.
[h] Numeric values were not stated in the article text. The reviewers agreed on trends based on visual inspection of Figure. 3 in van Mechelen et al.[38]/Figure 1 in Brooke et al.[9]

then declined. The full details of all studies in the organized PA domain can be found in Supplementary Appendix F.

Only two of the studies that reported longitudinal trends in organized PA were considered to have a low ROB.[26,37] Detection bias had the least number of studies coded as low ROB (n = 1/9).[37] All other studies had an unclear risk of detection bias, as validity and reliability information was either not reported at all (n = 7/9)[25,26,32,36,38,39,41] or reported for overall PA but not for the specific domain (n = 1/9).[7] In terms of attrition bias, two studies were coded as low ROB.[26,38] Seven studies had more than 30% of data missing (high ROB).[7,25,32,36,37,39,41] Six studies were coded as having a low risk of selection bias.[7,26,32,37,39,41] The other studies were deemed to have a high risk of bias due to the use of convenience sampling (n = 1/9),[36] exclusion of population segments (e.g. rural areas) (n = 1/9)[25] or a statement within the article text about a lack of representativeness (n = 1/9).[38] The studies that were deemed low ROB reported no change in organized PA during childhood [26] and an increase in participation during the transition to adolescence.[25]

The three studies that reported longitudinal data for the non-organized PA domain measured participation in non-organized PA,[7] non-organized sport[38] and leisure-time sports outside of sports clubs.[37] Studies reported either no change (n = 1/2)[7] or decline (n = 1/2)[37] in non-organized PA between childhood and adolescence (see Table 2). One study only sampled girls and reported no change in participation,[7] while another study did not stratify results by sex and reported a decline.[37] Studies conducted during adolescence reported no change among girls (n = 2/2)[7,38] and a decline among boys (n = 1/2).[38] The full details of all studies in this domain can be found in Supplementary Appendix G.

Only one of the studies of non-organized PA was considered to have a low ROB.[37] This one study had a low risk of detection bias and all other studies were rated as unclear, as validity and reliability information was either not reported at all (n = 1/3)[38] or reported for overall PA but not for the specific domain (n = 1/3).[7] In terms of attrition bias, one study was coded as low ROB[38] and the remaining studies had more than 30% of data missing (high ROB).[7,37] Two studies were coded as having a low risk of selection bias.[7,37] The other study was deemed to have a high risk of bias due to a statement about a lack of representativeness in-text.[38] The one study with an overall low ROB rating reported a decline in non-organized PA between childhood and adolescence.[37]

Two studies reported longitudinal data for active chores.[9,10] These studies reported an increase in participation in active chores from childhood to adolescence (n = 1/1)[9] and no change in participation within adolescence (n = 1/1)[10] (see Table 2). No studies were identified that reported longitudinal data for occupational PA (active work). The full details of these studies can be found in Supplementary Appendix H. Neither of the included studies had a low ROB. Both studies had a high risk of attrition bias due to having more than 30% of data missing.[9,10] The risk of detection bias was regarded as unclear in both studies because reliability/validity information was either reported only for overall PA (n = 1)[9] or not stated at all (n = 1).[10] Both studies were deemed to have a low risk of selection bias.[9,10]

The results of this review have generally been presented by PA domain. However, results may also be presented by age span to highlight changes during each developmental stage (see Supplementary Appendix I).

4. Discussion

This study reviewed longitudinal changes in four domains of PA during childhood and adolescence. Most studies of active transport reported an increase in participation during childhood (n = 3/6), no change in the transition to adolescence (n = 5/8) and no change (n = 1/2) or decline (n = 1/2) during adolescence. The majority of studies of organized PA reported an increase during childhood (n = 3/5), an increasing (n = 2/4) or stable (n = 2/4) pattern in the transition to adolescence, and no change (n = 2/3) or decline (n = 2/3) during adolescence. There was limited evidence for non-organized PA but it appears that this domain was more likely to remain stable among adolescent girls (n = 2/2) and decline among adolescent boys (n = 1/2). For active chores, there was limited evidence showing an increase in participation in the transition to adolescence (n = 1/1) followed by a plateau (n = 1/1).

Most studies of active transport during childhood reported an increase in participation. This supports the notion that parents become more confident in their child's ability to travel independently as they age.[43] Furthermore, most studies reported a stable trend between childhood and adolescence. This might reflect the dominance of studies conducted in Europe in this review, as adolescents in parts of Europe (such as The Netherlands) are among the most likely in the world to participate in active transport.[44] The studies in the present review reported a stable or declining trend during adolescence. Climate may be a factor in this difference, as the stable trend occurred in Australia,[33] while the decline occurred in the United Kingdom.[30] This is supported by a recent cross-sequential study in Canada which also reported a decline in active transport during adolescence.[43] Finally, it is worth noting that a previous systematic review[14] also reported secular changes in the frequency of active transport, such as an increase among 5–15 year olds in the USA (between 1995 and 2001)[45] and a decrease among 9–13 year olds in Australia (between 1985 and 2001).[46] Therefore, future systematic reviews of PA should adopt inclusion criteria based on the year of publication, as was done in the current review.

In the present review, the majority of studies of organized PA reported an increase during childhood but no change or decline during adolescence. This trend is similar to the most common trajectory models of a previous large-scale cross-sequential study.[47] Various factors have been linked to age-related changes in organized PA participation during childhood and adolescence, including the educational environment,[48,49] social norms[48,50] and biological changes.[51] In particular, girls[48] and lower-skilled students[49] may feel alienated by a greater emphasis on competition and performance during adolescence.[50] Some adolescents may also be dissuaded from organized PA due to their experiences during Physical Education (PE) classes at school.[48,49] Girls may particularly choose to refrain from organized sports due to self-consciousness and a fear of appearing too masculine or aggressive.[48] However, these gender differences may also be prone to secular changes.[14] For example, a Swedish study reported that sports club membership increased between 1974–1995 among 16 year old girls (+9%) but not boys (±0%).[52] However, other studies reported secular declines in organized PA among both genders in Australia[53] and Switzerland.[54]

Relatively few studies of non-organized PA were included in the present review. Non-organized PA tended to remain stable among adolescent girls and decline among adolescent boys, which is in line with the cross-sequential findings of Findlay et al.[55] According to a previous systematic review, the overall PA of boys declines at a faster rate during late adolescence than that of girls[5] which suggests that this domain may be a contributor to that decline.[4] Additional research is warranted to investigate this relationship in detail.

Participation in active chores was only reported by two studies in this review.[9,10] According to these studies, this domain increased in the transition to adolescence and then stabilized. This pattern was similar to the quadratic trajectory in a study of youth from age 8–18 in the USA.[56]

Information about changes in PA participation by domain is useful to support the development of targeted PA promotion strategies.[11] In particular, longitudinal trends in PA domains could be used to inform market segmentation strategies within a social marketing framework.[57] Market segmentation may be used to develop targeted strategies for particular groups, such as adolescents who are inclined to drop out of particular PA domains. Segmentation strategies are commonly supported by data analysis techniques such as cluster analysis (e.g. Leech et al.[58]) to identify the characteristics of individuals who share similar patterns of behavior. Further information about the relationship between domain-specific changes and the overall decline in PA would assist in determining the priority segments to be targeted. Despite these opportunities, the use of segmentation strategies in PA interventions appears relatively scant.[59,60] Therefore, market segmentation may be an appropriate means of developing more tailored approaches to PA promotion among children and adolescents.

To the authors' knowledge, this is the first systematic review to report age-related changes in the prevalence of PA domains during childhood and adolescence. This approach offers the capacity to develop a more nuanced understanding of PA changes during maturation. In addition, the review included four domains of PA which provides a more holistic picture of behavior than one domain in isolation. This review also employed rigorous selection criteria by only including studies that reported data for the same respondents over time.

However the review is also subject to some limitations. Few studies in this review were deemed to have a low risk of bias (6/23 studies), mainly due to high attrition rates and insufficient reporting of validity and reliability. Studies were also rarely compatible in terms of PA domain measurement (e.g. data type, reference period) which prevented aggregate data analysis. Instead, data synthesis focused on the significance and direction of change rather than magnitude. Also, few studies reported separate trends for in-school and out-of-school PA, so it was not possible to discuss these trends. It should also be noted that the participants of some studies spanned more than one age category (n = 8),[7,10,25,32,34,35,37,42] although the extent of the overlap was generally only one year (n = 6/8).[7,25,32,34,35,37] Although this review aimed to be as comprehensive as possible, it may have also been limited by a lack of a consistent nomenclature (e.g. interchangeable use of 'domain', 'mode', 'context', etc). The search terms were intentionally broad to encompass as many studies as possible, although consistent terminology is encouraged in future studies. Finally, most studies in this review were conducted in Europe which may affect the generalizability of the findings to other regions. However, an effort was made to account for this by highlighting regional variations in the text.

5. Conclusion

Despite the diversity of the included studies, this review has highlighted some overall trends in the domains of PA among youth. Most studies of active transport reported an increase during childhood (n = 3/6), a plateau in the transition to adolescence (n = 5/8) and no change (n = 1/2) or decline (n = 1/2) during adolescence. The majority of studies of organized PA reported an increase during childhood (n = 3/5), an increasing (n = 2/4) or stable (n = 2/4) pattern in the transition to adolescence, and no change (n = 2/3) or decline (n = 2/3) during adolescence. Non-organized PA participation tended to vary by sex — remaining stable among adolescent girls (n = 2/2) and declining among adolescent boys (n = 1/2). Active chores increased during the transition to adolescence (n = 1/1) and then stabilized (n = 1/1). Potential strategies for PA promotion among youth may include targeting non-organized PA among adolescent boys or organized PA among late adolescent boys and girls. Such strategies may have positive implications for overall PA and health in adulthood. However, additional high-quality studies of participation in PA domains are required, particularly non-organized PA and active chores.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.jsams.2018.12.012.

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