

Improving physical fitness and emotional well-being in adolescents of low socioeconomic status in Chile: results of a school-based controlled trial

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SUMMARY

Regular physical activity is associated with a reduced risk of all-cause mortality, and mortality due to cardiovascular disease and cancer. Among adolescents, physical activity is associated with benefits in the prevention and control of emotional distress, and improvement of self-esteem. Countries in transitional epidemiological scenarios, such as Chile, need to develop effective strategies to improve physical activity as a way to face the epidemic of chronic diseases. The objective of this study was to evaluate the effects of a school-based physical activity program on physical fitness and mental health status of adolescents living in a low socioeconomic status area in Santiago, Chile. A quasi-experimental design was used to evaluate the effects of the program over one academic year. The study included 198 students aged 15 years old. Two ninth grade classes were randomly selected as the intervention group, with two classes of the same grade as controls. A social planning approach was used to develop the intervention. The program was designed and implemented

based on student preferences, teachers' expertise and local resources. Changes in physiological and mental health status were assessed. After the intervention, maximum oxygen capacity achieved a significant increase of 8.5% in the intervention versus 1.8% in the control group ($p < 0.0001$). Speed and jump performance scores improved significantly more in the intervention versus the control group ($p > 0.01$). Anxiety score decreased 13.7% in the intervention group versus 2.8% in the control group ($p < 0.01$), and self-esteem score increased 2.3% in the intervention group and decreased 0.1% in the control group after the end of the program ($p < 0.0001$). No significant change was observed in the depressive score. Student participation and compliance with the program was $>80\%$. To conclude, a school-based program to improve physical activity in adolescents of low socioeconomic status, obtained a high level of participation and achieved significant benefits in terms of physical fitness and mental health status.

Key words: adolescents; fitness; school

INTRODUCTION

Regular physical activity has been associated with a reduced risk of all-cause mortality as well as a lower risk of cardiovascular disease, colon cancer and diabetes (Blair *et al.*, 1989; Berlin and Colditz, 1990; Kampert *et al.*, 1996). Countries in

transitional epidemiological scenarios such as Chile (Berrios *et al.*, 1997; Murray and Lopez, 1997) have experienced a significant shift in their main causes of death and disability. Infectious diseases that accounted for ~60% of deaths in

Chile in 1960 have been replaced by the outbreak of chronic diseases such as cardiovascular disease and cancer, which are currently associated with ~50% of all deaths (Albala *et al.*, 1997). In order to control this 'chronic disease epidemic' there is a need to develop effective strategies to improve healthy behaviors such as physical activity especially in young populations [Berrios, 1997; Pan American Health Organization (PAHO), 2002].

Emotional well-being has been considered another important benefit of physical activity among adolescents. Regular physical activity has been associated with a high self-esteem and a low level of anxiety symptoms in this population (Calfas and Taylor, 1994; Sothorn *et al.*, 1999). However, few studies have explored changes in emotional factors such as self-esteem, depression or anxiety before and after physical activity interventions targeted at adolescents (Steptoe and Butler, 1996; Paluska and Schenk, 2000).

Levels of regular physical activity in Chile are well below recommended international standards. About 80% of the adult population is sedentary (Berrios, 1997; Jadue *et al.*, 1999), a percentage that is similar to the 75% reported for the American population (Centers for Disease Control, 2001).

Childhood and adolescence are critical periods for the acquisition of healthy behaviors (Kelder *et al.*, 1994). There is strong evidence of a significant decline in the level of physical activity during early adolescence, especially in low socioeconomic status groups (Heath *et al.*, 1994; Kimm *et al.*, 2002). In Chile, a study developed by the Physical Education Program of the Catholic University in 10 schools revealed that the average time of effective physical activity of students was 6 min per physical education session a week (Zuñiga, 2002). Similar results have been published elsewhere (Simons-Morton *et al.*, 1988). This amount of time is well below the minimal standard estimated at 20–30 min of moderate to vigorous activity per class that is required to improve physical performance and achieve the health benefits associated with physical activity (Simons-Morton *et al.*, 1993).

The effectiveness of community-based interventions to improve physical activity was recently analyzed in a systematic review of the literature (Task Force on Community Preventive Services, 2002). The review concluded that school-based programs were, on average, successful at improving the physical fitness among school-aged children when compared

with other types of interventions. However, the evidence also showed high variability in the effect of different types of school-based programs. Some have achieved small but significant increases in the level of physical activity (Simons-Morton *et al.*, 1991; Nader *et al.*, 1999), but others have failed to produce a significant change despite intense implementation programs (Walter *et al.*, 1988; Sahota *et al.*, 2001a).

Few studies have used physiologic measures to evaluate the effects of intervention programs on physical fitness; most have relied on self-reported information on the amount of time spent on moderate to vigorous physical activity (Simons-Morton *et al.*, 1988; Sallis *et al.*, 1997; Sahota *et al.*, 2001b).

This study evaluates the effectiveness of a school-based intervention program aimed at improving physical fitness among adolescents living in a low socioeconomic area in Santiago. The program also evaluates some of the emotional benefits associated with physical activity, such as self-esteem, anxiety and depressive symptoms.

METHODS

The study was conducted in an urban public school located in a low socioeconomic area in Santiago. Participants were ninth grade students aged ~15 years old who attended the school in 2001 (March to December).

The study was coordinated by the Family and Community Medicine Department at the Catholic University in Chile, the Municipal Local Health Department and the Fernando de Aragon High School in Puente Alto, Santiago. It was approved by local authorities of the school, including the school director, the teachers committee council, the parents committee council and student representatives. Informed consent was obtained from the parents to allow students to participate in the study.

Characteristics of the community

Fernando de Aragon High School is located in Puente Alto, a municipal area with an estimated population of 400 000. Puente Alto is a relatively poor area. The percentage of the population living below the poverty level (defined in Chile as a household income less than US\$4690 for a family of four per year) in Puente Alto is 15%. In contrast, 10% of the population in Santiago

lives below the poverty level. The Aragon High School has an estimated student population of 3000, including students from 7 to 18 years of age. It is a public school that targets low-income families living in the north of Puente Alto. The community around the school, with an estimated population of 30 000, has a relatively small number of places to engage in physical activity. There is one community sport organization (Club Deportivo Centenario) with structured activities. There are four soccer leagues (Juventud Tricolor, Unión Juventud, Juventud Padre Hurtado, Villa La Foresta) that mainly have activities during the weekends and one community center with a soccer school (Escuela de Fútbol Municipal).

Intervention

The intervention program was developed using social planning and organizational change principles (Thompson and Kinne, 1999). Following a 'critical event' such as the educational curriculum reform occurring in the public school system in Chile, local school authorities selected new strategies to expand non-traditional activities for high school students.

Researchers at the Family and Community Medicine Program of the Catholic University came into contact with local school authorities and suggested they develop an intervention program to improve physical fitness in adolescents. Local school authorities were interested in enhancing healthy behaviors in this age group and in improving students' self-esteem, which they thought would happen if students were more active. Thus, an 'external change' (educational reform) triggered an 'internal change' (incorporation of a new program for a group of teenage students). The educational model used in the intervention program was based on the 'adult learning approach' (Vella, 1995). Principles of this model were used as strategies to work with students and teachers. The model assumes that adults decide what they want to learn and are active decision-makers in the learning process. Following these principles, teachers and students designed the intervention program and decided on the best way to implement it. School teachers developed a survey to assess students' preferences for the activities to be included, and students selected the type of activities in which they wanted to participate. After considering these preferences, it was agreed that four units of 30 sessions each would be tested.

Intervention condition

Three sessions were held each week and each lasted 90 min. Each session consisted of three steps. The first step included minimum activity with no weight transfer: stretching, and non-strenuous arm, leg and trunk movement. The second step included weight transfer activities and incorporated dynamic large muscle movements such as fast walking, running and jumping. The third step consisted of sports practice. This part of the session varied according to the unit students were involved in throughout the year. In each of the units, students learn and practice specific sports skills. Men and women chose different sports to practice. Women chose dance, aerobics, track practice and volleyball. Men chose soccer, basketball, volleyball and track practice. Each unit was conducted for 10 consecutive weeks so that all students were practicing the same sport at any given point in time during the year. Classes in the intervention group were given additional materials (e.g. balls) so that students had more opportunities to be active during a class.

The school board of directors decided to make a formal change in the 2001 curriculum specifically for those two extra sessions per week included in the intervention group. The sessions did not replace any course. Participation in these additional sessions was mandatory for students participating in the intervention. Sessions were taught by the regular teachers, who received an extra stipend from the researchers for the extra work (US\$6 per extra hour).

Control condition

Students in the control group received a 90 min standard exercise class once a week. Standard classes consisted of a variety of mixed activities, including general training (running, jumping), playing games and practicing sports that changed from session to session. The same teachers conducted both the intervention and control classes. Researchers assessed the performance of other physical activities (outside the school) in the intervention and control groups.

Design

The study used a quasi-experimental design. Four ninth grade classes were randomly selected from a total of six in the high school. From these, two were randomly selected as control and two as intervention groups (Figure 1). Sample size

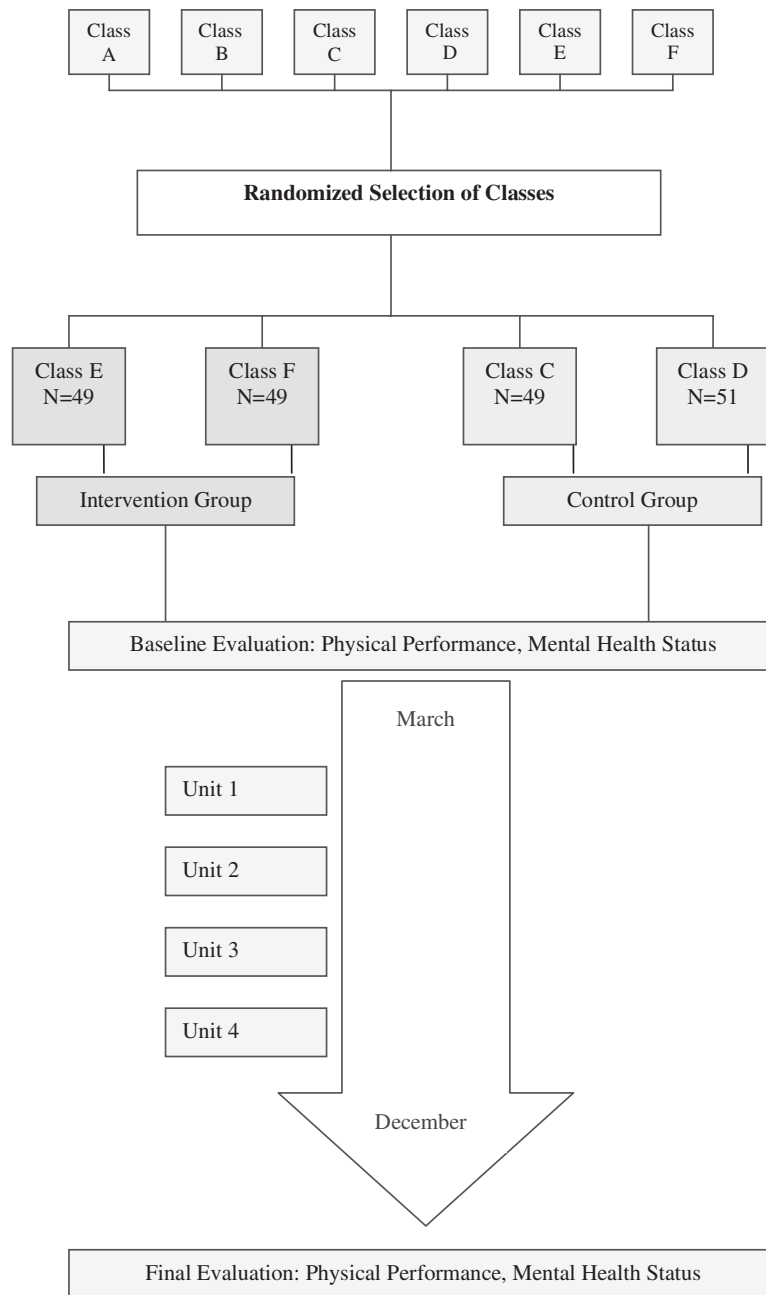


Fig. 1: Study design.

calculations were based on a change in physical performance of 5%, with an α value of 0.05 and a power of 80%. Given the relatively small number of clusters ($n = 4$), the study did not use a cluster randomization design and analysis.

Measures

General characteristics of the study population were assessed using a personal survey that contained information on age, gender, family income, smoking, alcohol consumption, use of

other drugs and regular physical activity out of school. We considered regular physical activity as any moderate intensity activity (e.g. brisk walking or biking) performed for at least 30 min, 5 or more days a week, or any vigorous activity (e.g. playing soccer or basketball) for at least 20 min, 3 or more days a week (Task Force on Preventive Services, 2002).

Academic performance was assessed using school records. Weight was measured using a standardized scale and relative weight was expressed as body mass index (BMI; kg/m²). Blood pressure was measured using a mercury sphygmomanometer.

The main dependent variables included physiological measures and mental health status indicators. Physiological measures included maximum oxygen consumption (VO₂max), speed and jump performance. Oxygen consumption was estimated using the Yo-Yo intermittent recovery test. This test is used as a reliable and accurate measurement of aerobic capacity (Krustrup and Bangsbo, 2001). Speed was measured using the 30-m speed test on a track using a photoelectric ergometer (Nummela *et al.*, 1996). This indicator is highly correlated with anaerobic capacity of the body and has been used in school-age children. Finally, muscular strength was estimated using the counter-movement jump that assesses explosive strength and muscular elasticity. It measures the intensity of jumping over a special platform that registers the level of impact using an ergometer (Marcora and Miller, 2000).

Mental health status was explored estimating three main dimensions: anxiety, depression and self-esteem. Anxiety and depressive symptoms were estimated using the HADS (hospital anxiety depression scale) instrument (Bjelland *et al.*, 2002). This self-administered test is validated and has been used extensively to measure anxiety and depressive disorders among adolescents (White *et al.*, 1999). In Chile there is no validated test for this population, therefore the selection of the instrument was based on the expert opinion of the Adolescence Unit at the Catholic University. Self-esteem was estimated using the Tennessee Self-Concept Scale (Castlebury and Durham, 1997). This instrument has been validated and used to measure self-esteem among Chilean adolescents from low socioeconomic status backgrounds (Valenzuela, 1984).

The main independent variable was participation in the physical activity program.

Statistical analyses

Results were analyzed at the individual level based on a quasi-experimental design. Students from both intervention classes were compared with students from the two control classes at baseline and post-intervention. We evaluated the normality of the variables by interpreting histograms and homogeneity of the variance. Mean differences were estimated for each outcome analyzed and then compared with each other to obtain weighted mean differences and 95% confidence interval (CI). A simple linear regression model was used to analyze the variables studied. No dichotomous dependent variables were included in the model. A multiple regression analysis was conducted to adjust the model for potential confounding variables such as gender, age, socioeconomic status, risk behaviors, self-report physical activity out of school, academic performance and BMI. Data was analyzed using EPI INFO 2000 version 1.1.

RESULTS

Baseline characteristics of the population

Baseline characteristics of the population are presented in Table 1. Intervention and control group participants were very similar with respect to all variables compared. Non-significant differences were found in age, gender and school performance. There was a trend towards lower socioeconomic status in the intervention group compared with the control group, which was not statistically significant. Health risk factors such as smoking and physical inactivity out of school were similar in both groups. Both groups were also comparable with respect to other health parameters such as BMI, alcohol consumption and blood pressure. Table 1 also shows that there were no statistically significant differences at baseline in physiological and mental health status indicators when comparing the intervention with the control groups.

Participation and implementation of the program

A total of 198 students participated in the study. Among them, 98 belonged to the intervention and 100 to the control group. Fifteen students dropped out of the study, eight in the intervention group and seven in the control group. Students who dropped out of the study had

Table 1: Baseline characteristics of participants

Characteristics	Intervention, <i>n</i> (%) (total <i>n</i> = 98)	Control, <i>n</i> (%) (total <i>n</i> = 100)	<i>p</i> -value
Female	45 (45.9)	57 (57)	NS
Low income (less than US\$286 per month)	64 (65.3)	53 (53)	NS
Smoking prevalence	44 (45.9)	39 (39)	NS
Students who consume alcohol	28 (28.6)	22 (22)	NS
Students who report regular physical activity outside of school	20 (20.4)	14 (14)	NS
	Mean (SD)	Mean (SD)	
Age	15.54 (0.89)	15.52 (0.95)	NS
Academic performance (1–7)	5.63 (0.66)	5.49 (0.52)	NS
Blood pressure (mmHg)	84.79 (6.59)	85.46 (7.41)	NS
BMI (kg/m ²)	21.95 (2.75)	22.34 (3.21)	NS

NS, not significant.

changed schools. No adverse effects were reported in the control or intervention groups during the year of intervention.

Eighty-seven percent (104 out of 120 sessions) of the designed sessions were completed. Weather conditions, holidays and special activities at school accounted for suspension of the 16 sessions not performed. Eighty-one percent (79 out of 98) of students in the intervention group completed the full program, with the major reason for non-completion being acute illnesses. Students from the intervention and control group who did not complete the study were similar to those who completed the program with respect to all characteristics described in Table 1. An intention-to-treat analysis using the imputation method with a carry forward strategy was performed. Using this method, we were able to analyze the information based on the 198 participants originally included at baseline.

Outcome measures

Table 2 shows the results of the outcome measures before and after the intervention. In terms of physiological indicators, there was a statistically significant improvement in the intervention group compared with the control group in the three indicators used to assess physical performance. Maximum oxygen consumption (VO₂max) improved by 8.5% among students in the intervention classes, but only by 1.8% in the reference (non-intervention) classes after the end of the program ($p < 0.0001$). Speed and jump performance increased by 10.3% and 9.8%, respectively, in the intervention

group, but only by 6.9% and 2.4% in the group that received the standard intervention ($p < 0.01$) (Table 2).

Mental health status indicators also changed after completion of the program. A statistically significant improvement of 13.7% in the anxiety score was observed in the group that participated in the program compared with a reduction of 2.8% in the control group ($p < 0.0001$). The self-esteem score increased by 2.3% in the intervention group, but decreased by 0.1% in the control group ($p < 0.001$). No statistically significant difference in the depressive symptom score was observed between the groups.

The significant differences observed in the outcomes were not affected after adjusting for potential confounding variables such as smoking, alcohol consumption, BMI, blood pressure, physical activity out of school and academic performance. A linear regression model was used for analyzing the effect of these variables on the outcomes studied.

DISCUSSION

This study shows that a school-based program targeted to teenagers of low socioeconomic status can produce significant increases in their physical fitness and better mental health status. The results of this study are particularly important in Chile since it, like many other Latin American countries, is facing a strong change in its epidemiological profile towards an 'epidemic of chronic diseases' (Murray and Lopez, 1997) and needs to implement effective

Table 2: Physical performance and mental health status indicators at baseline and post-intervention

Variable	Weighted mean difference											
	Control group					Intervention group					Intervention versus control groups	
	Baseline	Post-intervention	Mean difference	p-value	Baseline	Post-intervention	Mean difference	p-value	Score difference	95% CI	p-value	
Jump performance (cm)	22.22	22.75	0.53	0.570	23.26	25.55	2.29	0.012	1.75	0.97-2.53	0.000	
Maximum oxygen consumption (ml/kg/min)	36.07	36.72	0.65	0.337	34.85	37.82	2.97	0.000	2.31	1.62-2.99	0.000	
Speed (m/s)	4.74	5.07	0.33	0.0007	4.86	5.37	0.50	0.000	0.17	0.07-0.27	0.001	
Anxiety symptoms score	8.64	8.40	-0.24	0.797	8.61	7.43	-1.18	0.049	-0.94	-1.43 to -0.45	0.000	
Depressive symptoms score	7.03	7.05	0.02	0.968	7.01	6.96	-0.05	0.938	-0.07	-0.83-0.69	0.436	
Self-esteem score	302.55	302.25	-0.30	0.895	300.62	307.49	6.87	0.002	7.17	4.43-9.91	0.000	

health promotion activities in the population. The educational reform that is taking place in Chile (Delannoy, 2000) offers an opportunity to develop interventions that could enhance healthy behaviors in an age group that shows a consistent decline in its level of physical activity (Heath *et al.*, 1994; Kimm *et al.*, 2002; PAHO, 2002).

The PAHO initiative for developing 'healthy schools' (PAHO, 2002) seems to be an important step in changing the patterns of physical inactivity observed in most Latin American countries. However, as has been seen in many studies, there is high variability in the effect of physical activity programs implemented in schools and in many cases results have been disappointing (Walter *et al.*, 1988; Sahota *et al.*, 2001b). Many studies on physical activity have included students of young ages and have estimated the level of physical activity using observation or self-reported scales (Simons-Morton *et al.*, 1991; Sallis *et al.*, 1997; Sahota *et al.*, 2001a). In some cases, self-reported activity or observed physical activity have been difficult to quantify (Sahota *et al.*, 2001a) or have not had a good correlation with physical performance or health risk conditions (Kampert *et al.*, 1996; Nader *et al.*, 1999). Our study focused specifically on an adolescent age group and was able to use physiological indicators and show significant changes in the physical fitness of participants.

Improvements in self-esteem and a reduction in anxiety symptoms were other relevant outcomes observed in the intervention group of this study. A change in physical activity followed by an improvement in self-esteem and a reduction in anxiety symptoms among adolescents has been described elsewhere and our findings support such observations (Steptoe and Butler, 1996; Paluska and Schenk, 2000). A positive change in self-esteem and a reduction in anxiety level is a very relevant population goal in teenagers of low socioeconomic status given that these factors have much influence on important variables such as school adjustment and risky behaviors (Cavaola and Schiff, 1989; Haynes, 1990; Jackson *et al.*, 1995).

Our program tried to increase the level of involvement of the local school community. Participation and ownership are some of the factors that have been associated with beneficial results in health promotion interventions (Thompson and Kinne, 1999). Our program succeeded in achieving a high level of participation of local school authorities and students in the intervention. Involvement of the

board of directors was essential in incorporating the program into the curricular activities of the intervention group during the year 2001. The participation of teachers and students in the design and implementation of the program ensured a high level of commitment, which translated into a high participation rate and compliance with the program. These rates are higher than the 60–65% participation rate obtained in other school-based programs, where no increase in physical activity parameters was observed (Walter *et al.*, 1988; Sahota *et al.*, 2001a).

There is evidence that many health promotion interventions targeted at adolescents in Latin America are based on ‘classic’ or ‘vertical’ approaches that reduce ownership and decrease the impact and sustainability of the interventions (Pommier *et al.*, 1997). Even though a ‘social planning’ approach (Cox *et al.*, 1979) was taken to develop this intervention, researchers considered the importance of involving participants in the early stages of the project. The intervention was ‘constructed’ based on students’ preferences, teachers’ skills and local resources. An effective coalition among school authorities, teachers, students and researchers was achieved.

Feasibility and sustainability of the program was favored by the fact that the school in which the intervention was implemented is involved in the Chilean educational reform described previously; therefore it has resources to fund the needs of the new program. This is an example of a social planning approach where political opportunities and community needs are combined with research interests.

Limitations

This study has some important limitations that should be considered. First, the small sample size prevented us from applying the inferences of our results to other settings or school environments. However, the public school where the intervention was developed is located in the most populated district of Chile. The average socioeconomic income of the participants and their families is in the third decile of the national income distribution (MIDEPLAN, 2000), so it is likely to reflect an urban population of low socioeconomic status. Secondly, the small number of classes included in the selection process and the lack of accurate intraclass correlation coefficients for our Chilean population did not allow us to use a cluster randomization design or to analyze

the data considering a cluster effect. Instead, the study is analyzed as a quasi-experimental design. We do not anticipate a cluster effect ‘by teacher’ in our study given that the same teachers participated in the intervention and control groups. The differences were in the type of activities they delivered and the time they had to develop them. A cluster effect ‘by class’ might have been present and may explain some of the differences observed in the results. No differences were found in all measured variables between groups at baseline; the random selection of classes tend to favor comparable and equivalent intervention and control groups. Nevertheless, we cannot discard the presence of bias due to an uneven distribution of unmeasured variables that could have produced a cluster effect and affected the results observed. Finally, this study did not explore the type of physical activity students performed outside school at follow-up. There is some controversy surrounding whether or not children compensate for their level of physical education with physical activity out of school (Dale *et al.*, 2000; Mallam *et al.*, 2003). It is possible that the intervention developed in the project has also had an impact on the activities of children out of school. However, there is evidence from several cohort and randomized trials that physical activity out of school does not experience a significant change after a school-based intervention (Luepker *et al.*, 1996; Sallis *et al.*, 1997; Burke *et al.*, 1998).

CONCLUSION

A school-based intervention program designed to improve physical fitness in adolescents of low socioeconomic status can achieve a significant increase in their physical performance and parameters of mental health status. The intervention model could be a useful strategy to replicate in similar school environments. Given the growing recognition that physical activity is highly associated with increased health, it is necessary to find ways to encourage the adoption of such healthy behaviors early in the lifecourse.

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