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Individual versus group exercise effect on youth physical activity levels: a randomised controlled trial

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ABSTRACT

Objectives To explore the effects of two different types of exercise (individual vs group) on physical activity (PA) among Croatian university students.

Methods A total of 976 university students between the ages of 19 and 20 years (age 19.4±1.1 years, body mass index 21.9±2.9 kg/m^2) were randomly assigned to either the control group (individual exercise) (n=504) or the intervention group, which received group exercise (n=472). Pre- and postintervention measures included: self-rated health, parents' occupation, psychological distress, nutritional status and PA levels. The overall intervention effect was estimated using linear regression method, and heterogeneity in intervention effect was assessed by modelling complex variance.

Results Group-based exercise intervention significantly increased total PA time by more than 10 metabolic equivalents (METS) hours per week compared with individual-based exercise control group. When considering different types of activities, the intervention effect was stronger for vigorous activity (increase by almost 6 METS hours per week) than walking activity (2.5 METS hours per week). The change in moderate activity level was not significant after covariate adjustment. In addition, intervention was also effective in reducing sedentary hours. Finally, when complex level-1 heterogeneity was modelled by intervention status, we found substantially larger variance in the intervention group compared with the controls, indicating presence of heterogeneous treatment effect.

Conclusions This study discusses major implications of different ways of exercising among youths from a health, educational and sport perspective. Intervention and policies that leverage school social capital might serve as an avenue for health promotion in youth.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Physical activity (PA) is a powerful marker of health in youth.
⇒ So far, there has been four different systematic or meta reviews conducted on the effectiveness of group versus individual interventions to promote PA, and they were pretty much in contrast to each other.

WHAT THIS STUDY ADDS

⇒ This research provides the most unique effect of exercising in a true group (ie, a group that has experienced some form of team building) on PA levels other than adherence and/or social interaction.
⇒ This study clearly showed that exercising in a true group is superior to exercising individually.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Results of our study may help increase the effectiveness of PA interventions by offering significant information in regards with the importance of contact and social support to participants.
⇒ Moreover, it appears that in terms of adherence to PA programmes in particular, participants benefit most from PA when they are given the opportunity to interact with others.

INTRODUCTION

Robust and consistent evidence supports that physical activity (PA) is a powerful marker of health in youth.[1 2] PA is an important protective factor against the development of chronic diseases at any age.[2] Yet, the global prevalence of sedentary behaviour is high.[3] Furthermore, evidence suggests that PA levels during adolescence track into adulthood. Previous studies showed a very strong connection between PA levels during adolescence and at follow-up into adulthood.[3] PA during adolescence is a complex behaviour that is shaped by different personal and social factors.[4–10] Recent reports on PA indicated that majority of Croatian population are not physically active at frequency and intensity levels that are sufficient to result in health benefits or disease prevention. According to the latest surveys, 65% of adults had insufficient PA.[11] Furthermore, a Childhood Obesity Surveillance Initiative study of 7150 young children from Croatia found that among boys aged 8–9 years, 38.7% were overweight or obese, while the corresponding figure among girls was 31.0%.[12]

There is a permanent interest of researchers in creating protocols to stimulate involvement in and maintenance of PA. The most common contexts for PA are either group-based or individually based programmes. Which of these

two basic contexts (ie, group-based vs individually based) is superior in terms of individual adherence to PA has been the focus of considerable research attention and some controversy. So far, there has been four different systematic or meta reviews conducted on this topic, and they were pretty much in contrast to each other. Dishman and Buckworth[13] supported the efficacy of group-based interventions (vs individually based programmes).[13] In a second review, the efficacy of home-based interventions (vs group-based programmes) was also endorsed.[14] However, in a third review, an entirely different conclusion was reached. van der Bij, Laurant and Wensing[15] concluded that home-based individual and group-based interventions were equally effective at promoting PA over the short term.[15] And finally, results of the last meta-analysis revealed that exercising in a group was superior to exercising in a standard exercise class, which in turn did not differ from exercising at home with contact. Furthermore, exercising at home with contact was superior to exercising at home without contact.[16] Obviously, the reviews and conclusions offered by Dishman and Buckworth[13], Atienza[14], van der Bij and colleagues[15], and Burke and colleagues[16] contrast markedly with one another.[13–16] Thus, a question that arises is how a similar literature could lead to such opposite conclusions. One possibility is associated with the operationalisation of the contexts used in the various studies. As was pointed out above, the two basic contexts in which PA can be undertaken are individually based and group-based. Also, not all of these studies were randomised control trials, so there is possibility of various sources of bias that could have affect the study results. And most importantly, no studies have simultaneously examined the contribution of the effect of exercising in a true group (ie, a group that has experienced some form of team building) on PA levels other than adherence and/or social interaction.

Therefore, the primary aim of this article is to evaluate effects of two different types of exercise (individual vs group) on PA among Croatian university students. Secondary aim of this study was to go beyond average treatment effects and assess the possibility of heterogeneity in treatment effects by examining the differential variance in intervention versus control group.

METHODS

Data search and pooling

A randomised controlled trial was conducted among university students in Zagreb City in Croatia. All students enrolled during the 2016/2017 school year were invited to participate. A total of 976 university students between the ages of 19 and 20 years (age 19.4±1.1 years, body mass index (BMI) 21.9±2.9 kg/m^2) participated in the study. Students were randomly allocated to either the control group (individual exercise) (n=504) or the intervention group, which received group exercise (n=472). To participate in the study, all subjects had to meet the criteria that they are healthy and officially enrolled in the university study programme. All participants were informed about the study goals. The study used self-administered questionnaires that were administered during obligatory physical education classes before and at the end of the intervention protocol. The study was approved by the Institutional Review Board of the Faculty of Kinesiology University of Zagreb (protocol code number 46; date of approval: 11 September 2016). All students signed an assent form.

Equity, diversity and inclusion statement

The author group is gender balanced and consists of two women and three men from different disciplines (public health, kinesiology, social epidemiology). Our study population included both male and female university students from different socioeconomic backgrounds participating in physical education classes; thus, findings may not be generalisable to settings with fewer resources.

Study variables

The dependent variable was regular PA measured by the validated short version of International Physical Activity Questionnaire (IPAQ).[17] Four dependent variables were analysed: (1) regular vigorous and/or moderate PA, (2) walking, (3) sedentary PA and (4) overall regular PA. Regular PA was defined as 60 min or more of daily PA during the week. This definition was based on the recommendations of PA for this age group.[17] All outcome variables were converted into METS hours per week for analysis, except for overall regular PA.

The principal independent variable of interest is the intervention status. The 8-week intervention protocol (2×45 min per week) is composed of a different group exercise. Students were strongly encouraged to cooperate and interact with each other, whereas in the control group, students followed individually based programmes.

Other study covariates included:

i. Self-rated health was assessed by using the single question: 'How do you perceive your overall health?'. Possible responses were: 'very poor', 'poor', 'regular', 'good' or 'excellent'.[18]
ii. Self-perceived socioeconomic status (SES). Adolescents were asked to identify their family SES as high SES (ie, managers and professionals), middle SES (white collar workers) and low SES (blue collar workers).[19]
iii. Psychological distress was assessed using the 6-item Kessler scale.[20]Each question is scored from 0 (none of the time) to 4 (all of the time).[21 22]
iv. Nutritional status was assessed through BMI, and it was calculated based on the self-reported height and weight, as weight in kilograms divided by height in metres squared.

Similarly, all variables except BMI were coded as ordered categorical variables (self-rated health, 1–5; SES, 1–3; and 6-item Kessler scale, 1–5).

Table 1 Baseline characteristics of intervention and control groups

	Intervention (group)	Control (individual)	Difference (p value)
N (observations)	472	504	
Sex: female	326 (69.07%)	318 (63.1%)	p=0.05
Male	146 (30.93%)	186 (36.9%)	
Age (mean (SD))	19.71 (1.31)	19.21 (0.98)	p<0.00
BMI (mean (SD))	22.04 (3.04)	21.89 (2.77)	p=0.41
Self-rated health (mean (SD))	4.16 (0.75)	4.26 (0.69)	p=0.02
Father occupation: high SES	162 (34.32%)	208 (41.27%)	p=0.00
Middle SES	67 (14.19%)	89 (17.66%)	
Low SES	237 (50.21%)	203 (40.28%)	
Others	6 (1.27%)	4 (0.79)	
Mother occupation: high SES	155 (32.84%)	171 (33.93%)	p=0.00
Middle SES	75 (15.89%)	116 (23.02%)	
Low SES	241 (51.06%)	217 (43.06%)	
Others	1 (0.21%)	0	
K6:1 (mean (SD)) nervous	3.44 (0.88)	3.53 (0.87)	p=0.09
K6:2 (mean (SD)) hopeless	4.23 (0.89)	4.27 (0.88)	p=0.44
K6:3 (mean (SD)) restless/fidgety	3.47 (0.86)	3.6 (0.86)	p=0.01
K6:4 (mean (SD)) depressed	4.56 (0.69)	4.57 (0.74)	p=0.08
K6:5 (mean (SD)) everything was an effort	4 (0.86)	4.05 (0.88)	p=0.41
K6:6 (mean (SD)) worthless	4.5 (0.8)	4.61 (0.67)	p=0.01
K6: Total (mean (SD))	24.19 (3.75)	24.62 (3.69)	p=0.07
IPAQ-METS vigorous activity (hours per week) (mean (SD))	6.86 (15.93)	8.54 (18.5)	p=0.12
IPAQ-METS moderate activity (hours per week) (mean (SD))	6.67 (16.33)	4.88 (10.07)	p=0.03
IPAQ-METS walking activity (hours per week) (mean (SD))	14.87 (18.32)	12.65 (15.57)	p=0.04
IPAQ-total METS activity (hours per week) (mean (SD))	28.38 (33.82)	26.07 (30.10)	p=0.25
IPAQ-sitting activity (hours per week) (mean (SD))	45.52 (16.55) (n=337)	44.21 (15.81) (n=367)	p=0.28
Activity level: inactive	195 (41.31%)	216 (42.86%)	p=0.61
Minimally active	184 (38.98%)	201 (39.88%)	
Highly active	93 (19.7%)	87 (17.26%)	

*N(observations) except IPAQ-sitting activity due to missing values.
†For vigorous, moderate and walking, missing values were considered 0; for sitting, missing values were excluded.
‡For SC, 1:5=strongly disagree: strongly agree.
§For K6, 1:5=All: none.
¶Total METS activity is calculated by adding the values of vigorous, moderate and walking activity.
BMI, body mass index; IPAQ, International Physical Activity Questionnaire; METS, metabolic equivalents; SES, socioeconomic status.

Statistical analysis

Of the 976 study participants, after removing 11 students who answered their SES as 'others', 965 were eligible for the analysis. 628 students who recalled their sitting hours during the last 7 days were included in the analysis of sedentary behaviour. After eliminating the same students as above, the final analytic sample was 619 for the sedentary behaviour outcome.

To assess the intervention effect, we first conducted a linear regression model for each PA outcome assuming constant variance:

$$Y_i = \beta_0 + \beta_1 Intervention_i + \beta\left(X_i'\right) + \epsilon_i$$

where β_0 represents the estimate of the mean outcome when all variables are set to zero, β_1 represents the difference in expected outcome between the control and intervention groups, and ϵ_i is an error term for the observation.

In addition to the average intervention effect, we assessed heterogeneity in intervention effect by modelling complex variance.[23] That is, we relaxed the constant

variance assumption to allow differential variance in outcome to be estimated by intervention status. If intervention group had a larger increase in PA level on average *and* had larger variance compared with the control group, this would indicate significant yet heterogeneous intervention effect (ie, some students benefit significantly more than others). Complex variance models were fitted by partitioning the level 1 variance according to the intervention status (intervention group variance (σ^2_{e1}) and control group variance (σ^2_{e2})):

$$Y_i = \beta_0 + \beta_1 Intervention_i + \beta\left(X_i'\right) + e_{1i} Intervention_i + e_{2i} Control_i$$

For this model, residual distribution is specified as:

$$\begin{bmatrix} e_{1i} \\ e_{2i} \end{bmatrix} \sim N\left(0, \begin{bmatrix} \sigma^2_{e1} & \\ - & \sigma^2_{e2} \end{bmatrix}\right)$$

where Y_i represents the outcome (METS hours difference for each activity), $Intervention_i$ is an indicator variable for the intervention group ($Intervention_i$ =1 if one belongs to an intervention group, 0 if a control group), $Control_i$ is an indicator variable for the control group and X_i' is a vector of covariates.

RESULTS

Overall, 332 males (33.9%) and 644 females (66.1%), aged 19–20 years, responded to the survey. Table 1 presents the baseline characteristics of intervention and control groups. Most adolescents evaluated their family socioeconomic status as low, with statistically significant differences between intervention and control group at baseline. Also, the majority reported good self-rated health; control group reported higher scores of good health (4.26±0.69) compared with intervention group (4.16±0.75), and this difference was statistically significant. Participants reported average BMI of 21.96±2.90 kg/m^2. Regarding social capital, both groups reported high social capital more frequently for 'family social capital' and less frequently for 'neighbourhood trust' and 'neighbour criticise deviant behaviour'. Regarding psychological distress, the average score was 24.41±3.72 in the 6-item Kessler scale, with the average score slightly higher in control (24.6), compared with intervention group (24.1). Higher percentage of control group reported being inactive (42.8%) and minimally active (39.8%), comparing with the intervention group (41.3% and 38.9%, respectively). The intervention group reported higher percentage of highly active levels than the control group (19.7% vs 17.2%). But there was no statistically significant difference in the proportion of different activity levels.

Table 2 presents the within-group differences in pre- versus postintervention and between-group differences in the intervention effect. The crude comparison between the two groups does indicate a significant intervention effect. The K6 score indicated negative changes in the control group, while majority of activity changes were statistically significant (increase in activity times and reduction in sitting times). For control group, vigorous, walking and sitting times differences were not significant. The control and intervention groups showed a decline in 'inactive' status, while students in the intervention group showed a larger drop.

Table 3 reports the treatment effect on different PA outcomes (regular vigorous and moderate PA, walking and sedentary activity, and total PA, which are all set in METS unit). Regression results showing intervention effect on the change in PA levels from baseline to follow-up. We find that in the adjusted model, intervention significantly increased total PA time by more than 10 METS hours per week. When considering different types of activities, the effect was seen to be stronger for vigorous activity (increase by almost 6 METS hours per week) than walking activity (2.5 METS hours per week). The change in moderate activity level was not significant after covariate adjustment. Intervention was also effective in reducing sedentary hours.

Table 4 presents the results for (1) partitioned variance in different outcomes when assuming different variances (heterogeneity) by intervention status (level 1) and (2) constant variance after adjusting for all covariates. When we allow complex level 1 heterogeneity by intervention status, we see substantially larger variance in the intervention group among all types of outcomes, compared with the controls, indicating presence of heterogeneous treatment effect. For example, level 1 variance estimates for METS vigorous activity difference ($\sigma^2_{\text{Intervention Group}}$ (SE)=687.25 (45.06), $\sigma^2_{\text{Control Group}}$ (SE)=327.84 (20.74)) indicate that the intervention group variance is greater than the control group. Under the constant variance assumption, the variance estimates for the same outcome are consistent as 500.2 (22.77).

DISCUSSION

Summary of findings

The general purpose of the study was to evaluate effects of two different types of exercise (individual vs group) on PA among Croatian university students. With regard to the overall influence of context, it was found that exercising in a true group is superior to exercising individually without contact. These results demonstrate that as the amount of contact and/or social support available from other exercise participants in an intervention increase, so too do the beneficial effects of that intervention.

These findings are supported by other research. For example, Carron et al.[24] reported that engagement in regular PA is strongly connected with social support from important others, mostly from the family.[24] Also, efficacy for PA relates to social support from family, and effect relating to PA is in relationship with social support from both important others, mostly from family again. Similarly, Kahn and colleagues[25] found a pretty strong evidence that important others (ie, members of cohesive classes, family and friends) do have a strong effect

Table 2 Within-group differences in pre- versus postintervention and between-group differences in the intervention effect

	Intervention (group) n=472				Control (individual) n=504				
	Baseline	Endline	Difference (endline-baseline)	Paired t-test p value	Baseline	Endline	Difference (endline-baseline)	Paired t-test p value	Comparing the pre- versus postdifference between the intervention and control groups
Self-rated health (mean (SD))	4.16 (0.75)	4.25 (0.67)	0.09	0.00	4.26 (0.69)	4.28 (0.69)	0.02	0.43	0.07
K6:1 (mean (SD)) nervous	3.44 (0.88)	3.38 (0.89)	−0.06	0.18	3.53 (0.87)	3.22 (0.93)	−0.31	0	0
K6:2 (mean (SD)) hopeless	4.23 (0.89)	4.24 (0.87)	0.01	0.67	4.27 (0.88)	4.14 (0.99)	−0.13	0.00	0.01
K6:3 (mean (SD)) restless/ fidgety	3.47 (0.86)	3.56 (0.88)	0.09	0.03	3.6 (0.86)	3.44 (0.93)	−0.16	0.00	0.00
K6:4 (mean (SD)) depressed	4.56 (0.69)	4.53 (0.72)	−0.03	0.39	4.57 (0.74)	4.45 (0.87)	−0.12	0.00	0.10
K6:5 (mean (SD)) everything was an effort	4 (0.86)	3.94 (0.89)	−0.06	0.20	4.05 (0.88)	3.82 (0.94)	−0.23	0	0.00
K6:6 (mean (SD)) worthless	4.5 (0.8)	4.51 (0.77)	0.01	0.63	4.61 (0.67)	4.58 (0.77)	−0.03	0.40	0.35
K6: Total (mean (SD))	24.19 (3.75)	24.17 (3.77)	−0.02	0.90	24.62 (3.69)	23.66 (4.13)	−0.96	0	0
IPAQ-METS vigorous activity (hours per week) (mean (SD))	6.86 (15.93)	12.66 (25.52)	5.8	0	8.54 (18.5)	8.67 (17.2)	0.13	0.87	0.00
IPAQ-METS moderate activity (hours per week) (mean (SD))	6.67 (16.33)	11.19 (17.75)	4.52	0	4.88 (10.07)	6.78 (11.65)	1.9	0.00	0.01
IPAQ-METS walking activity (hours per week) (mean (SD))	14.87 (18.32)	18.4 (16.19)	3.53	0.00	12.65 (15.57)	13.81 (15.1)	1.16	0.11	0.03
IPAQ-total METS activity (hours per week) (mean (SD))	28.38 (33.82)	42.26 (41.54)	13.88	0	26.07 (30.10)	29.26 (30.08)	3.19	0.02	0
IPAQ-sitting activity (hours per week) (mean (SD))	45.52 (16.55) (n=337)	42.21 (16.61) (n=381)	−3.31	0.00	44.21 (15.81) (n=367)	44.67 (16.02) (n=390)	0.46	0.46	0.01
Activity level: inactive	195 (41.31%)	60 (12.71%)	−0.29	0	216 (42.86%)	163 (32.34%)	−0.11	0.00	0
Minimally active	184 (38.98%)	265 (56.14%)	0.17	0	201 (39.88%)	239 (47.42%)	0.08	0.01	0
Highly active	93 (19.7%)	147 (31.14%)	0.11	0.00	87 (17.26%)	102 (20.24%)	0.3	0.22	0

*N(observations) except IPAQ-sitting activity due to missing values.
†For vigorous, moderate, and walking, missing values were considered 0; for sitting, missing values were excluded.
‡For SC, 1:5=strongly disagree/strongly agree.
§For K6, 1:5=All: none.
¶Total METS activity is calculated by adding the values of vigorous, moderate and walking activity.
IPAQ, International Physical Activity Questionnaire; METS, metabolic equivalents.

Table 3 Treatment effect on different physical activity outcomes

	METS vigorous activity difference		METS moderate activity difference		METS walking activity difference		IPAQ total score difference		Sedentary hours per week difference	
	Model 1 unadjusted	Model 2 adjusted	Model 1 unadjusted	Model 2 adjusted	Model 1 unadjusted	Model 2 adjusted	Model 1 unadjusted	Model 2 adjusted	Model 1 unadjusted	Model 2 adjusted
Exercise type: control										
Intervention (group exercise)	5.689*** (2.876; 8.503)	5.794*** (3.222; 8.367)	2.620** (0.426; 4.814)	2.212 (–0.653; 5.076)	2.370** (0.129; 4.612)	2.510** (0.192; 4.827)	10.68*** (6.178; 15.18)	10.52*** (4.983; 16.05)	–3.566** (–6.530; –0.602)	–3.461** (–6.127; –0.794)
Sex: male										
Female		–0.131 (–3.293; 3.032)		0.276 (–2.050; 2.601)		1.764 (–1.053; 4.582)		1.910 (–2.488; 6.307)		4.737*** (2.355; 7.119)
Residence area: parents' house										
Student dormitory		1.824 (–4.310; 7.959)		2.315 (–3.600; 8.230)		0.178 (–1.523; 1.878)		4.317 (–6.521; 15.15)		0.259 (–1.947; 2.466)
Private accommodation		–0.558 (–3.907; 2.790)		2.637 (–0.638; 5.912)		–0.243 (–3.043; 2.556)		1.835 (–3.866; 7.537)		0.241 (–2.566; 3.049)
Father's occupation: high SES										
Middle SES		–1.761 (–8.203; 4.680)		0.723 (–2.780; 4.226)		–0.493 (–4.462; 3.477)		–1.531 (–10.82; 7.753)		–2.571 (–7.190; 2.049)
Low SES		–2.882 (–6.977; 1.213)		–0.282 (–1.928; 1.364)		0.917 (–3.295; 5.129)		–2.247 (–9.756; 5.262)		–1.534 (–5.152; 2.084)
Mother's occupation: high SES										
Middle SES		3.631 (–2.015; 9.278)		–0.582 (–4.869; 3.704)		–0.865 (–5.201; 3.471)		2.185 (–7.372; 11.74)		1.474 (–2.416; 5.365)
Low SES		2.023 (–2.459; 6.505)		–0.877 (–2.992; 1.239)		–2.199* (–4.620; 0.222)		–1.053 (–7.661; 5.556)		2.031 (–1.184; 5.245)
Self-rate health at the baseline		–1.632 (–5.029; 1.765)		–0.686 (–2.192; 0.821)		0.157 (–1.128; 1.443)		–2.161 (–5.962; 1.640)		0.885 (–0.681; 2.451)
Age		0.00 (–1.106; 1.112)		0.725 (–0.482; 1.933)		–0.509* (–1.118; 0.1000)		0.219 (–1.722; 2.161)		0.281 (–1.078; 1.639)
BMI		0.108 (–0.634; 0.850)		–0.0575 (–0.380; 0.265)		0.0183 (-–.410; 0.447)		0.0688 (–1.016; 1.154)		0.284* (–0.0351; 0.604)
Observations (N)	976	965	976	965	976	965	976	965	628	619

***p<0.01, **p<0.05, *p<0.1.
Model 2 Adjusted included vce cluster estimation in cities and covariates
Difference unit is hours per week
BMI, body mass index; IPAQ, International Physical Activity Questionnaire; METS, metabolic equivalents; SES, socioeconomic status.

Table 4 Variance in different outcomes when assuming constant variance and heterogeneity by intervention status

		METS vigorous activity difference	METS moderate activity difference	METS walking activity difference	IPAQ total score difference	Sedentary hours per week difference
Constant variance	Variance (SE)	500.20 (22.77)	300.15 (13.66)	318.32 (14.49)	1271.74 (57.9)	344.82 (19.6)
Heterogenous variance	Intervention group variance (SE)	687.25 (45.06)	461.61 (151.22)	363.91 (23.84)	1658.37 (108.76)	350.06 (28.72)
	Control group variance (SE)	327.83 (20.74)	151.21 (9.57)	275.97 (17.47)	914.01 (57.81)	339.97 (26.8)
N		965	965	965	965	619

*Variance (SE).
†Difference unit is hours per week.

on the involvement in and benefits derived from PA.[25] The results of our research are in contrast with van der Bij *et al*'s[15] results showing that home-based and group-based interventions are equally effective at promoting PA, as well as with Atienza's[14] conclusion that home-based PA programmes are superior to group-based programmes.[14 15] Our results mostly support Dishman and Buckworth[13] and Burke and colleagues'[16] findings that in terms of adherence to PA, group-based programmes are superior to home-based programmes (particularly those that do not include contact with participants).[13 16] However, as mentioned above, both contexts of exercise in our research were real-world context in the form of regular physical education classes.

Effective strategies to increase PA levels are particularly important when it comes to university and college students. The prevalence of physical inactivity among college students calls for immediate action. More and more students than ever before have adopted sedentary lifestyles.[26] Physical inactivity is one of the priority health risk behaviours for college populations. PA behaviours that students establish in college have a long-term impact on adult PA habits. That being said, university-based physical education and health interventions aim to set long-term behavioural patterns during the transition to adulthood. Therefore, researchers need to investigate how to increase college students' PA and study the impact of increased PA on the development of PA patterns across the life span. Our intervention was effective in reducing sedentary hours.

Additionally, when allowed complex level 1 heterogeneity by intervention status, we noticed substantially a larger variance in the intervention group compared with the controls, indicating presence of heterogeneous treatment effect. We believe this is an important finding as the presence of heterogeneous treatment effect essentially indicates that some children benefit more than others, thereby potentially exacerbating the inequity in PA level. This indicates that we need to better understand for whom this intervention works in order to induce more effective and equitable intervention effect. For example, male students are consistently found to be more active than girls, and it is important to provide PA according to their needs.[27] Overweight and obese students are usually less active and participate less in regular PA.[28] Therefore, it is very important to find appropriate physical activities, especially for overweight and obese students. There are also some indications that some connections between socioeconomic status and regular PA exist during adolescence. Previous studies have suggested that low socioeconomic status students are likely to display lower PA levels, engage in more sedentary activities and have a higher BMI.[20] Again, there should be a specific and targeted approach in providing PA for low socioeconomic status students.

Usefulness and practical implications of individual versus group exercise

Our findings have practical utility and implications. PA testing and monitoring are extremely important from a public health and clinical point of view. Since PA has repeatedly and consistently been shown to be a powerful marker of physical, mental and cognitive health in youth, PA testing and monitoring will provide valuable insights into the health status of youth at individual and group levels. Therefore, we believe that the results of our study may help to increase the effectiveness of PA interventions by offering significant information in regards with the importance of contact and social support to participants. Moreover, it appears that in terms of adherence to PA programmes in particular, participants benefit most from PA when they are given the opportunity to interact with others. Thus, for at least the short term, it is evident that contact with and among participants is invaluable in terms of leverage overall PA and health promotion in youth.

Limitation and strengths

The present manuscript is not without its limitations. First, PA was measured with the IPAQ, which may have led to recall and social-desirability bias. Studies comparing direct versus self-report measures for assessing PA in adults reported that self-report measures might provide less precision of the results. However, it pointed out that there were no clear trends in the degree to which PA measured by self-report and direct measures differ.

This review concluded that the costs and benefits of the direct measurement should be considered in any study to determine if additional resources justify the possible increase in the precision of the results.[29] Second, this study did not gather information about attributes of and neighbourhood participants living in; consequently, the relative contribution of neighbourhoods on adolescent's PA cannot be evaluated. Finally, the use of self-perceived social economic status is quite a crude measure that may not reflect properly the social economic differences in access to resources and opportunities. However, the strength of randomised control trials is in balancing out all measurable and unmeasurable individual characteristics across the intervention and control groups and thereby removing confounding bias that could be caused by individual characteristics.

On the other hand, there are some important strengths/contributions from our study including: first, unique effect of exercising in a real physical education setting; second, contrary to previous for the majority of studies where participants were 50 years of age or greater, participants of this study are university students between the ages of 19 and 20 years; and finally, to facilitate PA testing and interpretation through different types of exercise, which we hope will improve the amount, quality and availability of future PA of youth.

CONCLUSION

The present study shows intervention effect on the change in PA levels from baseline to follow-up. Intervention significantly increased total PA time by more than 10 METS hours per week. When considering different types of activities, the effect was seen to be stronger for vigorous activity than walking activity. In addition, intervention was also effective in reducing sedentary hours. Finally, when allowed complex level 1 heterogeneity by intervention status, we noticed substantially a larger variance in the intervention group compared with the controls, indicating presence of heterogeneous treatment effect. Furthermore, the current study suggests that particular attention should be devoted to developing practical interventions to build social capital in family, communities and schools. Such interventions must address, but are not limited to, a creation of family resources to foment youth physical participation and increase variety and quality of school-based and community-level programmes, such as community and recreation centres and after-school programmes. Intervention and policies that leverage overall PA might serve as an avenue for health promotion in youth.

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