What do we know about physical activity interventions in vocational education and training? A systematic review

Eva Grüne (eva.gruene@fau.de)
Friedrich-Alexander-Universitat Erlangen-Nurnberg https://orcid.org/0000-0001-7723-2895

Johanna Popp
Friedrich-Alexander-Universitat Erlangen-Nurnberg

Johannes Carl
Friedrich-Alexander-Universitat Erlangen-Nurnberg

Klaus Pfeifer
Friedrich-Alexander-Universitat Erlangen-Nurnberg

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Abstract

Background Although the health benefits of physical activity are well known, young people's physical activity behavior often is insufficient and declines in adolescence. Numerous studies have investigated the effectiveness of physical activity promoting interventions among young people, but none has reviewed the effectiveness of physical activity interventions in the vocational education and training (VET) setting. This systematic review aims to (1) synthesize and review the available literature on physical activity promoting interventions in VET and (2) examine their effects on physical activity-related outcomes, such as physical activity level, physical fitness, physiological parameters, or psychological factors.

Methods Five electronic databases were searched for studies involving adolescents aged 15 to 20 years that took place in a VET setting and evaluated the effects from an intervention, which had to comprise a physical activity component, on a physical activity-related outcome, such as PA level, physical fitness, physiological parameters, or psychological factors. The screening process and the quality assessment were conducted by two independent reviewer; data extraction was conducted by one reviewer and verified by another.

Results The literature search identified 18,959 articles and 11,282 unique records. After the screening process, nine studies met the pre-defined eligibility criteria and were included in qualitative analyses. All but two studies reported significant improvements for at least one physical activity-related outcome. The interventions substantially differed in their development approaches (top-down vs. bottom-up approaches), complexity (multi- vs. single-component), and addressed behavior (multi-behavioral vs. single-behavioral). The most conspicuous finding was that bottom-up approaches tend to improve outcomes at the psychological level and top-down approaches at the physical level. Regarding the interventions' complexity and addressed behavior, we could not reveal any conclusive results.

Conclusion This systematic review highlights the varying effects of physical activity promoting interventions in VET. Nevertheless, heterogeneous effects and overall weak study quality limited our ability to draw clear conclusions about the potentially most effective intervention strategies. Therefore, future research should focus on high quality studies with long-term follow-ups to make recommendations for practical use. Trial registration: PROSPERO CRD42018109845

Keywords: Physical Activity; Health Promotion; Adolescence; Apprenticeship; Students; School; Workplace

Background

The world is facing a high prevalence of physical inactivity among young people. Many adolescents do not meet the recommended guidelines of 60 minutes of moderate to vigorous physical activity (PA) [1, 2]. In Germany, only 7.5% of girls and 16.0% of boys between the ages of 14 and 17 meet these recommendations [3]. These alarming are reinforced by evidence that PA continues to decline between adolescence and young adulthood [4]. On the other hand, PA behavior adopted during childhood and adolescence is likely to be tracked into adulthood [5]. Incontrovertible evidence indicates lifelong health benefits from a physically active lifestyle [6, 7], underlining the need for actions that promote PA. Furthermore, adolescence or young adulthood is an important period for prevention measures, as many health-related behaviors, such as PA patterns, are learned and consolidated at this stage in life [8, 9]. At the same time, this transitional phase also is marked by some major life challenges. Difficulties in the transition from childhood to adulthood or from school to working life

and, thus, to independence and autonomy influence health and well-being, putting people at greater risk at this life stage [10].

For a large number of young people who do not pursue higher education after secondary school, vocational education and training (VET) is the first step toward working life. In VET, students acquire the knowledge, skills, and competencies specific to particular occupations to gain optimal professional qualifications [11]. A great heterogeneity exists between national VET systems. In Germany, VET is organized in a dual apprenticeship system combining school-based learning and company-based training. Other countries with well-established apprenticeship systems include Austria, Denmark, and Switzerland. In addition to the dual apprenticeship system, VET globally can be categorized into two other systems: school-based VET following a formal curriculum that combines general and occupation-specific knowledge (e.g., France, Sweden, United States) and informal-based VET outside of formal or general schooling (e.g., India, many African countries) [12, 13].

While numerous studies have confirmed PA promotion measures' effectiveness in school, university, and workplace settings [14–18], they are lacking in the VET context. Notwithstanding, VET is a promising setting for PA promotion, as it has a wide reach among adolescents and young adults, providing the opportunity to raise their awareness of PA and health at an early stage of life [19, 20]. Against this backdrop, this systematic review aims is to (1) synthesize and review the available literature on PA promoting interventions in VET and (2) examine interventions' effects on PA-related outcomes, such as PA level, physical fitness, physiological parameters, or psychological factors.

Methods

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [21] (see Additional file 1) and was registered prospectively in PROSPERO (CRD42018109845).

Search strategy

To identify interventions that promote PA in VET, we conducted a literature search to retrieve relevant articles published in English or German language between January 2000 and August 2018. The following five electronic databases were searched: PsychINFO, PubMed, Scopus, SPORTDiscus, and Web of Science. The literature search included a combination of keywords related to the setting (e.g., VET), health behavior of interest (i.e., PA), and type of study (e.g., intervention) (see Additional file 2). In addition, we used hand and snowball searching methods to ensure that all relevant publications were identified.

Eligibility criteria

In brief, we included studies on apprentices or VET students ($15 \leq \text{age} \leq 20$) in VET settings and evaluated the effects from an intervention that comprised a PA promoting component on at least one PA-related outcome, such as PA level, physical fitness, physiological parameters, or psychological factors. Due to the different international education systems, we also included studies within comparable settings such as community or junior colleges, as these populations and educational qualifications are very similar to those in VET. We

excluded studies that took place at universities due to entry requirements and degrees at universities. The full inclusion and exclusion criteria are outlined in Table 1.

Table 1: Eligibility criteria

	Inclusion criteria	Exclusion criteria
Population	apprentices or VET students aged between 15 to 20 years	apprentices or VET students younger than 15 or older than 20 years
Setting	VET or junior/community college	university, elementary school, primary school, high school, middle school
Intervention	single or multi-behavioral interventions aimed at promoting PA (i.e., ≥ 25% PA)	
Outcome	PA-related outcomes (e.g., PA level, physical fitness, physiological parameters, psychological factors)	
Study design	any kind of intervention study	cross-sectional study, review, validation study
Publication type	journal article	
Publication year	published between 2000 and 2018	
Language	English or German	all other languages
PA = physical activity; VET = vocational education and training		

Study selection

First, two independent reviewers (EG, JC) screened all titles and abstracts for eligibility using the pre-specified inclusion and exclusion criteria. In a second step, two authors (EG, JP) independently reviewed the full text of papers that potentially were suitable. If it was not clearly evident on the basis of the studies whether they met the eligibility criteria, additional information was requested from the investigators. All discrepancies during the study selection process were resolved through discussions among the research team. Inter-rater reliability in selecting studies for inclusion was measured with Cohen's kappa coefficient [22].

Data extraction

To summarize eligible studies' key points, we used a predefined data extraction form that included details on study characteristics, including author, publication year, study design, target group, setting, participants (sample size, sex, mean age), intervention (content, focus, strategy, period), and results. If additional information or clarification of data was required, we contacted the authors and included this data in the data extraction process. Additionally, effect sizes were taken either directly from the paper or computed using an online calculator [23]. Following Cohen's guidelines [22], the effect size was classified as trivial (|d < 0.2|), small (|d = 0.2|), medium (d=|0.5|), or large (|d = 0.8|). One reviewer (EG) conducted the extraction, then a second reviewer (JP) verified these results; discrepancies were resolved through discussions.

Study Quality

All studies that met the inclusion criteria underwent quality assessment using the Effective Public Health Practice Project's (EPHPP) quality assessment tool for quantitative studies [24, 25], recommended by the Cochrane Handbook for Systematic Reviews of Interventions [26]. Two reviewers (EG, JP) independently assessed the quality of the included studies, with the following domains considered: selection bias, study design, confounders, blinding, data collection methods, withdrawals and dropouts, intervention integrity, and statistical analysis. The first six domains were included in the assessment and rated as strong, moderate, or weak, according to the EPHPP dictionary. In case of discrepancies between raters, consensus was reached through discussions.

Results

The PRISMA flow chart in Fig. 1 outlines the search and screening process. The systematic search resulted in 18,959 potentially relevant articles. In addition, we found one article through hand searching. After removing duplicates, 11,282 articles were screened by title and abstract, and 61 full text articles were assessed for eligibility. The main reasons for exclusion by full text were an ineligible study population, i.e., the participants were younger than 15 or older than 20 years, or an inappropriate setting, i.e., middle school, university, etc. In total, nine articles met the afore mentioned inclusion criteria and were included in the qualitative synthesis [27–35]. Agreement among reviewers was moderate after title and abstract screening (k = 0.53), and very good after full text screening (k = 0.87) [36].

[Figure 1]

Study Quality

Quality ratings are shown in Table 2. With six out of nine studies, the global rating of the majority of studies was weak [27–29, 32–34]. Only one study was rated as strong [31], and two studies were rated as moderate [30, 35]. For the individual EPHPP domains across all studies, blinding was the most weakly rated domain (n = 7) [27–29, 32–35]. However, study design and selection bias had none or very few weak ratings (n = 0; n = 2) [27, 28]. In detail, four studies were rated as strong regarding their study design, including randomized controlled trial [35] or cluster randomized controlled trial study designs [30, 31, 33]. With quasi-experimental designs (two groups pre and post [27, 28, 34] or one group pre and post [29, 32]), the other five studies were rated as moderate. The remaining domains differed the most in their ratings. While confounders were rated as either strong or weak, data collection method, as well as withdrawals and dropouts, varied similarly in their ratings between weak, moderate, and strong.

Table 2
Assessment of study quality using the quality assessment tool for quantitative studies

Author, year	Selection bias	Study design	Confounders	Blinding	Data collection methods	Withdrawals and dropouts	Global rating
Angerer et al., 2015	weak	moderate	weak	weak	weak	moderate	weak
Braun et al., 2014	weak	moderate	weak	weak	weak	moderate	weak
Chen et al., 2001	strong	moderate	weak	weak	moderate	strong	weak
Hankonen et al., 2017	moderate	strong	strong	moderate	moderate	weak	moderate
Lee et al., 2011	moderate	strong	strong	moderate	strong	strong	strong
Sickinger et al., 2018	moderate	moderate	weak	weak	weak	weak	weak
Spook et al., 2016	moderate	strong	strong	weak	moderate	weak	weak
Verloigne et al., 2017	moderate	moderate	weak	weak	strong	weak	weak
Walter et al., 2013	moderate	strong	strong	weak	strong	strong	moderate

[Table 2]

Study characteristics

Table 3 provides an overview of study characteristics in detail. Seven of the nine studies were conducted in Europe: four in Germany and one each in Belgium, Finland, and the Netherlands. Two studies were performed at community colleges in Taiwan. Three German studies took place in workplace settings, while the other European studies were conducted at VET schools. Sample sizes ranged from 23 to 231 participants, with a mean age between 15.5 and 19.4 years.

Table 3
Study characteristics

Author, year	Country	Study design	Target group[1]; setting	Sample size (n)	Sex	Mean age
Angerer et al., 2015	Germany	controlled study	overweight apprentices; automobile factory	IG: 60 CG: 32	no data	15–19 (range)
Braun et al., 2014	Germany	controlled study	young adults with learning impairments; rehabilitation-institution for vocational training	IG: 27 CG: 25	46.2% female	18.9
Chen et al., 2001	Taiwan	pre-post design	overweight adolescent nursing students; junior college	IG: 55	only female	15.5
Hankonen et al., 2017	Finland	CRT[2]	vocational students; vocational school unit	IG: 26 CG: 17	85% female	18.9
Lee et al., 2011	Taiwan	CRT[2]	nursing students; junior college of nursing	IG: 46 CG: 48	only female	16.2
Sickinger et al., 2018	Germany	pre-post design	trainees in the metal industry; major company in the metal industry	IG: 51[4]	only male	17.0
Spook et al., 2016	The Netherlands	CRT[3]	secondary vocational education students; vocational education schools	IG: 105 CG: 126	62.8% female	17.2
Verloigne et al., 2017	Belgium	controlled study	lower-educated girls; vocational and technical schools	IG: 91[5] CG: 105[5]	only female	16.0
Walter et al., 2013	Germany	RCT	apprentices; Institute of Technology	IG: 12 CG: 11	52% female	19.4

CG = control group; CRT = cluster randomized controlled trial; IG = intervention group; RCT = randomized controlled trial;
[1]The target group is defined as young adults attending VET. The use of different terminology for VET students (e.g., apprentices or trainees) depends on the respective study. [2]Four classes of one school/college were randomized. [3]Four schools were randomized. [4]N=74 in total, but only men were included in the analysis. [5]Allocated to three control and intervention schools each.

[Table 3]

Intervention characteristics

Intervention details are presented in Table 4, with interventions ranging from four weeks to two years in duration. Regarding the addressed behavior, the interventions either focused on PA only [28, 30, 31, 34, 35] or followed a multi-behavioral approach in which, for example, alcohol consumption, life-skills training, and/or nutrition were treated in addition to PA [27, 29, 32, 33]. Three interventions comprised multiple components that either addressed a person's behavior or additionally adjusted the conditions in the setting [27, 30, 34]. For example, Verloigne et al. [34] offered various PA measures, while Angerer et al. [27] and Hankonen et al. [30] modified the context by providing PA equipment. The other six one-component interventions focused solely on an individual's behavior, comprising stand-alone information and course offerings that included the provision of information or behavioral training (e.g., information, motivation, and counselling).

Table 4

Intervention characteristics and study findings

Author, year	Intervention group	Control group	Period	Outcome measure	Effects and effect sizes (d)
Angerer et al., 2015	"Fit4U": intensive nutrition counselling, sports facilities, life-skills training, and introduction of health lessons into compulsory education in VET school, provision of sports equipment during breaks; behavior- and environment-oriented measures; multi-behavior (PA, nutrition, life-skills training)	no intervention offered	2 years	PF: BMI, cardiopulmonary fitness PP: sugar and fat metabolism PsF: psychological aspects related to mental health	no significant changes
Braun et al., 2014	one hour of individually adapted circuit training with endurance and strength training components once a week; single behavior (PA only)	compulsory physical education	1 year	PF: aerobic step test, coordination, flexibility, BMI; PP: blood pressure, heart rate; PsF: self-rating of physical and mental health characteristics	PF: significant increase in the number of steps (d_{corr}=1.17) and duration of the step test (d_{corr}=0.74)

Author, year	Intervention group	Control group	Period	Outcome measure	Effects and effect sizes (d)
Chen et al., 2001	Health Promotion Counselling: total of 8 hours of whole group education (nutrition behavioral change, exercise behavior modifications, instruction on physiological side effects of being overweight and the benefits of weight reduction, life appreciation, interpersonal support and stress management – 2 hours each), additional 12 hours of small-group health promotion counselling; multi-behavior (PA, nutrition)	no control group	1 year	PA: exercise behavior PF: body weight, WLI PP: blood pressure, HDL, LDL, TG, TC	PA: significant increase in PA level (d = 0.74) PF: significant decrease in body weight (d = 0.21) and WLI (d = 0.28) PP: significant decrease in systolic pressure (d = 0.87), HDL (d = 0.77) and TC (d = 0.26)
Hankonen et al., 2017	"Let's Move It": 6 hours of group-based intervention for students, two 2-hour training workshops for teachers to reduce their students' sitting in class, physical choice architecture (providing PA equipment to enable light PA in classrooms); individual and environmental changes; participatory approach involving stakeholders in stepwise intervention development; single behavior (PA only)	standard care, i.e., normal curriculum plus a leaflet on recommendations for youth PA	5 weeks	PA: moderate-to-vigorous PA PF: body composition PsF: self-reported use of behavior change technique	PsF: significant increase in use of behavior change technique ($0.74 < d_{corr} < 0.90$)

Author, year	Intervention group	Control group	Period	Outcome measure	Effects and effect sizes (d)
Lee et al., 2011	"SPAA-G": original content and activity in a physical education class, plus school-based PA intervention for adolescent girls program, combining the theoretical foundation of self-efficacy theory and provision of a pedometer; single behavior (PA only)	original content and activity in a physical education class	12 weeks	PA: aerobic step test PF: cardiopulmonary endurance PsF: perceived self-efficacy	PA: significant increase in the number of steps (d_{corr}=0.78)
Sickinger et al., 2018	12 theoretical and practical teaching units between 65–90 minutes each on the topics of nutrition, alcohol and nicotine consumption, and PA during VET; participatory approach involving 6 focus groups in the sensitization unit; multi-behavior (PA, nutrition, alcohol and nicotine consumption)	no control group	11 months	PA: at least 1 hour of PA per day PsF: general self-effectiveness expectations	PsF: significant increase in general self-effectiveness expectations (d = 0.27)
Spook et al., 2016	"Balance It": serious self-regulation game designed to target dietary intake and PA; this tailored, interactive multimedia game could be played at any time and place desired on a daily basis, entailing a combination of behavior change techniques derived from self-regulation theory with serious game elements; multi-behavior (PA, nutrition)	waiting list control group: no intervention between measures	4 weeks	PA: moderate PA, vigorous PA, active transport PsF: determinants of PA	no significant changes

Author, year	Intervention group	Control group	Period	Outcome measure	Effects and effect sizes (d)
Verloigne et al., 2017	specific interventions were developed by a co-creation group; several co-creation sessions during lunch break (about 50 minutes); group brainstormed on what it could do to change specific behaviors and ascertain what might be relevant for the girls in their school; co-creational approach; single behavior (PA only)	control schools did not receive any information on PA or health outside the normal curriculum	6 months	PA: time spent in PA PsF: self-efficacy, perceived benefits of PA, perceived barriers to be physically active	PA: significant increase in extracurricular sports participation (d = 0.19) PsF: significant intervention effect on self-efficacy (d = 0.63)
Walter et al., 2013	aerobic endurance intervention: instructed outdoor running training twice a week; initial duration of 30 minutes was increased continuously to 60 minutes over 10 weeks; single behavior (PA only)	Instructed not to alter their PA and exercise patterns during the control period	10 weeks	PA: mean activity intensity PF: aerobic endurance capacity PsF: mood state	PA: significant change in mean activity intensity (d = 0.87) PF: significant change in aerobic endurance capacity (1.03 < d < 1.40)

BMI = body mass index; HDL = high-density lipoprotein; LDL = low-density lipoprotein; PA = physical activity; PF = physical fitness; PP = physiological parameters; PsF = psychological factors; TC = total serum cholesterol; TG = triglycerides; VET = vocational education and training; WLI = weight-for-length index

Furthermore, the interventions differed in the way they were developed and implemented. Essentially, the interventions could be classified into top-down and bottom-up interventions. Top-down interventions were developed and implemented by experts and followed a theoretical and scientific orientation in terms of their goals and content [27–29, 31, 33, 35]. However, the bottom-up interventions followed a participatory approach, ranging from the target group's involvement in designing teaching units [32], through a stepwise intervention development involving different stakeholders [30], to the entire intervention development and implementation using a co-creation approach [34].

Further special characteristics of individual studies included, for example, an online-based intervention in the form of a multimedia game [33] or an additional intervention for teachers to reduce their students' sedentary behavior in class [30].

Study findings

The studies' outcomes are grouped into four major categories: PA, physical fitness, physiological parameters, and psychological factors. Most studies measured more than one of these outcome categories.

Seven studies measured PA either subjectively using standardized questionnaires or objectively using accelerometers. Four of the seven studies [29, 31, 34, 35] found significant baseline to post-intervention improvements in PA. Among these, two studies subjectively measured PA and identified a significant intervention effect on activity level [29] and on extracurricular sports participation [34], while two studies objectively measured PA and found significant effects. Thus, Lee et al. [31] revealed a significant increase in the number of aerobic steps, and Walter et al. [35] indicated a significant increase in mean activity intensity. Three studies did not find significant changes in PA level [30, 32, 33].

Physical fitness components were tested by motor performance tests or body analyses in six studies. Two of these studies identified a significant intervention effect on endurance [28, 35]. In another study, a significant decrease in body weight and weight-for-length index following the intervention was found [29]. The remaining three studies did not find significant changes in body mass index, body composition, and cardiopulmonary endurance [27, 30, 31].

Physiological parameters measured through blood pressure or blood tests were examined in three studies. Only Chen et al. [29] reported significant improvements from baseline to post-intervention for the following physiological parameters: systolic blood pressure, high-density lipoprotein, and total serum cholesterol. In two other studies, no significant effects on blood pressure, heart rate, as well as sugar and fat metabolism were found [27, 28].

Eight studies assessed psychological factors using standardized questionnaires. Of these, three identified a significant change in psychological factors. Hankonen et al. [30] reported a significant improvement in the use of behavior change techniques from baseline to post-intervention in the intervention group. Furthermore, Sickinger et al. [32] found significant improvements in general self-effectiveness expectations, and Verloigne et al. [34] reported a significant intervention effect on self-efficacy. Five studies could not find significant changes in psychological factors, such as determinants of PA, mood state, psychological aspects related to mental health, self-efficacy, and self-rating of physical and mental health characteristics [27, 28, 31, 33, 35].

Overall, two studies indicated significant effects in all measured outcome variables [29, 34], whereas two other studies did not find significant effects in any measured outcome variables [27, 33].

[Table 4]

Discussion

To our knowledge, this is the first systematic review to identify PA promoting interventions in VET and to examine their effects on PA-related outcomes such as PA level, physical fitness, physiological parameters, or psychological factors. In total, nine studies met the inclusion criteria, covering a broad range of interventions and outcomes measured. All but two studies found significant improvements for at least one PA-related outcome, with the majority of studies indicating a mix of both significant and non-significant effects. These

heterogeneous effects, coupled with the overall weak study quality, limited our ability to draw clear conclusions about the potentially most effective intervention strategies.

An existing problem, confirmed in our review, is the lack of studies dealing with the promotion of PA in VET. As already assumed, very few studies have focused on this issue, and unfortunately, these available studies are of poor quality. Ensuring high study quality while simultaneously taking local requirements and conditions into account is particularly difficult in real-world settings [37]. Accordingly, methodologically complex and comprehensive studies are necessary to better examine interventions' effectiveness in the VET field [38]. Regarding the countries in which the studies were carried out, it is striking that all but two Taiwanese studies were conducted in Europe, whereas Anglo-American studies were completely absent. One reason for this could be the large number of occupations with a required VET qualification and the associated high importance of VET in European countries, such as the Benelux and Scandinavian countries or, in particular, Germany [12]. However, pursuing higher education by enrolling in colleges or universities is the most common pathway after graduating from high school in the U.S. [38]. Thus, the lack of studies is astonishing and also indicates a research gap in physical activity promotion with VET students. In summary, the evidence for PA promotion in the VET context is sparse, comprising data mainly only from European studies. Furthermore, due to VET systems' heterogeneity in Europe, our findings cannot be generalized.

Nevertheless, we tried to identify further conspicuous aspects and similarities regarding intervention characteristics, such as their approaches, components, and content. One remarkable result that emerged from our review is that both bottom-up and top-down interventions revealed positive effects. Taking a closer look, interventions designed with a participatory bottom-up approach tended to improve relevant psychological factors related to PA, such as self-efficacy or the use of behavior change techniques, but not PA levels [30, 32, 34]. In contrast, none of the five top-down interventions that measured psychological factors indicated positive effects for this outcome [27, 28, 31, 33, 35]. Out of a total of six studies using top-down interventions, four reported significant improvements in PA level, physical fitness, and/or physiological parameters [28, 29, 31, 35]. According to this, top-down interventions seem to improve outcomes on the physical level. In terms of existing literature, "traditional" interventions designed using a top-down approach have shown limited success and are criticized for their low long-term sustainability [39–41]. A possible reason for these interventions' failure might be a lack of consideration of the complex influence of different factors between the individual and environment. To counteract this problem, bottom-up interventions seem to be promising. With a participatory or co-creational approach, it is possible to develop interventions tailored to the needs of the target group and given setting, thereby increasing acceptance of the target group and facilitating the intervention's sustainability [40, 42, 43]. In our case, we cannot estimate the long-term effectiveness and sustainable implementation of the interventions, as no long-term follow-ups and reports on the continuation and anchoring of the interventions exist. Therefore, it is not yet possible to generalize which approach is more appropriate, and the tendency for bottom-up approaches to improve outcomes on psychological level and top-down approaches on the physical level needs to be investigated in further studies. In studies like this, recommendations for the intervention research process made by van Sluijs et al. [43, 44] also should be taken into account. The authors report an apparent willingness among adolescents to increase PA by expressing the desire to do more types of PA more often. In reality, this intention often fails due to poor attainment. Therefore, it is necessary to transform this enthusiasm into effective PA promoting interventions [44]. Active engagement in the form of participatory or

co-creational approaches could be a possible key to success in developing acceptable and attractive interventions [43].

Recent literature recommends multi-component interventions that combine various measures to promote PA, e.g., behavioral, educational, and/or environmental elements [14, 42, 45]. In particular, combining individual and environmental changes also is acknowledged in other studies, as effective behavioral changes in individuals require supportive policies and environments [46, 47]. Although our data are not strictly conclusive, the two studies showing significant effects in PA level and psychological factors [30, 34] seem to support this approach. With several comprehensive measures, it is possible to extend the target group's reach and create a PA-friendly environment. To achieve this, PA intervention components of the examined studies include offering various PA programs, providing PA equipment, and conducting workshops for teachers as multipliers for PA promotion. In our case, the two studies in which multi-component interventions yielded significant effects also were interventions developed based on a participatory or co-creational approach. Therefore, the use of a bottom-up approach might be a promising strategy to create diverse and comprehensive PA promoting measures that consider both the individual and environment.

Prior studies have discussed the benefits and effectiveness of multi-behavior interventions compared with single-behavior interventions. In theory, it is assumed that different unhealthy behaviors co-occur and are mutually dependent. Therefore, targeting more than one behavior could lead to greater health benefits through lifestyle changes, not just a single behavior [48, 49]. However, in practice, such multi-behavioral interventions have proved to be an obstacle to success [14, 50, 51]. Our review demonstrated mixed results in terms of single-behavioral and multi-behavioral interventions' effectiveness. Two studies reported positive results from their multi-behavioral interventions [29, 32], while the only two studies that showed no significant effects also comprised multi-behavioral interventions [27, 33]. In contrast, all studies that focused only on PA behavior revealed significant effects on at least one outcome. On the basis of our review, multi-behavioral interventions can work, but changing multiple health behaviors simultaneously also can lead to excessive demands and burdens on participants and, thus, reduce the intervention effectiveness [48].

Against this backdrop and our review's results, the VET field seems to be promising for the implementation of PA promoting interventions, as many young people can be reached and a time and organizational framework is provided. Our review highlights the positive, yet inconsistent, effects from PA promoting interventions in VET. Thus, it is difficult for us to declare explicit practical recommendations based only on our results. Nevertheless, regarding the results from van Sluijs et al. [43, 44], multi-component interventions tailored to the target group and context seem to be a good way to increase acceptance and participation and, thus, interventions' effectiveness. To understand interventions' effectiveness and make further recommendations regarding developing and implementing PA interventions in VET, high quality studies with long-term follow-ups conducted in real-world settings are needed.

Limitations

Our review's limitations are influenced by the number and quality of the included studies. First, we limited our search to studies published in English and German language and did not search for grey literature. We might have been able to find some studies without these restrictions, but we believe that we found the core studies

through our extensive search. Second, we identified some weaknesses in the assessment of study quality using the EPHPP tool. The rigid scoring system may not always distinguish more robust studies from weaker ones. In particular, the lack of blinding was often the crucial factor for the studies' weak global ratings. This is in line with other studies that have reported on the challenges of blinding in behavioral interventions [52, 53]. Finally, due to the small number of included studies, overall weak study quality, and heterogeneity of outcome measures, we were unable to conduct a meta-analysis. Thus, it should be taken into account that the conclusions on the linkage between intervention characteristics and intervention effectiveness presented in this systematic review are based on a descriptive, rather than a quantitative, analysis.

Conclusion

The present systematic review provides detailed insight into literature concerning the effectiveness of interventions that promote PA in VET. First, with most of the examined studies revealing significant improvements in at least one PA-related outcome, PA interventions have the potential to be efficacious in VET. However, the results are inconclusive, as most studies indicated a mix of both significant and non-significant effects. Second, in contrast to the numerous studies on PA interventions in young people, only a few published studies feature PA interventions that are targeted specifically at VET students. Thus, these results also underline the need for further research in this young research area. In addition to addressing this current lack of studies, future research should focus on high quality studies with long-term follow-ups. Only in this way is it possible to take a closer look at PA promotion in VET, to draw clear conclusions about the effectiveness of studies, to make recommendations for practical use and, thus, to answer more precisely the question of what we know about physical activity interventions in VET.

Abbreviations

BMI
body mass index; CG = control group; CRT = cluster randomized controlled trial; HDL = high-density lipoprotein; IG = intervention group; LDL = low-density lipoprotein; PA = physical activity; PF = physical fitness; PP = physiological parameters; PsF = psychological factors; RCT = randomized controlled trial; TC = total serum cholesterol; TG = triglycerides; VET = vocational education and training; WLI = weight-for-length index

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and material

All data used to derive the study findings are included in this published article and its additional files.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

EG conducted the literature search, study selection, quality assessment, data extraction and analysis, and drafted the manuscript. JP screened full texts for eligibility criteria, assessed the study quality, and participated in the data extraction process. JC screened titles and abstracts for eligibility criteria. KP supervised the work. All authors were involved in data interpretation, critically reviewing drafts of the manuscript, and reading and approving the final manuscript.

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Not applicable

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Figures

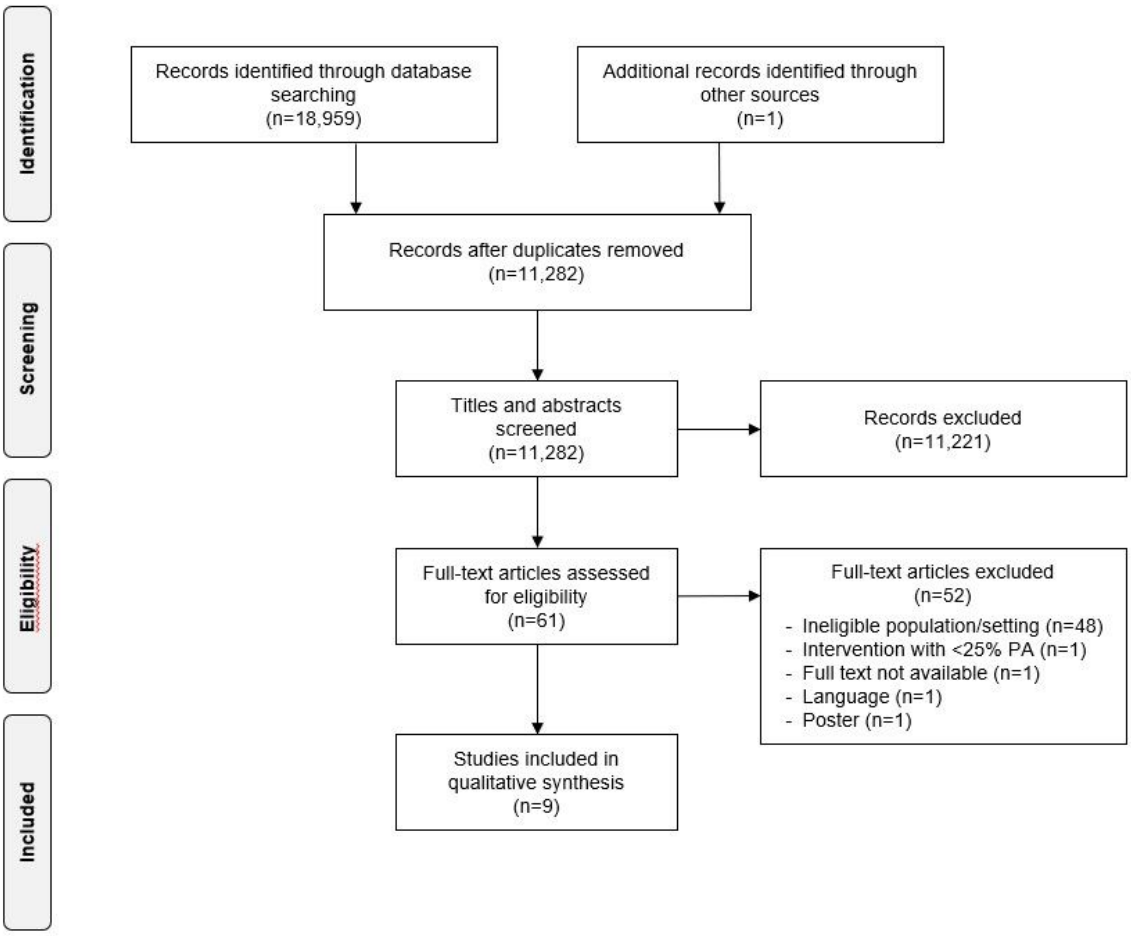

Figure 1

Flow chart

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