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A parallel group randomised trial

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Original Article

Evaluation of a participatory physical activity promotion intervention in Dutch adolescents: the SALVO study. A parallel group randomised trial.

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Abstract
This study assessed the efficacy of a co-designed, school-based intervention meant to promote physical activity and fitness among Dutch prevocational secondary students. In a two-year clustered randomized controlled trial, students' physical activity and fitness was measured by indirect and direct methods. In the intervention group, we used the triple-I procedure, a participatory action research method, to co-design the intervention together with the students and schools. This procedure involved focus group discussions by interviewing and imaging techniques, followed by a co-design process to align the intervention content and implementation processes with students' preferences. The study involved 22 Dutch schools, with a total of 2685 13-to-14-year-old prevocational secondary students. Schools were randomly assigned to either intervention (11 schools, 1446 students) or control group (11 schools, 1239 students).There were no significant intervention differences between students' overall physical activity behavior on intervention versus control schools. However, with regards to various specific physical fitness indicators, such as the long jump, handgrip strength, shuttle run test, and the sum of skinfolds, intervention school students performed significantly better than the control group students. Furthermore, when taking into account student participation, i.e. the success of the co-design process, schools with higher levels of student participation showed higher shuttle run scores. However, such graded effects were not similarly apparent with regards to students' physical fitness indicators. This study showed that co-designing a comprehensive physical activity intervention on numerous Dutch high schools via the Triple-I Interactive Method was feasible. Moreover, results showed that certain aspects of physical fitness were improved after two years of intervention, although taken together with the lack of effects on physical activity, results were mixed.
The trial was registered as ISRCTN35992636 of the ISRCTN registry, registered on February 12th 2020. http://www.isrctn.com/ISRCTN35992636.
Key Words Adolescents; School setting; Physical activity intervention; Co-creation; Trial

Introduction

Sufficient regular physical activity (PA) brings about significant benefits with regards to adolescents' direct and long-term physical and mental health, i.e. it reduces the risk of heart disease, diabetes, obesity and benefits mental health outcomes (Guthold et al., 2019). It also improves their school performance and reduces school dropout rates (Franklin et al., 2022; Singh et al., 2019; Visscher et al., 2011).

Yet, the engagement of young adolescents in sufficient PA is not self-evident (Committee Dutch Physical Activity Guidelines 2017 et al., 2018). A significant portion of two-third of the European children and adolescents, do not engage in sufficient physical activity (Steene-Johannessen et al., 2020). In the year 2022, the proportion of adequately active young people (aged 12-17) in the Netherlands was reported as 33% (National Institute for Public health and the Environment, 2023). Notably, this percentage has remained relatively constant over the past two decades. Additionally, in 2021, Dutch adolescents in the same age group (12 to 17 years) spent an average of 9 hours and 42 minutes per day sitting which is a slight decrease over the past 10 years.

Therefore, stimulating an active lifestyle at a young age is important for various reasons. However, particularly during adolescence, youngsters tend to become less physically active and drop out of sports clubs (Bélanger et al., 2009; Corder et al., 2015; Giuriato et al., 2022; Tiessen-Raaphorst, 2010; World Health Organisation, 2010). This is more prevalent among prevocational secondary school students (Dorsselaer, 2010; Slot-Heijs & Lucassen, 2018). They are more likely to be less physically fit and/or less involved in organised sports at sports clubs (Anselma, Collard, et al., 2020; Tomkinson et al., 2018).

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Although the challenge is a complex one, recent studies show that schools can play a key role in stimulating adolescents to be more physically active (Langford et al., 2015; Morton et al., 2016; Wareham et al., 2005; Waterlander et al., 2020). For example via the WHO's Health-Promoting School framework a supportive environment can be created that effectively stimulates healthy behaviour and improved health outcomes. (Langford et al., 2015; McHugh et al., 2020). Despite positive effects of some interventions, results across studies remain mixed and further development of the HPS model remains necessary to optimally support schools to stimulate their students' health. One concept that is not a standard part of the HPS model yet evidence shows to have additional benefits in terms of program effectiveness is co-creating interventions and implementation strategies together with schools and students (McHugh et al., 2020). The concept of agency emphasizes students' active participation and decision-making in matters of their health (Boonekamp et al., 2021; Rocca, 2010). This framework encourages their active engagement, and eventually to interventions that better fit their target audience and thereby likely resulting in greater effectiveness. Unfortunately, the current literature provides no clear consensus on how to optimally co-design school-based interventions, especially when targeting prevocational, often low-SEP, high schools (Centre for Healthy Living, 2015; Knowledge Centre for Sport Netherlands, n.d.; Kop et al., 2019). In an experimental study by How et al. (2013), the intervention group students were allowed to choose their preferred participatory role during the physical education (PE) class. At the same time, control students participated in a normal teacher-led physical education program. The provision of choice in PE enhanced students' autonomous motivation, perceived autonomy support, and PA levels relative to those in the "regular PE" control group. In a study by Ho et al. (2017), the students and mentors cocreated their groups' learning paths instead of executing a predesignated curriculum where mentors determine which sporting skills to learn. This intervention improved adolescents' mental well-being, psychological assets, physical fitness and PA levels.

Therefore, the aim of the current study is to evaluate the effectiveness of a school-based co-designed intervention on promoting PA behaviour and physical fitness of prevocational secondary students with a focus on student participation in the design of the school environment, since such participation is hypothesized to empower students to become agents in their own lives (Boonekamp et al., 2019). A school environment that offers these aspects (assets) will enhance the student's ability to achieve, maintain and sustain an active lifestyle. Therefore, this study will not only evaluate whether the co-designed intervention significantly impacted PA and fitness indicators, but also whether that impact varied by degree of co-design.

Material & methods

Intervention framework SALVO

The intervention framework SALVO aims to increase the long-term PA level of the adolescents using an asset-based approach, ensuring that interventions to be developed mirror student preferences and interests instead of their needs. SALVO is the Dutch abbreviation for stimulating physical activity in prevocational students, Salutogenesis is the theoretical framework for the SALVO study, aiming to engage all students in decision-making, empowering them to create opportunities for PA (El-Sherif, 2014; Morgan & Ziglio, 2007).

Participants

We conducted cluster randomised trial (n = 2685; 22 schools) with a duration of two years, starting in 2014 with two yearly follow-ups in 2015 and 2016. The participating prevocational schools were from the two Dutch provinces of Gelderland (N=10) and Noord-Holland (N=12). There were no specific eligibility criteria to be included in the study other than being students in the second school year. All participants and their parents received a letter explaining the goals and content of the study and the associated data collection. The researchers asked parents for a passive consent form for the child's participation. The parents and children were given clear instructions on the option to drop out of the study whenever they wanted without giving a reason. The authors had no access to information that could identify individual participants. The study was approved by the HAN University of Applied Sciences ethics committee (approval number ACPO 34.05/16). The trial was retrospectively registered as ISRCTN35992636 in the ISRCTN registry on February 12th, 2020 (http://www.isrctn.com/ISRCTN35992636). The study was performed according to the original plan. This study was funded by the Netherlands Organisation for Scientific Research (NWO) ref. 2014/02542/BOO and the Netherlands Organisation for Health Research and Development (ZonMW), ref. 525001009.

Student involvement

The process of student involvement consisted of three steps described in more detail elsewhere (Boonekamp et al., 2020; van de Kop et al., 2021). The first step involved determining the drivers of behaviour (assets) in the context of PA. "Assets" refer to the various resources, skills, and qualities possessed by young individuals that contribute to their engagement, participation and enjoyment of physical activities. In a randomly selected class of 25 students in each of the eleven intervention schools, the triple-I method was used. The triple-I method consisted of two interactive methods: the Structured Interview Matrix (SIM) and the Photovoice (PV) (Boonekamp et al., 2020; van de Kop et al., 2021). All conversations were recorded (audio only) and transcribed

ad verbatim. The transcriptions were analysed using inductive thematic analysis according to Browne and Clarke (2006) (Boonekamp et al., 2021). During the second step, in all intervention schools, focus group sessions were held between a subsample of four students, researchers, members of the teaching staff and the school board.

The goal was to engage students and school staff to cocreate an intervention plan for each school based on the results from step one. Researchers participated in the focus group discussions, monitoring that students' voices were heard, and proposed recommendations on using interventions from a database for well-described interventions (Loketgezondleven, n.d.).

Making use of these interventions would be a step towards the design of an evidence-based intervention plan. During the focus group sessions, students and school staff were encouraged to advise and co-decide in developing their school-specific intervention plan. In the third step, the intervention plan was implemented. Although the use of structured interactive methods was the same for each intervention school, the resulting specific content of the interventions could vary for each school.

Developed interventions

Table 1. Overview of the dose and content of the cocreated interventions for each school

Intervention School	1	2	3	4	5	6	7	8	9	10	11
Intervention content	1. School break activities, 2. clinics: wall climbing, smash ball, climbing, beach rugby,dance, music, organising sports events	After school sports activities: martial arts, table tennis, free running, cultural activities music and dj clinics	School break activities: monday 1st year, tuesday 2nd year wednesday 3rd year, 2 days boot camp activities	Extra after school activities for less active students like soccer, badminton	Adjustments of PE program: more choice options for students, goal setting activities by students, weekly evaluations,. Every 4th week students choose prefered activity	1. Run2beFit: 8 week exercise and lifestyle program carried out in the biology, PE and mentoring class. 3 events are organised, including a 5 km run. Teachers and parents are involved in the program. 2. After school sports activities in collaboration with the municipal combination officer	1. After school class for recreational sports activities. Students set goals in a training program and end with a tournament. The activities provides visiting sports events, a role as activity organiser, media assistant, or attend in a soccer competition. 2. A rooftop playground is available for school break and after school activities. 3. The school started a healthy school advisor, and Topscore activities in combination with the municipal combination officer. 4. The school offers a referee assistant and activity assistant courses for students	After school voluntary based clinics for fencing, kickboxing, dance, sailing	1. Extra PE class intended for students with recreational motives in stead of competition. Students choose their prefered activity, like ball games, gymnastics. Lessons are PE teacher led. 2. After school trips to sportsfacilities like fitness centre or dance school.	1. Daily school break activities and after school sports competition organised by students and supervised by teachers. 2.Yearly agenda of sports competitions. 3. An energy bike challenge was set up to pay attention on sustainable energy production.	1. A municipal led Topscore program was set up intracurricular student choice program (normally organised after school). Students choose from 15 different sports in a first meeting. Then the students attend in a series of training sessions to discover all aspects of the sport. They attend in a tournament in the final phase of the program. 2. After school soccer and basket ball activities were set up by PE students.
Additional information	School break activities were succesful	Students choose their prefered activity. Activities were linked to local sports clubs. PE students mentor activity participation. Oudoor student participation was less than indoor.	The school moved to another location during intervention period. Student participation was higher with monitoring PE students.	School already had a strong after school activity program and extra PE lessons added to the regular program. Number of participating students depend on type of activities offered. Increasing awareness of staff towards students options. Due to growth the additional PE lessons were stopped.	Students and staff changed their mindset towards the input of students. Students' input enhanced the variety of activity types. Focus on PE teachers was succesfull. School board liked the plans, but teachers counted on more support	The Run2befit program is a prescribed program form a commercial organisation: www.run2bfit.nl		A collaboration with the Sports Service Office has been set up. This is a sports promotion agency financed by the municipality. The clinics have been organised by this agencyin cooperation with local sports clubs. A fund application has been drawn up for additional financial recources.	Collaboration has been set up with a local organisation SPURD, a municipal funded sports facilitator supporting events and tournaments. The school program already included extra PE class for sporty minded students that prefer competition. The school board funded the extra PE class.	A Sports Service organisation facilitated small equipment to use during school breaks. Students played a role in organising events and mange the sports equipment. Students and teachers build theor own soccer goals during craft lessons.	A ceiling net was constructed to prevent loosing balls flying out of the outdoor playground
Frequency	1. daily 2. 1/4 weeks	1/week	5/week	1/week	3/week	1. 4/week during 8 weeks 2. 1/week	1. 1/week 2. 5/week 3. 1/week 4. 1/year	1/week	1. 1/week 2. 1/month	1. 5/week 2. 4/year 3. Once	1. 2/week 2. 1/week
Activity duration	1. 20 minutes 2. 1.5 hours	1.5 hours	40 minutes	1 hour	1 hour	1. 1 hour Biology, 2 hours PE, 1 mentoring hour. 2. 30 min- 1 hour	30 min-1 hour	1.5 hours	1 hour	20-30 min	1 hour
Intervention Duration	2 years	2 years	1 year	1.5 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years

Procedure

We randomized schools within a province in order to have an approximately even distribution of intervention and control schools per province. In total there were 1446 intervention group students versus 1239 students in the control groups. PA, anthropometrics and physical performance were measured at baseline in the specific school setting, at one-year and at two-year follow-up. Using uniform protocols, specifically trained research assistants conducted the measurements during students' regular PE class. The level of student involvement in the codesign and implementation of the intervention was assessed retrospectively after the final measurements.

Measures

The primary outcome measure of interest was PA behaviour, conceptualized here as the number of hours a student was physically active per week. We measured this via a validated questionnaire (Janssen et al.,

2014) that students filled out digitally, in class. Variables measured aside from the main outcome of total PA time per week were time spent doing sports activities, active transport (to school and other destinations), and screen time. Questioning ethnicity was part of the questionnaire. Ethnicity was defined according to the guidelines of the database of Statistics Netherlands (CBS, n.d.).

The second main outcome measure of this study is students' physical fitness. To asses this, anthropometric and physical performance data were collected using the validated Eurofit test (Mechelen, 1991). This assesses coordination, flexibility, endurance, strength, speed and body mass index (BMI). Outcome measures were expressed in the applicable units. To get an idea of the level of observed performance, the results are described in terms of international percentile scores (Tomkinson et al., 2018).

Finally, to be able to relate intervention effects to the level of student involvement, a validated empowerment questionnaire (EKI) was used (Visser et al., 2007). The EKI consisted of nine questions about the degree of student participation in the analysis, implementation and evaluation phases of the research. A score of 1–3 was assigned per question according to the prescribed procedure, whereby the total score determines the level of participation as 'low' (1), 'medium' (2), or 'high' (3).

Statistical methods

The data were checked for outliers and normal distribution. A log transformation was performed for measures not normally distributed. Results of log-transformed data are presented as ratio of intervention to control group. Baseline comparisons between intervention and control groups were made using an independent t-test or chi-squared (χ^2) test. Significantly different variables were included as covariates in the regression models.

Generalised estimating equations (GEEs) were performed to determine intervention effects on the outcome measures. GEEs were applied since they account for the possible intragroup correlation. An exchangeable correlation structure was assumed for these analyses (Twisk, 2013). The final GEE regression model illustrated the change over time in outcome variable in the intervention group compared to the controls, considering the baseline differences as well as gender and ethnicity as covariates.

The results of GEE analyses were expressed as the beta coefficient (β) of the group (intervention/control), the corresponding 95% confidence interval (CI) and the associated *P*-value. To determine whether effects differed for boys and girls, effect modification was investigated by the interaction of group (intervention/control) with gender. A sensitivity analysis was conducted, including the model's moderate/high participative intervention schools or the low participative intervention schools. Here, a cut-off value of participation level 1.5 was used. *A priori*, the criterion for statistical significance was set at $\alpha = 0.05$. All analyses were performed using SPSS software, version 25 (IBM Corp, 2017).

The study's sample size calculations, aiming for a power (β) of 0.90 and alpha (α) of 0.05, was based on a previous large Dutch study in a similar population of prevocational students (de Lange, 2012). When further taking into account potential/likely clustering effects within the data due to the repeated measurement and data structure of students within schools, the sample size was calculated for 901 students when applying a standard intraclass correlation coefficient (ICC)10%.

Results

A total of 2998 (100%) prevocational 13–14-year-old students from a total of 22 schools were included in this study, 1392 intervention group students and 1606 controls. On average, students were13.8 (±0.5) years old and 66% had a native Dutch background, meaning that both of the parents were born in the Netherlands. At baseline, 2685 students were measured, including 1446 control and 1239 intervention students, which is 90% of the students. At one-year follow-up, 1547 control and 1261 intervention students were reassessed. At two-year follow-up, 1405 control and 1124 intervention students were reassessed, a retention of 84% of the original student sample (for more details, see Fig. 1).

The student flow varies per outcome measure (Fig. 1). Student dropout mainly occurred due to reasons unrelated to the content of the study or intervention. Mostly, students were absent from follow-up measurements due to being absent from school and having switched schools between measurement moments. Table 2 shows the students' physical fitness scores and PA behaviour at baseline and follow-up. All outcome measures were distributed normally except for the bent arm hang scores and anthropometric outcome measures.

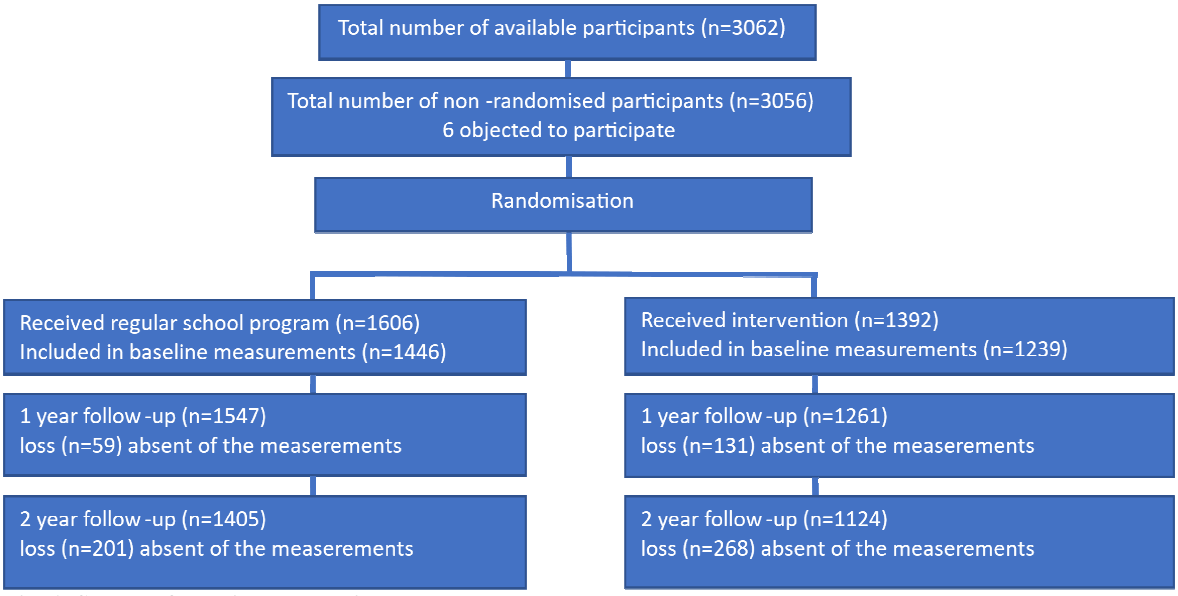

Fig. 1. Student flow diagram during the study

Table 2. Descriptive sample characteristics at baseline and follow-up for the control and intervention groups. [1]n = number, [2]SD = standard deviation

	Baseline						Follow-up 1 year						Folow-up 2 years					
Characteristics	**Total**		**Girls**		**Boys**		**Total**		**Girls**		**Boys**		**Total**		**Girls**		**Boys**	
Control	**n[1]**	**Mean (SD[2])**	**n**	**Mean (SD)**	**n**	**Mean (SD)**	**n**	**Mean (SD)**	**n**	**Mean (SD)**	**n**	**Mean (SD)**	**n**	**Mean (SD)**	**n**	**Mean (SD)**	**n**	**Mean (SD)**
Screen time, h/wk	1059	53.7 (18.4)	493	52.1 (19.6)	566	55.1 (17.3)	1332	51.8 (19.4)	575	50.3 (19.9)	757	53.0 (18.9)	1307	48.6 (18.9)	583	46.0 (17.6)	724	50.7 (19.6)
Active Commuting School, h/wk	1048	1.3 (1.0)	487	1.2 (1.0)	561	1.31 (1.0)	1319	1.2 (1.0)	568	1.1 (0.9)	751	1.3 (1.1)	1300	1.2 (1.0)	581	1.2 (0.9)	719	1.3 (1.0)
Active commuting other, h/wk	477	0.5 (0.5)	248	0.5 (0.5)	229	0.5 (0.5)	517	0.4 (0.5)	222	0.4 (0.5)	295	0.5 (0.5)	530	0.4 (0.5)	245	0.4 (0.5)	285	0.4 (0.5)
Total Time sport, h/wk	841	4.7 (2.5)	385	4.3 (2,4)	456	5.1 (2.4)	964	5.0 (2.4)	390	4.6 (2,3)	574	5.3 (2.4)	905	4.9 (2.2)	395	4.6 (2.2)	510	5.2 (2.2)
Total physical activity, h/wk	1038	5.3 (3.1)	479	5.0 (3.1)	559	5.6 (3.1)	1287	5.2 (3.2)	546	4.6 (3.1)	741	5.7 (3.2)	1247	5.0 (3.1)	560	4.6 (3.0)	687	5.4 (3.2)
Standing broadjump, cm	1428	149.7 (26.2)	643	139.5 (22.7)	785	158.0 (25.8)	1499	159.5 (29.6)	622	141.4 (24.8)	877	172.3 (25.7)	1353	163.2 (32.8)	578	140.4 (23.2)	775	180.3 (28.2)
Bent armhang, Ln	1429	1.9 (1.5)	642	1.3 (1.5)	787	2.3 (1.3)	1521	2.0 (1.4)	631	1.2 (1.3)	890	2.5 (1.1)	1358	2.1 (1.5)	576	1.2 (1.5)	782	2.8 (1.0)
10x5 mtr. Sprint, sec	1407	20.6 (2.0)	634	21.5 (1.9)	773	19.8 (1.7)	1441	20.7 (2.3)	588	21.7 (2.2)	853	20.0 (2.1)	1293	20.1 (2.3)	533	21.4 (2.2)	760	19.2 (1.9)
Sit & reach, cm	1439	23.5 (8.4)	651	27.1 (8.3)	788	20.5 (7.3)	1537	24.1 (9.0)	642	27.9 (9.0)	895	21.4 (8.0)	1376	25.0 (9.1)	594	28.2 (9.0)	782	22.5 (8.3)
Plate tapping, sec	1443	12.6 (1.7)	653	12.6 (1.8)	790	12.5 (1.7)	1533	12.2 (2.0)	641	12.3 (1.9)	892	12.2 (2.0)	1314	11.3 (1.7)	573	11.6 (1.7)	741	11.1 (1.6)
Sit-up, n/30sec	1428	20.2 (4.2)	644	18 (4)	784	22 (4)	1522	20.8 (4.9)	631	18 (5)	891	23 (4)	1353	20.3 (5.0)	576	17 (5)	777	22 (4)
Handgrip, kg	1446	31.1 (6.8)	656	29.4 (5.4)	790	32.6 (7.5)	1547	36.4 (8.3)	648	32.0 (5.7)	899	39.5 (8.4)	1405	39.3 (9.1)	607	33.1 (6.1)	798	44.0 (8.2)
20 mtr Shuttle run, score	1160	6.9 (2.3)	511	5.9 (2.0)	649	7.8 (2.2)	1197	7.7 (2.5)	467	6.3 (2.2)	730	8.7 (2.3)	1278	7.4 (2.7)	522	5.7 (2.1)	756	8.6 (2.3)
Sum skinfolds, Ln	1423	3.7 (0.5)	635	3.0 (0.2)	783	3.0 (0.2)	1522	3.7 (0.5)	615	3.1 (0.2)	886	3.0 (0.2)	1349	3.7 (0.5)	567	3.1 (0.2)	763	3.0 (0.2)
Body mass index, Ln	1418	3.0 (0.2)	634	4.0 (0.4)	779	3.5 (0.5)	1501	3.0 (0.2)	634	3.9 (0.4)	888	3.5 (0.5)	1330	3.1 (0.2)	584	4.0 (0.4)	765	3.5 (0.5)
Intervention																		
Screen time, h/wk	979	54.2 (18.5)	515	52.1 (18.2)	464	56.6 (18.6)	688	52.7 (19.1)	355	50.1 (18.6)	333	55.5 (19.2)	576	49.1 (19.1)	282	48.3 (19.1)	294	49.8 (19.1)
Active Commuting School, h/wk	975	1.4 (1.0)	514	1.4 (1.0)	461	1.3 (1.0)	676	1.4 (1.0)	349	1.5 (1.0)	327	1.4 (1.0)	572	1.2 (0.9)	280	1.3 (1.0)	292	1.2 (0.9)
Active commuting other, h/wk	435	0.5 (0.5)	225	0.4 (0.5)	210	0,.6 (0.6)	278	0.4 (0.4)	141	0.4 (0.4)	137	0,.4 (0.5)	253	0.3 (0.4)	133	0.3 (0.4)	120	0,.3 (0.4)
Total Time sport, h/wk	723	4.6 (2.5)	359	4.1 (2.4)	364	5,1 (2.5)	468	4.6 (2.3)	223	4.0 (2.3)	245	5,1 (2.2)	381	4.8 (2.4)	169	4.1 (2.2)	212	5,3 (2.4)
Total physical activity, h/wk	935	5.2 (3.2)	482	4.8 (3.1)	453	5.7 (3.3)	654	4.9 (3.0)	330	4.4 (2.9)	324	5.4 (3.0)	539	4.8 (3.1)	266	4.1 (2.9)	273	5.5 (3.1)
Standing broadjump, cm	1221	147.5 (24.3)	624	139.7 (21.9)	597	155.6 (24.1)	1229	154.2 (29.9)	601	137.5 (22.4)	628	170.2 (27.4)	1084	161.7 (33.1)	543	140.9 (23.0)	541	182.6 (28.3)
Bent armhang, Ln	1187	1.6 (1.6)	612	1.1 (1.5)	575	2.0 (1.5)	1253	1.8 (1.5)	618	1.1 (1.5)	635	2.4 (1.3)	1101	2.0 (1.4)	558	1.2 (1.3)	543	2.8 (1.1)
10x5 mtr. Sprint, sec	1210	21.2 (2.2)	620	21.9 (2.2)	590	20.5 (2.0)	1204	20.9 (2.5)	578	22.1 (2.3)	626	19.8 (2.0)	1049	20.4 (2.4)	524	21.6 (2.1)	525	19.1 (2.0)
Sit & reach, cm	1233	23.1 (8.6)	630	26.0 (8.5)	603	20.0 (7.5)	1256	24.1 (8.9)	620	26.9 (8.6)	636	21.3 (8.2)	1110	24.9 (9.2)	566	27.5 (9.0)	544	22.3 (8.6)
Plate tapping, sec	1234	12.9 (2.0)	630	13.0 (2.0)	604	12.8 (1.9)	1260	12.1 (2.0)	624	12.2 (2.0)	636	11.7 (2.0)	1110	11.2 (1.8)	569	11.5 (1.7)	541	10.9 (1.8)
Sit-up, n/30sec	1229	19.3 (4.4)	626	17 (4)	603	21 (4)	1243	19.8 (4.8)	615	17 (4)	628	22 (4)	1083	19.3 (5.3)	550	16 (5)	533	22 (4)
Handgrip, kg	1239	30.9 (7.2)	633	29.4 (5.6)	606	32,.5 (8.2)	1261	25.3 (8.3)	624	31.1 (5.6)	637	39.5 (8.5)	1124	39.1 (9.2)	580	33.8 (6.0)	544	44.8 (8.6)
20 mtr Shuttle run, score	788	6.3 (2.7)	387	5.3 (2.3)	401	7.3 (2.7)	899	7.6 (2.7)	440	6.2 (2.2)	459	8.9 (2.4)	952	7.2 (2.6)	484	5.9 (2.1)	468	8.6 (2.4)
Sum skinfolds, Ln	1216	3.7 (0.5)	613	3.0 (0.2)	596	3.0 (0.2)	1242	3.7 (0.5)	609	3.1 (0.2)	629	3.0 (0.2)	1074	3.7 (0.5)	548	3.1 (0.2)	526	3.0 (0.2)
Body mass index, Ln	1209	3.0 (0.2)	620	3.9 (0.4)	596	3.5 (0.5)	1238	3.0 (0.2)	617	4.0 (0.4)	625	3.5 (0.5)	1074	3.1 (0.2)	546	4.0 (0.4)	528	3.5 (0.4)

Physical Activity (PA) behaviour

At baseline, the average total PA for the intervention students was 5.2 (±3.2) hours per week versus 5.3 (±3.1) hours per week in the control students. After two years, the total PA level was found to be 5.0 (±3.1) and 4.8 (±3.1) hours per week, respectively (Table 2). Analyses showed that these PA changes not to be statistically different when comparing changes in intervention school students with those in controls (β = 0.30; CI = −0.11:0.71; *P* = 0.15). In addition, no significant differences were found between intervention and control students in screen time (β = −0.60; CI = −3.61:2.42; *P* = 0.70), active commuting (β = 0.03; CI = −0.09:0.15; *P* = 0.65) and sports activities (β = 0.11; CI = −0.26:0.34; *P* = 0.59) (Table 3). There was no effect modification between intervention and gender. Only boys reported to be fourteen-minute per week less active transport compared to girls (β = −0.24; CI = −0.41:−0.081; *P* = 0.03). Sensitivity analysis was conducted in four intervention schools that were identified as having low student participation and six as moderate and one as high. In general, different participation levels showed no specific intervention effects (CI includes zero; P > 0.05; Table 3); the only significant effect in with regards to participation degree was that students in intervention

schools labelled as having low student participation reported significantly more time spent actively commuting to other destinations than to school compared to control students (β = 0.36; CI = 0.70:0.02; P = 0.04).

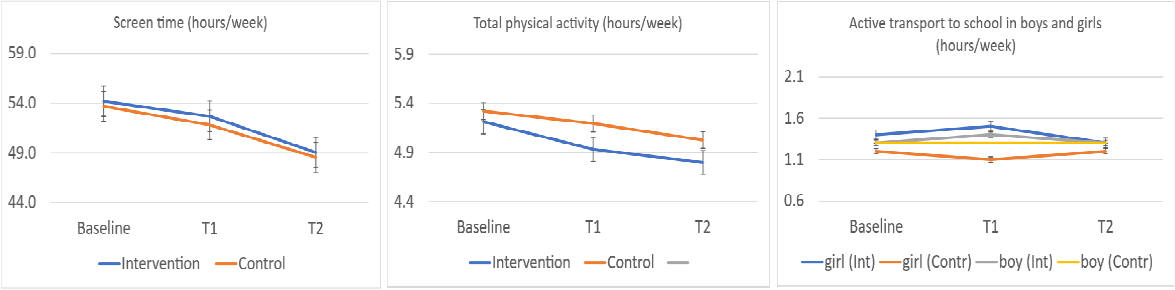

Fig. 2. Changes over time (year) in the mean total PA level (hours/week) in the intervention and control groups

Table 3. Effectiveness of the SALVO intervention expressed as differences between the intervention and control groups over time (β_4). The table shows the model's results with all intervention schools included:. [1]model: y = b0 + β1 intervention + β2 ybaseline + β3 time +β4 intervention × time + β5 sexe + β6 ethnicity with [a]All intervention schools included, [b]Middle to High participative intervention schools included or [c]Low participative intervention schools included. [2]The results of transformed variables (LN) are presented as the ratio between intervention and control group.

		All schools[1a]				MHPI schools[1b]				LPI schools[1c]			
	Variable	β_4	CI-L	CI-U	*P*-value	β_4	CI-L	CI-U	*P*-value	β_4	CI-L	CI-U	*P*-value
Physical Activity (h/wk)	Screen time	-0.60	-3.61	2.42	0.70	-2.50	-5.91	0.91	0.15	5.28	-0.30	10.86	0.06
	Active commuting school	0.03	-0.09	0.15	0.65	0.07	-0.07	0.22	0.34	-0.07	-0.26	0.12	0.46
	Active commuting other	0.00	-0.14	0.13	0.97	-0.02	-0.17	0.12	0.77	0.36	0.02	0.70	0.04
	Total time sport	-0.43	-0.70	-0.16	0.00	0.29	-0.04	0.62	0.09	-1.26	-1.58	-0.94	0.00
	Total PA	0.30	-0.11	0.71	0.15	0.29	-0.18	0.76	0.23	0.15	-0.68	0.99	0.72
Physical Fitness	Longjump (cm)	3.44	1.29	5.58	0.00	0.15	-2.25	2.55	0.90	7.77	4.78	10.76	0.00
	LN_Bended armhang[2] (s)	1.13	1.01	1.52	0.04	1.08	0.95	1.23	0.24	1.18	1.02	1.36	0.02
	10X5 Shuttle (s)	0.22	0.02	0.42	0.03	0.28	0.03	0.54	0.03	0.12	-0.12	0.36	0.33
	Flexibility (cm)	0.06	-0.45	0.56	0.82	-0.31	-0.95	0.33	0.34	0.60	-0.03	1.23	0.06
	Platetapping (s)	0.19	0.02	0.36	0.03	0.11	-0.09	0.31	0.30	0.25	0.02	0.47	0.03
	Situp (n/30s)	-0.13	-0.52	0.27	0.53	-0.34	-0.84	0.16	0.18	0.09	-0.40	0.58	0.72
	Grip strength (kg)	0.55	0.02	1.08	0.04	0.01	-0.59	0.60	0.98	1.34	0.61	2.06	0.00
	Shuttle run (level)	0.28	0.02	0.54	0.03	0.58	0.29	0.87	0.00	0.12	-0.29	0.53	0.55
Antropometry	LN_Skinfold[2]	0.92	0.90	0.94	0.00	0.97	0.94	1.00	0.04	0.85	0.82	0.90	0.00
	LN_BMI[2]	1.00	0.99	1.01	0.85	1.00	0.99	1.01	0.83	1.00	0.99	1.01	0.98

Physical fitness

Figure 3 shows gender-specific changes in physical fitness relative to the European fiftieth percentile (P50) norm values (Tomkinson et al., 2018). Our study findings indicate that the physical fitness levels of the prevocational boys and girls align with the normative trends observed among European adolescents. These students perform relatively well in hip flexibility (P60), shuttle run (P60-80) and hand grip (P60-P90). However, average scores in the long jump (P30), plate tapping (P30-60), and sit-ups (P30) fall below the P50 norm over time. Furthermore, our study population shows an overrepresentation of students who struggle to hang from bent arms, have a high BMI, or possess higher sum of skinfold values. Figure 3 illustrates the effect of the intervention on physical fitness characteristics. The students in intervention schools demonstrate significantly higher performance in the long jump (β = 3.44; CI = 1.29:5.58; *P* = 0.01), handgrip strength (β = 0.55; CI = 0.02:1,08; *P* = 0.04) and shuttle run scores (β = 0.28; CI = 0.02:0.54; *P* = 0.03) compared to their counterparts in the control schools (Table 3). In the intervention group, students demonstrated a 1.13 times longer hanging time on bent arms compared to students in the control group (CI = 1.01:1.52; *P* = 0.04) and show 0.92 times lower sum of skinfolds (*CI* = 0.90:0.94; *P* = 0.00). The impact of gender on physical fitness is evident in the 10×5-metre shuttle runs and sit-ups. Over time, boys exhibit a sprint speed that is 0.53 s faster than that of girls (β = −0.53; CI = −0.81:−0.245; *P* = 0.00). Additionally, boys perform 0.7 more sit-ups in 30 s than girls (β = 0.70; CI = 0.15:1.25; *P* = 0.01). When examining the intervention effect based on participation levels, moderate to high participating intervention students achieve significantly higher shuttle run test scores than control students (β = 0.58; CI = 0.29:0.87; *P* = 0.00) and exhibit a 0.97 times lower transformed sum of skinfold scores (CI = 0.94:1.00; *P* = 0.04). Moreover, low participative intervention students demonstrate significantly better scores in

the long jump (β = 7.77; CI = 4.78:10.76; *P* = 0.00) and grip strength (β = 1.34; CI = 0.61:2.06; *P* = 0.00) and exhibit a 0.85 times lower sum of skinfolds (CI = 0.82:0.90; *P* = 0.00) compared to control students (Table 3).

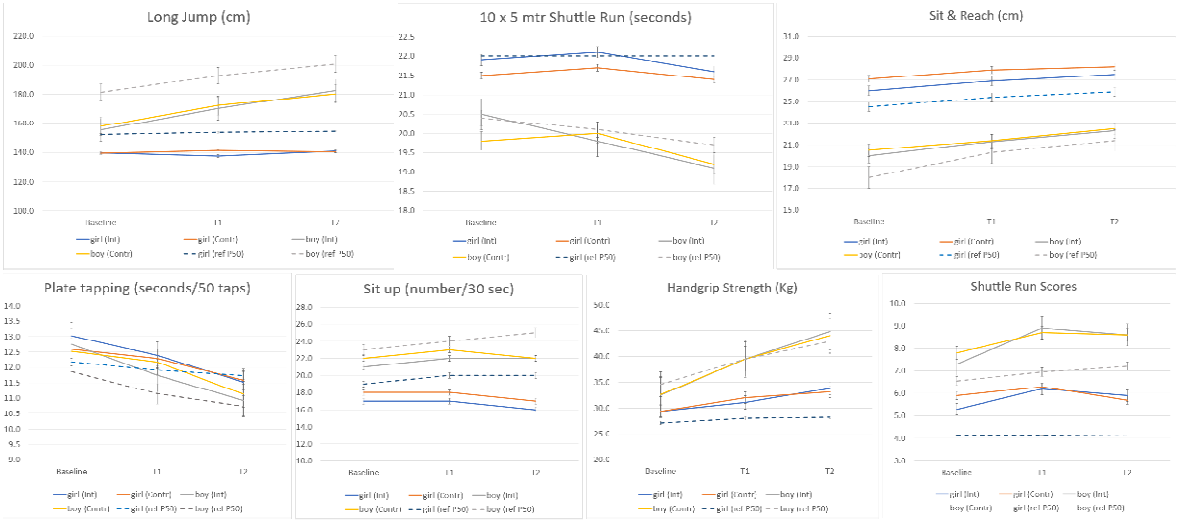

Fig. 3. The mean physical fitness changes over two years in long jump, 10×5-metre shuttle run, sit & reach, plate tapping, sit-ups, handgrip strength and 20-metre shuttle run scores in girls and boys. Dashed lines represent reference values (P50) according to Tomkinson et al. (2018).

Discussion

This study evaluated the effects of a co-designed school based intervention aimed to stimulate the PA behaviour and physical fitness of prevocational students in the Netherlands. The specific intervention content and implementation processes were co-designed with participating schools and their students via specific participatory action research methods in order to create a program to optimally fit the schools' and the students' needs and thereby be more likely to be effective. The intervention's impact on students' PA behaviour and certain physical fitness aspects was determined over the course of two school years via a cluster-randomized trial in which the intervention was implemented at 11 intervention schools (1446 students) versus 11 schools (1239 students) were no such intervention took place. In addition, we determined whether the degree of participatory co-design applied in the intervention's shaping per school led to differences in effects on health and health behaviour outcomes. No measured PA behaviours changed significantly in the intervention group students after two years of intervention compared to the control group students. However, certain positive effects were found in the intervention groups compared to the controls with regards to three of the eight physical fitness tests (long jump, handgrip strength, and shuttle run test) and the sum of skinfolds. Subgroup analyses on the level of participation showed mixed results: students at intervention schools where student participation was more successful showed higher scores in the shuttle run compared to controls, while students at intervention schools with low participation levels showed higher scores in the long jump, sit & reach, grip strength and the sum of skinfolds.

In this study, the observed physical fitness levels of the prevocational students follow the normative trends of European adolescents over time, performing relatively well in hip flexibility, shuttle run and hand grip (Tomkinson et al., 2018). However, students who can barely hang from bent arms are overrepresented, as well as students with high BMI and the sum of skinfold values. In this study, the stable level of PA behaviour is consistent with the national trend for Dutch youth (*Overzicht Kernindicatoren Sport En Bewegen | Sport En Bewegen in Cijfers*, n.d.). The percentage of prevocational students who meet the number of physically active minutes per week is 28% at the three measuring points, corresponding to the national trend of 28.3% during 2015–2016. The PA level did not significantly decrease in this study, in contrast to findings in other longitudinal studies (Dumith et al., 2011; Remmers et al., 2020). Dumith et al. (2011) concluded that interventions that attenuate the PA decline could be considered effective even without an increase in PA levels. Thus, one would expect the control group to show a decrease in PA behaviour compared to the intervention group. However, this was not found in our study. In this study, the physical activity behavior of young people was evaluated, and it is possible that examining such a singular aspect might not provide sufficient information to develop a comprehensive understanding of effective intervention strategies. Changing the PA level of adolescents is indeed a complex task. Recognizing this complexity, we have endeavoured to find solutions in collaboration with the students. While we may not have been able to address all barriers, we consider our efforts as a successful first step. The remaining barriers are more intricate and call for further choices at the student level, curriculum level and policy level (Somerset & Hoare, 2018; Waterlander et al., 2020). It therefore may be relevant to consider

schools as more complex systems in future research to gain a better understanding of explanatory factors, which could potentially lead to more appropriate interventions (Cefai C et al., 2021; Kearney et al., 2016; Rosas, 2015; Rutter et al., 2017).

Besides recognizing the complexity of school interventions, a significant focus of this study was empowering individuals and the school community by giving them a voice and an active role in shaping a challenging school environment when it comes to physical activity. Active student participation can take different forms. Two experimental studies reported strong positive effects owing to active student participation (Ho et al., 2017; How et al., 2013). Compared to a teacher-led PE program of 15 weeks, How et al. (2013) found significantly increased PA levels when students could choose their preferred participatory role such as the creator of a personal training program. Ho et al. (2017) also found positive effects on PA levels in an 18-week youth-centred program. In these studies, students set goals and created their learning paths in a semi-structured curriculum supported by facilitators, allowing students to strengthen their developmental assets such as self-efficacy, resilience and connectedness. Both studies focused on creating personal programs by students during didactically designed PE lessons. This approach resonates with the basic psychological needs of autonomy, connectedness and competence as defined in the Self-determination Theory (SDT) (Deci & Ryan, 2008). In both studies, the increase in autonomy and connectedness, along with the experience of success in their developed activities, could lead to an expectation that students would feel more competent. Thematic analyses of student interactions in the SALVO study confirm that students value the opportunity to share their perspectives on PA-related assets (Boonekamp et al., 2021).

The authors conclude that shifting the focus towards developing school-based interventions that build on student perspectives and active participation provides students with realistic opportunities for shaping PA and motivates them to be more physically active. In this study, we have observed intriguing positive developments concerning effectiveness and the implementation process, but we have also encountered mixed signals in this regard. The involvement of students in the Participatory Video (PV) and Social Interaction Mapping (SIM) methods was limited to one class per school, resulting in approximately 5 students participating in the focus group meetings. Moreover, participation in extracurricular activities was voluntary, possibly leading to a selection bias where more physically active students attended these activities, while relatively inactive students remained unreached. This selective participation of students could explain the limited effects found in our study, despite that some schools organized activities to encourage relatively inactive students to participate. An alternative approach, considering the diverse personal barriers among this student group from the outset of the study, may have resulted in higher levels of student participation for those in greater need (Somerset & Hoare, 2018).

For future research, it is crucial to explore the form, content, and context in which active student participation effectively influences physical activity (Anselma, Chinapaw, et al., 2020) This will help to design more inclusive and impactful interventions to promote physical activity among students.

Strengths and limitations

The Salvo study employed a robust experimental design, including 22 schools with a substantial participant pool of approximately 3000 individuals. This two-year intervention study utilized validated measurement instruments, enhancing the reliability and validity of data collected. A strength of the study lies in its high retention rate of participating schools, ensuring continuity and minimizing potential bias.

One of the strengths of the study was the active involvement of students in co-creating interventions alongside school staff and other stakeholders from the study's inception. This participatory approach, integrated with evidence-based interventions identified in a prior literature review (Kop et al., 2019), facilitated the development of effective strategies tailored to the school context. The use of participatory and interactive methods is recognized as a feasible and inclusive approach for implementation within schools.

However, the study faced some limitations. For practical reasons, an indirect method was chosen to assess the participants' physical activity levels, potentially introducing recall bias and over-reporting. The limited number of annual measurements made it challenging to discern short-term fluctuations in physical activity accurately. Additionally, gathering more precise information about the activities conducted by control schools would have provided valuable insights into the comparative effectiveness of the intervention.

Another potential limitation lies in the co-design processes, where achieving a greater consensus among stakeholders could have improved the effectiveness analysis based on varying levels of implementation. A more stringent protocol for co-design would have allowed for a more nuanced evaluation of the intervention's impact.
In conclusion, the Salvo study exhibits strengths in its rigorous design, substantial participant pool, and high retention rate of schools. The participatory approach in co-creating interventions and integrating evidence-based strategies further adds to its value. Nonetheless, the study's limitations, including the indirect method of assessing physical activity levels and the need for more frequent measurements, as well as the desire for more comprehensive information about control schools' activities and enhanced co-design protocols, should be acknowledged when interpreting the study's findings.

Conclusions

The SALVO study assessed the efficacy of a co-designed, school-based intervention meant to promote physical activity and fitness among Dutch prevocational secondary students.The study yields mixed results. Over the two-year follow-up, certain indicators for physical fitness showed improvement compared to the control group, while no significant differences were observed for PA. The level of student participation demonstrated limited association with PA and fitness outcomes. Despite this, the SALVO method presented in this study provides a protocol for tailoring intervention plans to students' assets through cocreation. Practical insights and evaluations with students and school staff suggest that cocreation is a promising and feasible method to be employed in the school context. Schools have the autonomy to work independently and scale up interventions according to their own insights, leading to a potentially more sustainable implementation of student-oriented programs. From our perspective, long-term implementation is crucial.

While schools play a vital role, they are not the sole setting for intervention. A broader system-level approach is necessary to create a comprehensive impact. Therefore, it is essential to extend our focus beyond the school setting and intervene within a broader municipal education and exercise stimulation policy. Further research is needed to develop and implement concrete tools that customize cocreation programs to suit the target group and ensure their effectiveness. We must view the student not only as an actor in the intervention program but also acknowledge the roles of other actors within the school and beyond such as teachers, management and broader municipal policy. By integrating various actors and considering the broader system, we can potentially achieve successful implementation, standard policy embedding and scalability of promising, empowering methods such as SALVO.

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