Physical activity interventions among youth living in rural and remote areas: A systematic review

John Dennehy,[1]* Melainie Cameron,[1,2,5] Tania Phillips,[3] Tracy Kolbe-Alexander[1,4,5,6]

[1]School of Health and Medical Sciences, University of Southern Queensland, Ipswich, Australia
[2]Research Unit for Physical Activity, Sport, and Recreation (PhASRec), North-West University, Potchefstroom, South Africa
[3]School of Psychology and Wellbeing, University of Southern Queensland, Ipswich, Australia
[4]UCT Research Centre for Health through Physical Activity, Lifestyle and Sport (HPALS), Division of Research Unit for Exercise Science and Sports Medicine, University of Cape Town, South Africa
[5]Centre of Health Research, University of Southern Queensland, Springfield, Australia
[6]Manna Institute, Australian Government Department of Education, Australia

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Abstract

Objectives: Physical activity (PA) interventions have potential to improve health and social outcomes among youth. The aim of this study was to collate the evidence on the effectiveness of PA and sports-based interventions among youth living in rural and remote areas.

Methods: We searched five databases and grey literature (HealthInfoNet). Search terms included *PA, rural status, adolescents*, and *outcome measures*. Studies were included if published in English, recruited 10- to 18-year olds, and were based in rural or remote communities (Modified Monash Model [MMM] area classification range of MMM 3–7). Quasi-experimental and pre-experimental and post-experimental PA interventions were included. Two authors evaluated the articles independently following the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines, and relevant data were extracted. *International Prospective Register of Systematic Reviews (PROSPERO)* (CRD42020199001).

Results: Of the 11802 studies identified, 6 were included in the review. Most studies were excluded for not meeting MMM 3–7 criteria. Four of the included studies had sports-related interventions, and 2 had walking-based interventions. Outcomes included self-efficacy, mental health, and academic performance. One study reported a positive effect of PA on self-efficacy ($\beta = 0.26$, p=0.018, odds ratio = 1.43 [95% confidence interval: 1.07–1.92]).

Conclusion: Few community-based PA interventions have been evaluated in rural areas. There is a need for future evaluations in rural areas and include PA as an outcome measure.

Implications for Public Health: The findings highlight the need for measurement of PA outcomes in PA interventions in rural and remote areas. The findings also highlight the need for research to utilise a standardised measure of rurality.

Key words: physical activity, rural and remote, adolescent, youth

Introduction

The health and wellbeing benefits of physical activity (PA) in children and adolescents are well established,[1] including improving body composition, cardiorespiratory fitness, muscular strength, and bone and cardiovascular health .[2,3] Regular PA decreases the risk of depression and has a positive impact on cognitive and academic outcomes.[4] Importantly, physically active adolescents are more likely than their inactive counterparts to continue PA in adulthood.[5]

Abbreviations

ES, effects size; IYSP, Indigenous Youth Sports Program; MMAT, Mixed Methods Appraisal Tool; MMM, Modified Monash Model; MVPA, moderate to vigorous physical activity.

***Correspondence to**: John Dennehy, 13 Banyula Drive, Torrington, QLD, 4350, Australia;
e-mail: john@bettermovementclinic.com.au.

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The global prevalence of physical inactivity, defined as less than an average of 60 minutes of moderate to vigorous PA each day, is 81% among adolescents[6] and 78.3% in Australian adolescents.[7] Boys are more physically active than girls from 5–17 years of age.[8] Habitual levels of PA start to decline from the age of 5 years, at a rate of 4.2% per year, accompanied by a simultaneous increase in sedentary time.[8] Data from international studies show that adolescents living in rural and regional areas participate in significantly less PA and have lower cardiorespiratory fitness levels than those in urban areas.[9] Indigenous rural-living adolescents also show more marked decline in habitual levels of PA from ages 8–17 years.[10] Limited access to PA and sporting facilities, lack of opportunities, and distance to travel to access sport are factors that might contribute to the decreased levels of PA in rural areas.[11]

Sports participation is one of the main contributors to adolescents reaching the PA guidelines.[12] However, one in three Australian children aged 5–14 years do not participate in any organised sport.[12] Girls who dropped out of sport during adolescence reported significantly lower scores on the physical component summary of the SF-12 health survey at 20 years of age than who remained physically active. Compared to physically active adolescent girls, those who did not participate in organised sport had lower lean body mass, lean mass index, and SF-12 physical component summary scores. Similarly, boys who stopped organised sport reported significantly less weekly physical and had higher percentage body fat than boys who remained active .[13] Multiple factors contribute to young people stopping organised sport including lack of access to physical education specialist teachers, coaching, and facilities.[13]

PA interventions in rural locations demonstrate the value of community sport engagement. Community sport is associated with significant improvements in quality of life, self-management strategies, self-efficacy, and improved family and peer support.[11,14] Despite the potential benefits, community-based sport and PA interventions have had limited effect on habitual levels of PA among adolescents.[11] Furthermore, there are few PA and sport interventions targeting rural-living adolescents.[14]

A challenge in the literature is the inconsistency when classifying regionality. For example, some studies categorise urban centres as >50 000 residences and anything smaller as rural.[15] Other studies use more nuanced classifications, such as urban (>100,000 population), peri-urban (>25,000–99,999 population), or rural (<10,000 population).[16,17] Australia has two classification systems to define rurality. The first system is the Australian Standard Geographical Classification Remoteness Area (ASGS-RA) uses population density to classify regions.[18] The second system is the Modified Monash Model (MMM) that builds on the ASGS-RA criteria with additional adjustments for needs and distance to healthcare, secure food, and affordable housing, and is therefore considered as more comprehensive.[19] The MMM is the preferred system as it accounts for both population distribution and the socioeconomic status and determinants of the communities and was applied in this review.

Previous systematic reviews exploring the effectiveness of school-based PA interventions in adolescents have shown diverse findings, including a 2.6-minute increase in physical education lessons and an 83-minute increase in total weekly PA.[20] Physical education lessons have resulted in increased moderate to vigorous PA .[21] Most of the studies included in these reviews were from urban areas,[11,22] demonstrating limited evidence in rural and remote areas.

The disparities in rural schools have been highlighted in a recent systematic review.[9] Barriers to participation by students at rural schools include fewer opportunities for PA and sport after school, social isolation, fewer resources, and significant distances to resources for PA such as ball fields and community centres.[9] A previous review by Pfledderer, Burns[9] that included five rural studies, four of which does not meet the MMM classification for rurality. This review[9] only reported school-based programs and did not include community and grey literature.

In summary, despite the benefits of PA, PA declines at a disproportionate rate among adolescents living in rural areas compared to those living in urban areas.[23] Effective strategies and interventions targeting rural-living children and adolescents, especially girls, is needed. The majority of systematic reviews have focussed on urban areas with little research into adolescent PA in rural areas. Therefore, the aim of this systematic review was to collate community-based PA interventions among youth living in rural areas.

Methods

We conducted a systematic review of community-based PA interventions in rural living youth following the PRISMA guidelines.[24] The review was registered with PROSPERO (CRD42020199001, registered 15/08/2020).

Search strategy

Literature searches were conducted in the following electronic databases: EBSCOHost Megafile (includes but not limited to APA PsychInfo, CINAHL Ultimate, and SPORTDISCUS), PUBMED, SCIENCEDIRECT, Cochrane Library, and Google Scholar from inception to September 2023. Search terms used included *PA* or *sport* or *exercise*, *youth* or *adolescent* not *child*, *rural* or *regional* or *remote*, *overweight* or *obese*, *cognitive* or *academic*, *social* or *school attendance* or *psychological*, as well as known synonyms. Keywords were entered into each database using the population, intervention, comparison, and outcomes framework. Grey literature and unpublished program searches were conducted via HealthInfoNet.[14] Forward and backward citation tracking was also conducted .[14]

Geographic classification systems

The Australian MMM was used as the inclusion criteria for remoteness (Table 1). The geographic characteristics of kilometres from regional centres and access to services was used to categorise the MMM level (MM4 categorised as within 10-kilometres road distance from a town with a population between 5000 and 15 000) .[19] This model was applied to all studies, both those from Australia and those from other countries. For non-Australian studies, the authors were contacted via email to obtain geographic location and resourcing information such as access to housing, food security, and health care. This information was then used in conjunction with distance to main highway and regional centres, as well as the locations socioeconomic index.

Inclusion criteria

Inclusion criteria were (i) participants aged 10–18 years, (ii) PA intervention (any research design), (iii) region identified as rural and or remote MMM 3–7 (Table 1), and (iv) published in English. Grey literature reports and unpublished programs were included if undertaken in Australia at any stage until September 2023 and were

Table 1: Description of the Modified Monash Model classification area.

Modified Monash Category	Description
MM 1	Metropolitan area: Major cities accounting for 70% of Australia's population. All areas categorised ASGS-RA 1
MM 2	Regional centres: Inner (ASGS-RA 2) and outer regional (ASGS-RA 3) areas that are in, or within a 20-km drive of a town with over 50,000 residents
MM 3	Large rural towns: Inner (ASGS-RA 2) and outer regional (ASGS-RA 3) areas that are not MM 2 and are in, or within a 15-km drive of a town between 15,000 to 50,000 residents
MM 4	Medium rural towns: Inner (ASGS – RA 2) and outer regional (ASGS-RA 3) areas that are not MM 2 or MM 3, and are in, or within a 10-km drive of a town between 5,000 to 15,000 residents
MM 5	Small rural towns: All remaining Inner (ASGS – RA 2) and outer regional (ASGS-RA 3) areas. Islands that have an MM 5 classification with a population of less than 1,000 without bridges to the mainland will now be classified as MM 6
MM 6	Remote communities: Remote mainland areas (ASGS-RA 4) and remote islands less than 5 km offshore. Islands that have an MM 5 classification with a population of less than 1,000 without bridges to the mainland will now be classified as MM 6
MM 7	Very remote communities: Very remote areas (ASGS-RA 5) and all other remote island areas more than 5 km offshore

Abbreviations: ASGS-RA = Australian Standard Geographical Classification Remoteness Area; MM = Modified Monash Model Classification.

subject to all other inclusion criteria. International grey literature was not searched due to the absence of a single repository of sources.

Screening and selection

Retrieved titles, abstracts, and full-text articles and were reviewed for eligibility by two reviewers. A third reviewer was available for consultation in the event of disagreements; however, this was not required.

For grey literature, if further data were required, the program coordinator was contacted in the first instance via email to obtain data and verify information. If there was no response, 2 more follow-up emails (a week apart) were sent, followed by 2 telephone calls (a week apart). Reports with Incomplete data were excluded.

Data extraction

One reviewer undertook the data extraction, which was checked by a second reviewer. Data extraction was documented in structured template using Excel (Microsoft). Data extracted included author, publication year, study design, sample size, participant characteristics, description of intervention, control group (if included), and primary and secondary outcomes.

Outcomes of interest

PA participation included mode, duration, frequency, intensity, academic performance outcomes such as test results or cognitive measures, and body composition. Further adverse events, reasons for withdrawal from PA program, feasibility, and sustainability were collected.

Quality assessment

Study quality and risk of bias was assessed using the Mixed Methods Appraisal Tool (MMAT).[25] Two authors independently assessed all studies for quality and risk of bias and reviewed results. A third reviewer was available for adjudication of discrepancies; however, this was not required.

Results

Of the 11802 articles identified, 11346 were from database searches. Grey literature searches including 451 were found in the Australian Indigenous HealthInfoNet. An additional 5 were included from citation checking. There were 11739 articles remaining after duplicates were removed. After initial screening, 11642 articles were removed based on title and abstract. The remaining 97 articles were screened in full text, and 91 were excluded. Six studies met eligibility criteria (see Figure 1) after all screening was completed.

These articles had diverse objectives and outcome measures, and consequently, a quantitative analysis and meta-analysis was not conducted.

Quality assessment

All papers were appraised using the MMAT.[25] Of the MMAT questions asked, the screening questions and quantitative non-randomised ones were answered. The quality of all studies was graded as *poor* because none scored 'yes' on all five MMAT measures.

Research designs

There was one quasi-experimental[26] study, and 4 studies had pre–post designs[27–30] (Table 2). Awotidebe, Monyeki,[29] Akiyama, Gregorio,[26] Manley and, Cowan[30] reported that they had a control group; however, Akiyama and Gregorio,[26] provided no information on the control group's activities. The 3 remaining studies did not have control groups (see Table 3).[27,28,31]

Study population

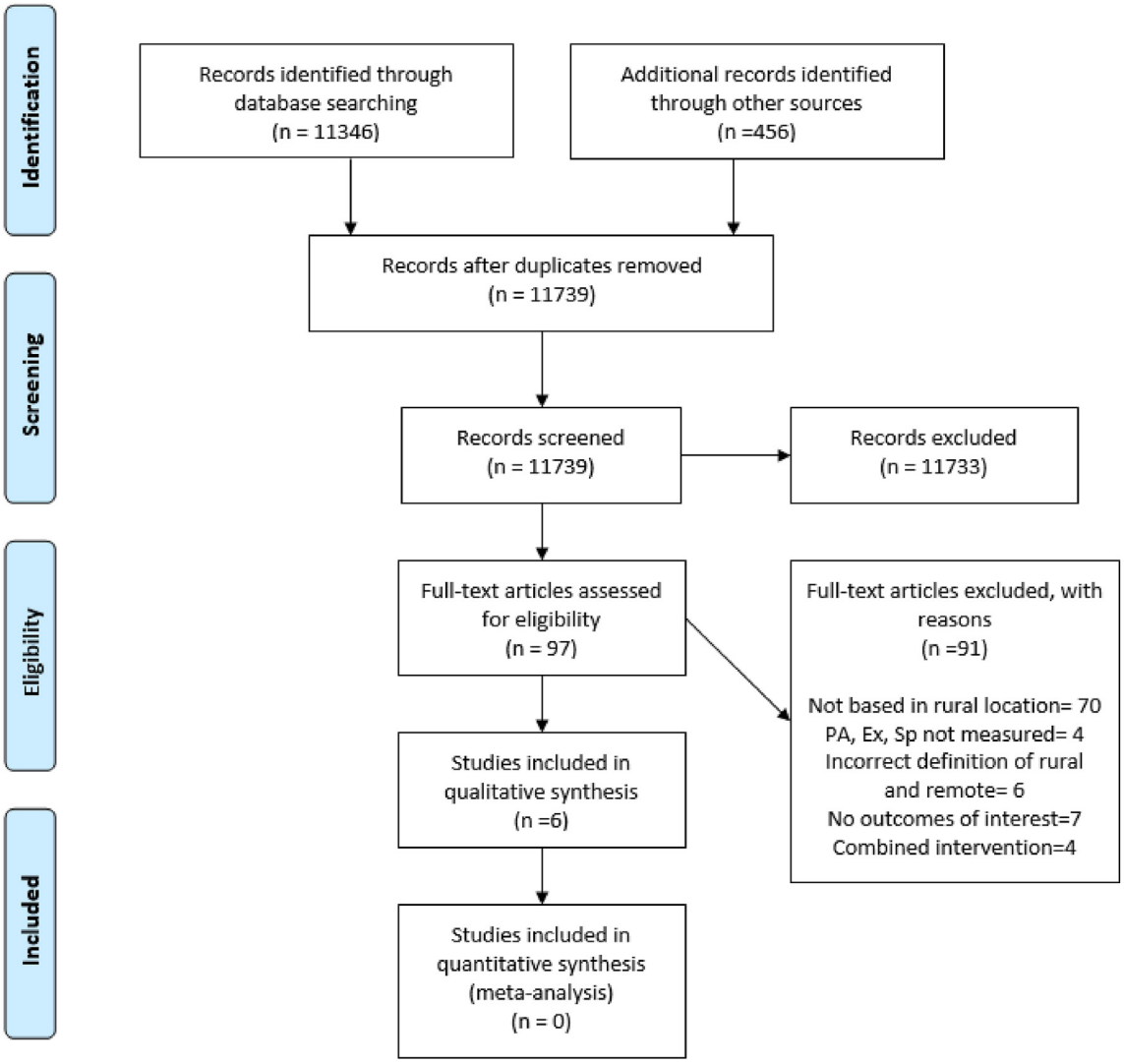
There were 1105 participants in the included studies (range: 12 – 430 participants per study). Studies were conducted in Australia ,[27,31] Germany ,[28] Philippines ,[26] United States of America ,[30] and South Africa [29] (Table 2). Four studies were conducted in MM3 areas (Table 1). One study was spread across MM 3–5 areas. One study was conducted in an MM 6 area.

The grey literature searching returned one report only of the Sporting Chance Program.[31] This program reported implementation within 143 schools; however, the total number of adolescents participating was not reported. The Sporting Chance Program encompassed several programs including Clontarf Academy (Clontarf Foundation) and Sport for Life (Stride Foundation).

Physical-activity interventions

Duration of the interventions ranged from 3 days to 12 months (Table 2). Sport-related activities were utilised as the intervention in four studies,[26,27,29,31] pedometer intervention was utilised as the fifth,[30] and the final study involved hiking .[28]

Figure 1: PRISMA flow diagram showing systematic approach to literature review.[24] Abbreviation: PRISMA = Preferred Reporting Items for Systematic Review and Meta-Analysis.



Soccer

The effects of a 12-week sport-based HIV prevention program on HIV risk and self-efficacy in high school students was investigated by Awotidebe and Monyeki.[29] This sport for development intervention took place in an MM 3 area and comprised 430 participants aged 13–18 years; 50.4% were female. The intervention included the 'Grassroot Soccer Skillz' curriculum comprising of 11 soccer-based practice sessions and discussions about HIV and AIDS, peer pressure, awareness of gender roles, sexual-risk awareness, stigma, discrimination, and counselling. All sessions were delivered by a trained peer educator. The control group participated in a sport activity once a week but did not receive any of the educational sessions.

Self-reported outcomes related to sexual behaviour, HIV knowledge, self-efficacy, peer influence, sexual communication and negotiation skills, and time perspective inventory were collected. These data were collected before and immediately after the intervention and again at 16 weeks after the intervention. The intervention group had significantly higher self-efficacy scores at 16 weeks than the control group ($\beta = 0.26$, $p = 0.018$, odds ratio: 1.43 [95% confidence interval: 1.07–1.92]). Over the 12-week intervention, there were no significant changes in sexual behaviours; however, participants reported getting tested for HIV more often. Similarly, HIV knowledge (effect size [ES]: 0.45, $p < 0.000$), self-efficacy (ES: 0.09, $p < 0.02$), and negotiation skills (ES: 0.07, $p < 0.02$) improved significantly in the intervention group, with no changes in the control group. Despite the positive effects in self-efficacy, no significant impact was found to risky sexual behaviours. PA outcomes were not measured.

Volleyball

Akiyama and Gregorio[26] aimed to use volleyball activities to increase at-risk adolescents' personal and social development, especially self-esteem. The Mastery Approach to Coaching education program included training and intra-school competition, in addition to training school leaders and teachers to become coaches. There were 293 students (56.7% female) enrolled, and their mean age was 16.6 years (±1.61). The 2-month intervention comprised of volleyball activities 1 hour a day, for 4 days a week. Self-esteem was measured using the Rosenberg Scale before and after intervention. Self-esteem improved

Table 2: Rural physical activity intervention.

Author Year	Location	Participants	Control	Age	Setting	Intervention	Outcome Measure					
							Self-efficacy	Mental health	Academic	Physical activity	Aerobic fitness	BMI
Awotidebe, A. Monyeki, A. Phillips, J. Lens, W. 2014	South Africa MM3	N = 430 (250 Intervention)	180	13-18 years	School and community	Soccer D = 12 week	P = 0.01 OR: 1.43					
Akiyama, T. Gregorio, E.R. Kobayasji, J 2018	Philippines MM3	N = 293 (Female = 166, Male = 127) Intervention = 51	242	16.6 years old (SD = 1.6)	School	Volleyball D = 8 week F = 1 hour a day/4 days a week		Self-esteem p = 0.02				
Manley, D. Cowan, P. Graff, C. Perlow, M. Rice, P. Richley, P. Sanchez, Z. 2013	USA MM3	N = 116 (Intervention 29)	9 available for repeated measures analysis	11.6 (SD = 0.71)	School	Physical activity D = 12 weeks	Intervention: B = 14.74 ±2.88, P = 15.54 ±2.09. Control B = 15.13 ±2.22, P = 15.67 ± 2.13			Step count Intervention: B = 8963.8 ± 2880.4, P = 7644.5 ± 2331.3. Control: B = 11297.4 ± 3409.8, P = 10765.0 ± 3489.4.	1-mile walk test Intervention: B = 46.79 ± 10.91, P = 49.57 ± 9.80. Control: B = 51.79 ± 13.06, P = 51.42 ± 12.82.	RBMI Intervention: B = 130.18 ± 29.96, P = 120.45 ± 35.70. Control: B = 116.99 ± 26.37, P = 114.07 ± 25.68.
Mutz, M. Muller, J. 2016	Germany MM6	N = 12 (5 female, 7 males)		14 years	School	Physical activity D = 9 days F = 8 hours/day	ES = 0.26 *p*=0.188	Stress ES = -0.66 p = 0.022 Wellbeing ES = 0.58 p = 0.034				
Macgregor, C. Mann-Yasso, M. Wallace, S. Savage, S. Signal, T. 2015	Australia MM3	254 (59.3% male)		10–15 years	Community	Multisport D = 3–5 days			Positive shift towards higher agreement 6 out of 8 questions			
Australian Council for Educational Research for Department of Educational, Employment and Workplace Relations. 2011	Australia MM3–5	143 schools		10–18 years	School	Multisport		Self-report school attendance and self-confidence: r = 0.23 p = 0.01	Increase school attendance 11.5% girls 15.4% boys			

Abbreviations: MM = Modified Monash Model Classification; D = Duration; F = Frequency; B = Baseline; P = post-12-week intervention; BMI = body mass index; SD = standard deviation; OR = odds ratio; ES = effect size.

Table 3: Mixed Methods Appraisal Tool.

Category of study designs	Methodological quality criteria	Awotidebe, A. Monyeki, A. Phillips, J. Lens, W.	Akiyama, T. Gregorio, E.R. Kobayasji, J	Manley, D. Cowan, P. Graff, C. Perlow, M. Rice, P. Richley, P. Sanchez, Z.	Mutz, M. Muller, J.	Macgregor, C. Mann-Yasso, M. Wallace, S. Savage, S. Signal, T.	Australian Council for Educational Research for Department of Educational, Employment and Workplace Relations.
Screening questions (for all types)	S1. Are there clear research questions?	Y	Y	Y	Y	Y	Y
	S2. Do the collected data allow to address the research questions?	Y	Y	Y	Y	Y	Y
3. Quantitative non-randomised	3.1 Are the participants representative of the target population?	Y	Cannot tell	Y	Cannot tell	Y	Y
	3.2 Are measurements appropriate regarding both the outcome and intervention (or exposure)?	Y	Y	Y	Y	N	N
	3.3 Are there complete outcome data?	Y	Cannot tell	N	Y	Y	N
	3.4 Are the confounders accounted for in the design and analysis?	N	Y	Y	N	N	N
	3.5 During the study period, is the intervention administered (or exposure occurred) as intended?	N	Y	Y	Y	Y	Cannot tell

significantly in the intervention group with no changes in the control group. Consequently, the authors suggested sport intervention could improve self-esteem in at-risk groups. PA outcomes were not measured.

Multisport

The Indigenous Youth Sports Program[27] aimed to investigate the impact of PA and the Indigenous Youth Sports Program on Indigenous Australian students' perception, beliefs, and views on higher education. Indigenous Australia students (n = 253) living in MM 3–5 locations, mean age: 11.5 years (±1.1), with 40.7% being female, volunteered to participate. The program was sports-focused; however, students also participated in cultural activities (dance and storytelling). The primary outcome of this study was whether participants aspired to tertiary education. The study found significant improvement in questionnaire scores towards (a) likely to attend school regularly, (b) doing sufficiently well to attend tertiary education, and (c) shown interest in continuing education. The authors concluded that sport could be used as a strategy to increase engagement and participation in education. This in turn might increase employment opportunities and enrolling in tertiary studies.

The Sporting Chance program[31] is a multicomponent program that aims to encourage school attendance, strengthen engagement with learning, and increase school retention up to year 12. This program used different sports to achieve its objectives. Students aged from 10–18 years from 143 schools participated in the program. Both female and male Indigenous Australian students are included; however, there was no information on the number of participants enrolled. Eighty-five percent of the girls participating in the Sporting Chance program reported attending school nearly every day and 96.5% compared to 85% by those who did not participate. Boys reported a 15.4% increase in school attendance. The study also showed a positive correlation between self-reported school attendance and self-confidence (r = 0.23, p = 0.01). PA outcomes were not measured.

Pedometer

The aim of the study was to examine the effectiveness of a school-based pedometer intervention in improving self-efficacy, PA, body mass index, and aerobic fitness.[30] The study comprised of 116 participants; however, only 29 participants completed pre and post–data collection. The main intervention component was to include an additional 10 minutes of walking- and jogging-based activity during physical education class. Participants wore a pedometer for 12 weeks and steps taken, aerobic fitness, and self-efficacy were measured at baseline after the 12-week intervention. Self-efficacy improved by 0.75 in the intervention group in comparison to 0.5 in the control group. Daily step count decreased by approximately 500 steps, and there were no other improvements in the other outcome measures.

Hiking

The effects of a 9-day hike on adolescent mental health and subjective wellbeing (SWB)[28] was assessed in 12 participants. Self-reported stress, self-efficacy, mindfulness, and SWB were measured at the start and end of the hike. There were significant reductions in measures of stress (d = -0.66, p = 0.022) as did SWB (d = 0.58, p = 0.034).[28] Minimal improvements were observed in self-efficacy and happiness scores. However, these equivocal results may be due to the study being underpowered by a small sample size.

Discussion

Our review demonstrates that previous interventions have used organised sport as the favoured intervention for youth participation in rural and remote areas. Some of the interventions resulted in improvements in self-efficacy, mental health, and academic outcomes. However, it is notable that PA was not a primary or secondary outcome of any of the included studies in this systematic review. Consequently, changes in PA were not quantified, apart from one study using pedometers. Future interventions have an opportunity to measure PA in rural and remote areas.

PA not being measured in rural and remote interventions means we are unsure whether interventions can influence PA behaviours of rural living adolescents. The one study[32] in this review that measured PA found no improvement to PA in rural-living youth. The global "sport for development and peace" sector has been using PA in rural and remote areas with a primary focus of social development and to reduce poverty. There is a current motivation amongst policy makers to increase the quality of "sport for development and peace" programs to increase promotion as an effective approach to increase PA and international development.[33] A study into play streets in rural areas found the activity-engaged participants in PA however highlighted they did not measure total PA; the limit was unknown.[34] We recommend that where an intervention includes PA or sport as part of the program, habitual levels of PA are included as an outcome measure.

Rural and remote PA interventions have a varied design due to access to PA facilities and equipment. There is significant evidence of a positive association between access to recreational and sporting infrastructure and youth PA.[35] Urban dwelling adolescents report good access to PA facilities and public open spaces, by foot, bike, or public transport.[36] Urban youth are more likely to participate in PA if facilities and open spaces are close to schools, shops, and city centres.[36] An Australian study found parents' reports of good sporting facilities nearby were associated with higher self-reported walking or cycling in adolescents.[37] In rural areas, adolescents report a lack of access to PA facilities and poor transportation. The impact of the lack of access to facilities is exemplified by the poor rates of PA in rural-living adolescents, particularly as they age.[23] The true influence of PA interventions is however unknown as there is little published evidence measuring objective PA outcomes in rural areas.

Our results suggest that schools are the most frequently used setting for interventions in rural locations. Schools have been proposed as an ideal setting to increase PA;[38] however, research into older adolescents (15–19 years) is limited.[38] School sport has previously been used as an intervention model for mental health and social wellbeing programs for adolescents living in rural areas.[39] Long waiting periods for health professional service, few health providers, cost, transportation, stigma, and stoicism are drivers to rural adolescents' poor mental health.[40] Due to poor-access school sport, sporting clubs and community organisations have been used as a critical substitute for support networks for young people living in rural locations.[39] There is emerging literature to support the effectiveness of school-based PA for improving time-on-task classroom-based behaviours.[41,42]

High-intensity interval training (HITT) has recently emerged as a novel and time-efficient model for promoting PA in schools .[43] HITT may be considered as a possible intervention design to improve PA in rural and remote areas.[43,44] A recent Australian study[44] reported an increase in cardiorespiratory fitness of adolescents after 6 months by implementing teacher-led high-intensity interval activity breaks during school time. Aiming to increase cardiorespiratory fitness, models have been developed such as increasing quality and intensity of physical education lessons, changing school environments to promote activity, and creating opportunities for PA breaks through lesson time.[44] Collated evidence from PA interventions conducted in urban and rural areas resulted in modest increases in habitual levels of PA in urban areas.[9] Little improvement was seen in rural school-based interventions.

Self-efficacy was the main outcome in three of the studies in our systemic review. Our results demonstrated PA has a positive effect on self-efficacy of rural living adolescents.[28,29] Previous findings in adolescents suggest a small and insignificant effect of PA on self-efficacy (0.29 [95% confidence interval = 0.07, 0.52]).[45] A comprehensive review, with a majority of cross-sectional studies, into PA correlates in adolescents found that its impact on self-efficacy was uncertain.[46] However, a more recent review reported that changes in self-efficacy were directly related to changes in adolescent PA.[47] Evidence from Lubans and Foster [47] suggests that interventions with the aim to increase PA should target self-efficacy using appropriate strategies such as the use of PA in conjunction with peer support and outcome expectancy.

Our review found sport as the favoured intervention type. Sport has previously been used to generate positive community identity and cohesion in indigenous communities.[48] Australian Indigenous adolescents reported that they enjoyed participating in sport and had greater self-confidence.[49] Sports team membership was associated with higher levels of PA in Non-Indigenous Australians but not among Indigenous Australians.[50] Macniven and Hearn[50] reported the reason for this might be racial stereotyping in sport and claimed the assumptions of the positive effects of Indigenous sport programmes (such as Macgregor, Mann-Yasso,[27] and Australian Council for Educational Research [31]) may have been overstated.[50,51] Targeted programs specific to community aiming to create equity in access to health in all populations may return a greater adoption of healthy behaviours.

There is a maldistribution of research towards urban areas. Interventions in rural areas have yet to show a positive long-term effect on adolescent PA. Current funding mechanisms in rural Australia focus predominantly on chronic-disease treatment in adult populations. Macniven and Canuto[52] theorised the cause of this is upstream public policy that aims to reach the greatest number of people, which is likely to have the greatest impact on the population. Further, the lack of consistency of how to classify rural areas has demonstrated a gap in repeatability, scalability, and long-term feasibility of program development.[53] Rural classification is the foundation for allocation of resources by state and federal governments. The strength of the MMM to form the basis of analysis and program development as it highlights areas that have both a critical mass of population and differing levels of socio-economic background.[54] Decisions about resourcing have significant ramifications for the amount of spending in the region as well as the wellbeing of the rural populations.[55]

Strengths

The strengths of this study include the use of the MMM to help characterise degrees of rurality. This has enabled more transparent reflection of the interventions access to resources.[19] The inclusion of both published literature and online and grey sources has enabled a more comprehensive review of the PA of rural-living adolescents and enhanced the scope and completeness of the review.

Limitations

The main limitation of this systematic review is the small number of participants in the studies that met the inclusion criteria, together with the diverse variation in the outcomes assessed. Many of the grey literature sources were not included in the review due to a lack of

responsiveness from the program managers or insufficient data collected. Improvement in data collection of community programs will enable formal evaluations of grey literature to occur. The small number of eligible studies included reported a small number of participants and demonstrated poor quality.

Conclusion

The main finding from our systematic review was that measures of PA were not assessed. These studies measured diverse outcomes and found that PA interventions have a positive influence towards mental health and self-efficacy. Sport-based interventions in a school setting are the predominant intervention component for rural-living adolescents. The lack of studies meeting inclusion criteria in this systematic review underscores the importance for developing and evaluating PA interventions for adolescents living in rural areas. Future interventions must address the participation in PA in rural areas, particularly when infrastructure and support programs are absent. Consequently, the overall effectiveness of PA interventions among adolescents living in rural areas is still unclear.

Practical implications

- Highlights the need for measurement of PA outcomes in interventions targeting rural-living adolescents.
- Highlights the need for research to utilise a standardised measure of rurality.
- Sport-focussed interventions linked with a school or community organisation more likely to be sustainable and effective for improving PA in rural-living adolescents.

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Ethical approval

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Conflicts of interest

The authors have no competing interests to declare.

Author ORCIDs

John Dennehy https://orcid.org/0000-0002-7556-7461
Melainie Cameron https://orcid.org/0000-0001-5788-8790
Tania Phillips https://orcid.org/0000-0003-4810-8566
Tracy Kolbe-Alexander https://orcid.org/0000-0002-5025-3204

References

1. Okely A, Salmon J, Vella S, Cliff D, Timperio A, Tremblay M, et al. *A systematic review to update the Australian physical activity guidelines for children and young people*. Report prepared for the Australian Government Department of Health; 2012.
2. Janssen I, Leblanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *Int J Behav Nutr Phys Activ* 2010;**7**:40.
3. Strong WB, Malina RM, Blimkie CJ, Daniels SR, Dishman RK, Gutin B, et al. Evidence based physical activity for school-age youth. *J Pediatr* 2005;**146**(6):732–7.
4. Alvarez-Bueno C, Pesce C, Cavero-Redondo I, Sanchez-Lopez M, Garrido-Miguel M, Martinez-Vizcaino V. Academic achievement and physical activity: a meta-analysis. *Pediatrics* 2017;**140**(6).
5. Ferreira I, van der Horst K, Wendel-Vos W, Kremers S, van Lenthe FJ, Brug J. Environmental correlates of physical activity in youth - a review and update. *Obes Rev* 2007;**8**(2):129–54.
6. World Health Organisation. *WHO guidelines on physical activity and sedentary behaviour*. 2020. Licence: CC BY-NC-SA 3.0 IGO).
7. Australian Sports Commission. *AusPlay National Sport and Physical Activity Participation Report, October 2023, 25-29. The AusPlay survey is an initiative of the Australian sports commission*. All AusPlay data is the intellectual property of the Australian Sports Commission. 2018. https://www.clearinghouseforsport.gov.au/research/ausplay/results.
8. Cooper AR, Goodman A, Page AS, Sherar LB, Esliger DW, van Sluijs EM, et al. Objectively measured physical activity and sedentary time in youth: the International children's accelerometry database (ICAD). *Int J Behav Nutr Phys Activ* 2015;**12**:113.
9. Pfledderer CD, Burns RD, Byun W, Carson RL, Welk GJ, Brusseau TA. School-based physical activity interventions in rural and urban/suburban communities: a systematic review and meta-analysis. *Obes Rev* 2021;**22**(9):e13265.
10. Evans JR, Wilson R, Coleman C, Man WYN, Olds T. Physical activity among indigenous Australian children and youth in remote and non-remote areas. *Soc Sci Med* 2018;**206**:93–9.
11. Casey MM, Harvey JT, Telford A, Eime RM, Mooney A, Payne WR. Effectiveness of a school-community linked program on physical activity levels and health-related quality of life for adolescent girls. *BMC Publ Health* 2014;**14**:649.
12. Hesketh K, Iubans D, Cleland V, Olds T, Reece L, Ridgers N, et al. *Reboot! Reimagining physical active lives: 2022 Australian report card on physical activity for children and young people*. 2022.
13. Howie EK, McVeigh JA, Smith AJ, Straker LM. Organized sport trajectories from childhood to adolescence and health associations. *Med Sci Sports Exerc* 2016;**48**(7):1331–9.
14. Macniven R, Elwell M, Ride K, Bauman A, Richards J. A snapshot of physical activity programs targeting Aboriginal and Torres Strait Islander people in Australia. *Health Promot J Aust* 2017;**28**(3):185–206.
15. Bennett KJ, Borders TF, Holmes GM, Kozhimannil KB, Ziller E. What is rural? Challenges and implications of definitions that inadequately encompass rural people and places. *Health Aff* 2019;**38**(12):1985–92.
16. Janz KF, Letuchy EM, Eichenberger Gilmore JM, Burns TL, Torner JC, Willing MC, et al. Early physical activity provides sustained bone health benefits later in childhood. *Med Sci Sports Exerc* 2010;**42**(6):1072–8.
17. Olson JL, March S, Brownlow C, Biddle SJH, Ireland M. Inactive lifestyles in peri-urban Australia: a qualitative examination of social and physical environmental determinants. *Health Promot J Aust* 2019;**30**(2):153–62.
18. Australian Bureau of Statistics. *Australian statistical geography standard (ASGS)*. Edition 3 2021 [updated 20/07/2021. 3:[Available from:. https://www.abs.gov.au/statistics/standards/australian-statistical-geography-standard-asgs-edition-3/jul2021-jun2026.
19. Humphreys J, Wakerman J. Learning from history: how research evidence can inform policies to improve rural and remote medical workforce distribution. *Aust J Rural Health* 2018;**26**(5):329–34.
20. van Sluijs EM, McMinn AM, Griffin SJ. Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials. *BMJ* 2007;**335**(7622):703.
21. Kriemler S, Meyer U, Martin E, van Sluijs EM, Andersen LB, Martin BW. Effect of school-based interventions on physical activity and fitness in children and adolescents: a review of reviews and systematic update. *Br J Sports Med* 2011;**45**(11):923–30.
22. Dudley D, Okely A, Pearson P, Peat J. Engaging adolescent girls from linguistically diverse and low income backgrounds in school sport: a pilot randomised controlled trial. *J Sci Med Sport* 2010;**13**(2):217–24.
23. Corder K, Sharp SJ, Atkin AJ, Griffin SJ, Jones AP, Ekelund U, et al. Change in objectively measured physical activity during the transition to adolescence. *Br J Sports Med* 2015;**49**(11):730–6.
24. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Int J Surg* 2010;**8**(5):336–41.
25. Hong Q, Fàbregues S, Bartlett G, Boardman F, Cargo M, Gagnon M-P, et al. The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers. *Educ Inf* 2018;**34**(4):285–91.
26. Akiyama T, Gregorio Jr ER, Kobayashi J. Youth sports activity and young people's well-being after a disaster: a trial with the Mastery Approach to Coaching (MAC) in the Philippines. *BMC Res Notes* 2018;**11**(1):747.
27. Macgregor C, Mann-Yasso M, Wallace S, Savage S-K, Signal T. Indigenous youth sports program - widening participation for higher education. *Widening Participation and Lifelong Learning* 2015;**17**(1):86–102.
28. Mutz M, Muller J. Mental health benefits of outdoor adventures: results from two pilot studies. *J Adolesc* 2016;**49**:105–14.

29. Awotidebe A, Monyeki A, Phillips J, Lens W. The outcomes of a sport-based intervention on risky sexual behaviours amount rural school-going adolescents. *Afr J Phys Health Educ Recreat Dance (AJPHERD)* 2014;**20**(4:1):1436–54.
30. Manley D, Cowan P, Graff C, Perlow M, Rice P, Richey P, et al. Self-efficacy, physical activity, and aerobic fitness in middle school children: examination of a pedometer intervention program. *J Pediatr Nurs* 2014;**29**(3):228–37.
31. Australian Council for Educational Research. *Evaluation of the sporting chance program*. Department of Education EaWR; 2011.
32. Manley AF. Cardiovascular implications of smoking: the surgeon general's point of view. *J Health Care Poor Underserved* 1997;**8**(3):303–10.
33. Langer L. Sport for development – a systematic map of evidence from Africa. *South African Review of Sociology* 2015;**46**(1):66–86.
34. Umstattd Meyer MR, Bridges Hamilton CN, Prochnow T, McClendon ME, Arnold KT, Wilkins E, et al. Come together, play, be active: physical activity engagement of school-age children at Play Streets in four diverse rural communities in the U.S. *Prev Med* 2019;**129**:105869.
35. Davison KK, Lawson CT. Do attributes in the physical environment influence children's physical activity? A review of the literature. *Int J Behav Nutr Phys Activ* 2006;**3**(1):1–17.
36. Van Hecke L, Deforche B, Van Dyck D, De Bourdeaudhuij I, Veitch J, Van Cauwenberg J. Social and physical environmental factors influencing adolescents' physical activity in urban public open spaces: a qualitative study using walk-along interviews. *PLoS One* 2016;**11**(5):e0155686.
37. Carver A, Salmon J, Campbell K, Baur L, Garnett S, Crawford D. How do perceptions of local neighborhood relate to adolescents' walking and cycling? *Am J Health Promot* 2005;**20**(2):139–47.
38. van Sluijs EMF, Ekelund U, Crochemore-Silva I, Guthold R, Ha A, Lubans D, et al. Physical activity behaviours in adolescence: current evidence and opportunities for intervention. *Lancet* 2021;**398**(10298):429–42.
39. Dowell TL, Waters AM, Usher W, Farrell LJ, Donovan CL, Modecki KL, et al. Tackling mental health in youth sporting programs: a pilot study of a holistic program. *Child Psychiatr Hum Dev* 2021;**52**(1):15–29.
40. Boyd CP, Aisbett DL, Francis K, Kelly M, Newnham K, Newnham K. Issues in rural adolscent mental health in Australia. *Rural Rem Health* 2006;**6**:501.
41. Mavilidi MF, Mason C, Leahy AA, Kennedy SG, Eather N, Hillman CH, et al. Effect of a time-efficient physical activity intervention on senior school students' on-task behaviour and subjective vitality: the 'burn 2 learn' cluster randomised controlled trial. *Educ Psychol Rev* 2020;**33**(1):299–323.
42. Owen KB, Parker PD, Van Zanden B, MacMillan F, Astell-Burt T, Lonsdale C. Physical activity and school engagement in youth: a systematic review and meta-analysis. *Educ Psychol* 2016;**51**(2):129–45.
43. Daly-Smith AJ, Zwolinsky S, McKenna J, Tomporowski PD, Defeyter MA, Manley A. Systematic review of acute physically active learning and classroom movement breaks on children's physical activity, cognition, academic performance and classroom behaviour: understanding critical design features. *BMJ Open Sport Exerc Med* 2018;**4**(1):e000341.
44. Lubans DR, Smith JJ, Eather N, Leahy AA, Morgan PJ, Lonsdale C, et al. Time-efficient intervention to improve older adolescents' cardiorespiratory fitness: findings from the 'Burn 2 Learn' cluster randomised controlled trial. *Br J Sports Med* 2020;**55**(13):751–8.
45. Schranz N, Tomkinson G, Olds T. What is the effect of resistance training on the strength, body composition and psychosocial status of overweight and obese children and adolescents? A Systematic review and meta-analysis. *Sports Med* 2013;**43**(9):893–907.
46. Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Med Sci Sports Exerc* 2000;**32**(5):963–75.
47. Lubans DR, Foster C, Biddle SJ. A review of mediators of behavior in interventions to promote physical activity among children and adolescents. *Prev Med* 2008;**47**(5):463–70.
48. Howie EK, Daniels BT, Guagliano JM. Promoting physical activity through youth sports programs: it's social. *Am J Lifestyle Med* 2020;**14**(1):78–88.
49. Mohajer N, Bessarab D, Earnest J. There should be more help out here! A qualitative study of the needs of Aborginal adolescents in rural Australia. *Rural Rem Health* 2009;**9**:1137.
50. Macniven R, Hearn S, Grunseit A, Richards J, Nutbeam D, Bauman A. Correlates of physical activity among Australian Indigenous and non-Indigenous adolescents. *Aust N Z J Publ Health* 2017;**41**(2):187–92.
51. Hallinan CJ, Bruce T, Coram S. Up front and beyond the centre line: Australian aborigines in elite Australian rules football. *Int Rev Sociol Sport* 1999;**34**:369–83.
52. Macniven R, Canuto K, Wilson R, Bauman A, Evans J. Impact of physical activity and sport on social outcomes among Aboriginal and Torres Strait Islander people: a scoping review protocol. *JBI Database of Systematic Reviews and Implementation Reports* 2019;**17**(7):1305–11.
53. Humphreys JS, Wakerman J, Wells R. What do we mean by sustainable rural health services? Implications for rural health research. *Aust J Rural Health* 2006;**14**(1):33–5.
54. Versace VL, Skinner TC, Bourke L, Harvey P, Barnett T. National analysis of the Modified Monash Model, population distribution and a socio-economic index to inform rural health workforce planning. *Aust J Rural Health* 2021;**29**(5):801–10.
55. Hart LG, Larson EH, Lishner DM. Rural definitions for health policy and research. *Am J Publ Health* 2005;**95**(7):1149–55.