Effect of a school-based intervention on physical activity and quality of life through serial mediation of social support and exercise motivation: the PESSOA program

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Abstract

The aim of this study was to explore the effects of social support and behavioral regulation of exercise on physical activity (PA) and quality of life (QoL), in a Portuguese school-based intervention. We hypothesized that serial mediation effects would be present leading to greater levels of PA and QoL. The sample comprised 1042 students (549 boys), aged 10–16 years, BMI = 19.31 ± 3.51, allocated to two groups of schools: control (n = 207) and intervention (n = 835). This study will report the 24 months results of the program, which aimed to develop healthy lifestyles. Questionnaires were used to measure PA, QoL, motivation to exercise and social support. There was no direct impact of the intervention on QoL or PA. Serial mediation analyses were conducted. Social support (P < 0.019) and intrinsic motivation (P = 0.085) increased more on intervention group. Indirect effects were observed in all serial mediation models. The positive indirect effects on PA and QoL were explained by the increase on peer/parent support in serial with the increase in intrinsic motivation (P < 0.01). Parental support led to an increase on external motivation (P < 0.05), which buffered the effects of the intervention. This school-based intervention promoted the development of social support and motivational mechanisms that explained higher levels of PA and QoL.

Introduction

Promoting physical activity (PA) in adolescents is a public health concern [1–3]. Despite the existing current recommendations on providing and promoting PA in school settings [4] and the strong evidence on the prevention of obesity in children [5], school-based interventions have not been effective in increasing PA rates in adolescents [6]. In addition, health-related quality of life (QoL), an important outcome measure in health research with children and adolescents, has been consistently reporting smaller scores for the older adolescents [7, 8].

In Portugal, a recent study using accelerometers (N = 4696) showed that only 36% of 10–11 years old meet the recommendations of moderate-to-vigorous PA, and they decrease progressively to 4% in the ages of 16–17 years [9]. Relatively to overweight and obesity, Sardinha et al. [10] using the International Obesity Task Force criteria, found that in a sample of 22 048 Portuguese adolescent (aged between 10 and 18 years), about 25% were overweight and obese. The reported results add concerns to the fact that obese youth have a reduced QoL, specifically in their perceptions regarding physical appearance, athletic competence and
social functioning [11]. Furthermore, it is widely documented on scientific research that a positive youth development is positively related to well-being and perceived QoL [e.g. 12]. Health-related QoL, an important outcome measure in health research with children and adolescents [13], is a multidimensional psychological construct that describes physical, emotional, social and functional aspects of well-being [8, 14]. Recent research showed that being physically active is positively linked to the QoL of adolescents [15]. As such, and from a health perspective alone, understanding better how to motivate PA and lifestyle changes is considered a critical issue [16].

Evidence-based literature, about PA behavior change, recommends that we focus our efforts on mediating mechanisms [17, 18], to better understand the how and why interventions could help adolescents to achieve positive effects on health behavior and on health status measures [19]. Mediators \((M)\) are causal links between intervention \((X)\) and outcome \((Y)\) [20], and when testing this causal processes we are interested in estimating and interpreting direct \((X \rightarrow Y)\) and indirect effects \((X \rightarrow M \rightarrow Y)\) [21]. Models with two mediators operating in serial \((X \rightarrow M_1 \rightarrow M_2 \rightarrow Y)\) allow to investigate the direct and indirect effects of \(X\) on \(Y\) while modeling a process in which \(X\) causes \(M_1\), which in turn causes \(M_2\), which finally causes \(Y\) [22]. Change in a mediator may be an important outcome in and of itself [19], but the indirect effect is also as much relevant as to whether \(X\)’s effect on \(Y\) can be said to be transmitted through the causal chain of events [22].

One of the most studied mediating variables is motivation. It is a motivation that underlies the attempts to change behavior and that provides the energy needed to promote change, playing a central role in the long-term results [23]. To be motivated means ‘to be moved’ to do something [24]. Based on the evidence, self-determination theory (SDT) [25, 26] demonstrates considerable efficacy in explaining exercise motivation and behavior [27]. SDT is a theoretical framework that focuses on the dialectic between the active growth-oriented human organism and, the social contexts that either support or undermine people’s attempts to master and integrate their experiences into a coherent sense of self [28]. According to SDT, we can distinguish between different types of motivation based on the different reasons or goals that give rise to an action [24]. People can be motivated because they value an activity and find them challenging and enjoyable (intrinsic motivation) or, because they want to obtain some separable outcome (extrinsic motivation). There are also people who do not act at all or act passively, these are considered a motivated [25].

Many health behaviors are extrinsically motivated [29]; specifically in the scope of physical activities, the extrinsic motivation assumes extreme importance [16]. SDT proposes that different types of extrinsic motivation can be distinguished depending on the degree to which it is experienced as autonomous versus controlled [30]. There are four different forms of extrinsic regulation that lie along a continuum of autonomy between amotivation—lack of motivation or psychological energy (non-self-determined)—and, intrinsic motivation—behavior is enjoyable and important in its own right (completely self-determined). The four distinct forms of extrinsic motivation are underpinned between amotivation and intrinsic motivation and are: external regulation (the most controlled or the least autonomous form of extrinsic motivation)—behavior is oriented to obtain rewards or avoid punishments; introjected regulation—internal pressure to avoid guilt and shame or attain ego enhancements and feelings of worth; identified regulation—belief in the personal importance or value of the behavior; and, integrated regulation (the most autonomous form of extrinsic motivation)—behavior is consistent with one’s other goals and values [28]. Examples of these six forms of self-behavioral regulation toward PA includes: ‘I do not see the point in exercising’—amotivation; ‘I feel under pressure from my friends/family to exercise’—external regulation; ‘I feel guilty when I do not exercise’—introjected regulation; ‘It is important to me to exercise regularly’—identified regulation; ‘I exercise because I want to stay in shape’—integrated regulation; ‘I find exercise a pleasurable activity’—intrinsic motivation. Consistently, an autonomy orientation has
been positively related to psychological health and effective behavioral outcomes [31].

Social factors have also a deep impact on motivation [26]. SDT addresses the social conditions that enhance versus diminish the different types of motivation [31]. Social environments that support individuals basic psychological needs, will increase autonomous motivational patterns [32], leading to greater long-term persistence [31]. Brown et al. [33] systematically reviewed the intervention effects on potential mediators of children’s PA and observed that social support for PA was the most commonly targeted social mediator. The most consistent determinants of PA in adolescents are support from significant others [34, 35]. On the other hand, perceiving another person’s motivational orientation toward an activity provides a self-generated source of influence on intrinsic motivation, affording this way an informal path for social contagion [36]. Examples of perceived social support toward PA include: ‘My mum or dad takes me to exercise or play sports’—parent support; ‘My mum or dad tells me that exercise is good for my health’—parent encouragement; ‘My friends exercise or play sports with me’—peer support; and, ‘My teachers tell me to exercise or play sports’—teacher support.

SDT emphasize the importance of motivational quality [19, 31] highlighted by the task interest or enjoyment of performing an activity for its own sake [37] and, the malleability of effects of social events on motivational processes [26]. The SDT model for health behavior predicts enhanced physical health (through increased PA) and well-being (e.g. increased QoL) [38].

To our knowledge, school-based studies have focused more attention on weight change outcomes and/or PA levels, than on understanding the mechanisms (specifically SDT-related) by which the intervention exerts effect on the outcome. In addition, this is an understudied population. The analyses and interpretation of the proposed causal sequences should provide important information concerning how one can build better interventions to promote PA and increment the QoL among adolescents.

**Objective**

The aim of this study was to explore the effects of social support and behavior regulations toward exercise on PA and QoL in a 2-year school-based intervention. We hypothesized that changes in PA and QoL (outcomes) are influenced by a causal sequence (serial mediation) in which intervention (causal agent) influences perceived social support (Mediator1), which in turn influences the endorsement of more autonomous forms of motivation toward PA (Mediator2), which positively influences PA and QoL.

**Methods**

This Project, named ‘Promoção do Exercício e Saúde no Sedentarismo e Obesidade da Adolescência’ (PESSOA program, http://programapessoa.dgidc.min-edu.pt), stands for Physical Activity and Family-based Intervention in Pediatric Obesity Prevention, is a school-based cluster randomized controlled trial. It addresses mediator variables such as personal and social factors, and physical and social environmental factors within an ecological model that are related to and influence PA and health.

The study received approval from the Scientific Committee of the Faculty of Human Kinetics of University of Lisbon, the Portuguese Minister of Education, and the principals of each of schools surveyed. Parents received written information on the study and provide their informed consent prior to participation. This project was comprised of 13 schools of Oeiras town hall (Lisbon, Portugal), and the first cohort was implemented during two academic years (2008/2009 and 2009/2010) on girls and boys enrolled in the 5th, 6th, and 7th grades. The second cohort was implemented in the next two academic years (2010/2011 and 2011/2012), on a similar population and provided the data for the present study.

The study used a group-randomized design in which schools were the unit of randomization and students were the unit of analysis. Schools were randomly allocated to one of two different groups: the
first (control) group was intervened with a standard protocol with general information regarding eating and PA behaviors; the second group (intervention), besides the standard counseling, was provided a 90-min additional weekly sessions with health and weight educational program and PA activities. Besides regular physical education classes based on the Portuguese national curriculum (usually one weekly session of 90 min and another of 45 min), students in the intervention group also received a standardized set of extra opportunities for further PA. On these educational sessions, basic knowledge about PA, eating behavior and well-being were taught, using an experiential learning methodology [39] in an autonomy supportive style, where the importance of the behavior is valued, and can be experienced in consonance with other important life values and goals and, at the same time, be interesting and enjoyable. The classroom lessons deal with healthy nutrition, active living, and healthy lifestyle choices and are provided by the regular classroom teacher, who receives an extensive manual on the lessons [40]. The central theme of the lessons is to enjoy a fit and healthy lifestyle. Specific topics start with a homework assignment to be completed with the help of parents. Assessment and awareness of the child’s behavior are the central themes of the home assignment. Each classroom lesson consists of theoretical and practical parts, during which knowledge is transferred and subsequently applied through activities like games, puzzles and tests. Each lesson finishes with goal setting by drawing up a joint agreement regarding lifestyle for the period until the next lesson. Educational material and classroom posters for writing down the agreements are part of the provided material.

Participants

At baseline, our sample comprised 1042 children and adolescents (549 boys), aged 10–16 years ($M = 10.42$, $SD = 1.09$) with a BMI of $19.31 \pm 3.51 \text{kg/m}^2$, allocated in sample groups by school attended: control ($n = 207$) and intervention ($n = 835$). The program had an attrition rate of 16%, but for the specific purpose of the study, which involves mediation analysis, we did not observed an intention to treat procedure. Therefore, only the students who have completed baseline and final assessments comprised our sample—53% of the initial sample.

Measures

Baseline data were gathered in the beginning of the 2010–2011 school year (pre-intervention) and final assessments were conducted on the end of the 2011–2012 (post-intervention). Trained physical education teachers gathered this data in classroom context but these were not considered for final physical education grades. A questionnaire was built containing scales of published and validated questionnaires to assess personal and social indicators of psychosocial health. Therefore, we used the validated Portuguese version of the Physical Activity Questionnaire—PAQ [41], to assess the PA level; the validated Portuguese version of the Kidscreen-10 [14], to measure QoL; the validated Portuguese version of the BREQ-2 [42], for the Behavioral Regulations for Exercise; and, a selection of the parental support, parental encouragement, peer support and teacher support-related items present in the questionnaire used in the Personal and Environmental Associations with Children’s Health (PEACH) study [43], to assess perceived social support.

Statistical and data analysis

All analyses were performed using IBM SPSS Statistics version 19. Descriptive analyses, including means and standard deviations, were calculated for self-reported data. Variable changes were expressed by the residuals of the final values regressed in the baseline value, for the following variables: Perceived Social Support (parental support, parental encouragement, peer support and teacher support), Behavioral Regulations for Exercise (amotivation, external regulation, introjected regulation, identified motivation and intrinsic motivation), QoL and PA level. General linear model analyses with repeated measures by sample group were conducted on
outcome variables, after controlling for age and gender. To examine intervention effects, under the tenets of SDT [44], on the variables that showed significant impact, serial multiple mediation analyses were conducted, using 5000 bootstrap samples, with age and gender as covariates [22].

Serial multiple mediation analyses
To test the serial multiple mediator models we used the procedures described by Hayes [22], implemented by the macro named PROCESS v2.10 for IBM SPSS and, generally described in the following paragraphs. In Fig. 1, we can see the generic model of the serial multiple mediation with two mediators. Independent variable (X) was a dichotomous variable (control = 0 versus treatment = 1), while changes in PA (ΔPA) and changes in QoL (ΔQoL) were the dependent variables (Y).

Because mediation is a causal process we assigned Mediator 1 (M1) as changes in social support (parental support or peer support) and Mediator 2 (M2) as changes in motivation towards PA (external regulation or intrinsic motivation). This serial multiple mediation model contains four indirect effects (Total, Ind1, Ind2 and Ind3) estimated as products of regression coefficients linking X to Y.

The total indirect effect is equal to the sum of all the specific indirect effects and they are constructed by multiplying the regression weights corresponding to each step: Ind1 = a1b1; Ind2 = a1d21b2; and Ind3 = a2b2. The indirect effect quantifies how much two cases that differ by a unit on X are estimated to differ on Y as a result of X’s influence on M, which in turn influences Y; and, it can be interpreted as significantly (does not include zero—¥) positive if the bootstrap confidence interval (BCa 95%) is entirely above zero.

Results
The analysis of the impact of the program is presented in Table I.

There was no direct impact of the intervention on QoL or PA. Changes in parental social support (F(1,545) = 7.478, P = 0.006) and peer support (F(1,546) = 4.357, P = 0.037) showed significantly improvements at the end of the intervention. When comparing differences between groups (time×group), the intervention group showed significant increases in parental social support (F(1,545) = 10.953, P = 0.001) and peer support (F(1,546) = 5.502, P = 0.019). Results also displayed a not significant but showing a promising trend, in changes in intrinsic motivation (F(1,544) = 2.974, P = 0.085), when compared with control group.

Through serial multiple mediation analysis, intervention effects of social support (parental and peer) and behavior regulations for exercise (external and intrinsic motivation) in QoL and PA were examined (Fig. 2). The result of the serial multiple mediation analysis is presented in Table II.

Indirect effects were significant in all of the eight mediation models tested, although total and direct
effects were all non-significant. Intervention affected positively QoL and PA indirectly through M1 (changes in parental support or in peer support) in all the models.

Intervention also affected positively QoL and PA indirectly through M1 in serial with M2, when the model assumed M2 as changes in intrinsic motivation (models numbers 3, 4, 7 and 8) (Fig. 3).

Our path results (Table III) also acknowledge that the intervention failed to directly influence behavioral regulations toward exercise (external regulation and intrinsic motivation—path $a_2$) but succeeded to influence intrinsic motivation through parental and peer support and, external regulation through parental support (path $d_{21}$).

Finally, models 4 ($R^2 = 0.224$ $F(5,496) = 28.579$, $P < 0.001$) and 8 ($R^2 = 0.199$ $F(5,498) = 24.696$, $P < 0.001$) had a significant effect on PA outcomes.

### Table I. General linear model analyses with repeated measures by sample group with gender and age as covariates

<table>
<thead>
<tr>
<th>Variables</th>
<th>Control</th>
<th>Intervention</th>
<th>Time</th>
<th>Time*Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M(n)$ SD</td>
<td>$M(n)$ SD</td>
<td>$F$ $P$</td>
<td>$F$ $P$</td>
</tr>
<tr>
<td>QoL (Kidscreen10)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Baseline</td>
<td>50.81(207) 7.75</td>
<td>54.71(426) 10.20</td>
<td>1.094 0.296</td>
<td>0.280 0.597</td>
</tr>
<tr>
<td>Final</td>
<td>50.71(207) 8.81</td>
<td>54.69(689) 10.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA (PAQuestScore)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>10.47(201) 4.61</td>
<td>9.69(416) 4.29</td>
<td>0.377 0.540</td>
<td>0.125 0.724</td>
</tr>
<tr>
<td>Final</td>
<td>10.01(207) 4.86</td>
<td>9.81(665) 4.44</td>
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<tr>
<td>Perceived social support (PEACH)</td>
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<tr>
<td>Parental Social Support</td>
<td></td>
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</tr>
<tr>
<td>Baseline</td>
<td>5.34(202) 1.80</td>
<td>5.97(410) 2.03</td>
<td>7.478 0.006</td>
<td>10.953 0.001</td>
</tr>
<tr>
<td>Final</td>
<td>5.10(204) 1.95</td>
<td>6.22(680) 2.12</td>
<td></td>
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<tr>
<td>Parental encouragement</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>4.90(200) 1.58</td>
<td>5.09(404) 1.72</td>
<td>0.483 0.487</td>
<td>0.463 0.497</td>
</tr>
<tr>
<td>Final</td>
<td>4.59(204) 1.69</td>
<td>4.91(675) 1.66</td>
<td></td>
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<tr>
<td>Peer Support</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>5.83(203) 1.92</td>
<td>6.46(412) 2.22</td>
<td>4.357 0.037</td>
<td>5.502 0.019</td>
</tr>
<tr>
<td>Final</td>
<td>5.69(205) 2.25</td>
<td>6.65(674) 2.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher Support</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>5.48(203) 1.61</td>
<td>6.40(419) 1.91</td>
<td>0.425 0.515</td>
<td>1.140 0.286</td>
</tr>
<tr>
<td>Final</td>
<td>5.29(206) 1.62</td>
<td>6.43(685) 2.04</td>
<td></td>
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<tr>
<td>Exercise Motivation (BREQ-2)</td>
<td></td>
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<tr>
<td>Amotivation</td>
<td></td>
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</tr>
<tr>
<td>Baseline</td>
<td>1.66(203) 3.13</td>
<td>2.30(412) 3.81</td>
<td>0.023 0.880</td>
<td>0.058 0.810</td>
</tr>
<tr>
<td>Final</td>
<td>1.71(206) 3.52</td>
<td>2.55(668) 3.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>External</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>3.07(204) 3.46</td>
<td>4.93(413) 4.23</td>
<td>0.306 0.581</td>
<td>2.606 0.107</td>
</tr>
<tr>
<td>Final</td>
<td>3.28(206) 3.65</td>
<td>4.23(673) 4.27</td>
<td></td>
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</tr>
<tr>
<td>Introjected</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>4.49(200) 3.32</td>
<td>4.44(401) 3.35</td>
<td>1.381 0.241</td>
<td>0.534 0.465</td>
</tr>
<tr>
<td>Final</td>
<td>4.86(204) 3.41</td>
<td>4.70(656) 3.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identified</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>11.85(204) 2.95</td>
<td>11.38(413) 3.85</td>
<td>0.245 0.621</td>
<td>1.653 0.199</td>
</tr>
<tr>
<td>Final</td>
<td>11.20(206) 3.29</td>
<td>11.35(667) 3.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intrinsic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline</td>
<td>13.12(204) 3.14</td>
<td>13.21(414) 3.24</td>
<td>1.304 0.254</td>
<td>2.974 0.085</td>
</tr>
<tr>
<td>Final</td>
<td>12.37(206) 3.59</td>
<td>13.06(666) 3.06</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: $M$, Mean; $n$, Sample size; SD, Standard Deviation.
The purpose of this study was to explore the effects of social support and behavior regulations toward exercise on PA and QoL, in a 2-year school-based intervention. We intended to examine the mechanism by which the PESSOA program influenced changes in adolescents QoL and PA, by exploring the serial mediation effects of the causal sequence

PESSOA → Social Support → Behavior Regulations → Outcome. Our main conclusion is that our results supported our hypothesis, corroborated by the fact that positive changes in PA and QoL were influenced by the endorsement of more autonomous forms of motivation toward PA (intrinsic versus external regulations), which in turn were influenced by increased perceived social support (parental and peer support), as a result of the PESSOA intervention.

Our data showed that perceived social support (parental and peer) exerted positive indirect effects on PA and QoL. These findings are consistent with a recent review that evaluated 103 studies and concluded that parental support was consistently...
Table II. Serial multiple mediation analyses

<table>
<thead>
<tr>
<th>Model number</th>
<th>(M1) Social support</th>
<th>(M2) Behavior regulations</th>
<th>(Y) Outcome</th>
<th>YR²=F(df)=, P</th>
<th>Total c = t(df)=, P</th>
<th>Direct c' = t(df)=, P</th>
<th>Indirect# = effect, [to]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Parental</td>
<td>External</td>
<td>QoL</td>
<td>$R^2 = 0.061$ $F(5,530) = 6.944,$ $P &lt; 0.001$</td>
<td>$0.229 \ t(536) = 1.717,$ $P = 0.087$</td>
<td>$0.136 \ t(536) = 1.019,$ $P = 0.309$</td>
<td>Tot = 0.092</td>
</tr>
<tr>
<td>2</td>
<td>PA</td>
<td>External</td>
<td>QoL</td>
<td>$R^2 = 0.142$ $F(5,499) = 16.573,$ $P &lt; 0.001$</td>
<td>$-0.017 \ t(505) = -0.127,$ $P = 0.899$</td>
<td>$0.201 \ t(505) = -1.528,$ $P = 0.127$</td>
<td>Tot = 0.183</td>
</tr>
<tr>
<td>3</td>
<td>Intrinsic</td>
<td>QoL</td>
<td>YR² = 0.075 $F(5,527) = 8.596,$ $P &lt; 0.001$</td>
<td>$0.220 \ t(533) = 1.661,$ $P = 0.097$</td>
<td>$0.122 \ t(533) = 0.923,$ $P = 0.357$</td>
<td>Tot = 0.098</td>
<td>Ind1 = 0.077, [0.028 to 0.157]; Ind2 = 0.018, [0.006 to 0.041]</td>
</tr>
<tr>
<td>4</td>
<td>PA</td>
<td>Intrinsic</td>
<td>QoL</td>
<td>$R^2 = 0.224$ $F(5,496) = 28.579,$ $P &lt; 0.001$</td>
<td>$-0.010 \ t(502) = -0.073,$ $P = 0.097$</td>
<td>$0.208 \ t(502) = -1.661,$ $P = 0.127$</td>
<td>Tot = 0.198</td>
</tr>
<tr>
<td>5</td>
<td>Peer</td>
<td>External</td>
<td>QoL</td>
<td>$R^2 = 0.055$ $F(5,532) = 6.226,$ $P &lt; 0.001$</td>
<td>$0.225 \ t(538) = 1.713,$ $P = 0.087$</td>
<td>$0.158 \ t(538) = 1.197,$ $P = 0.232$</td>
<td>Tot = 0.067</td>
</tr>
<tr>
<td>6</td>
<td>PA</td>
<td>Intrinsic</td>
<td>QoL</td>
<td>$R^2 = 0.110$ $F(5,501) = 12.401,$ $P &lt; 0.001$</td>
<td>$-0.025 \ t(507) = -0.184,$ $P = 0.854$</td>
<td>$-0.136 \ t(507) = -1.041,$ $P = 0.299$</td>
<td>Tot = 0.112</td>
</tr>
<tr>
<td>7</td>
<td>Intrinsic</td>
<td>QoL</td>
<td>YR² = 0.068 $F(5,529) = 7.698,$ $P &lt; 0.001$</td>
<td>$0.216 \ t(535) = 1.654,$ $P = 0.099$</td>
<td>$0.147 \ t(535) = 1.130,$ $P = 0.259$</td>
<td>Tot = 0.069</td>
<td>Ind1 = 0.050, [0.008 to 0.118]; Ind2 = 0.016, [0.005 to 0.037];</td>
</tr>
<tr>
<td>8</td>
<td>PA</td>
<td>Intrinsic</td>
<td>YR² = 0.199 $F(5,498) = 24.696,$ $P &lt; 0.001$</td>
<td>$-0.018 \ t(504) = -0.131,$ $P = 0.896$</td>
<td>$-0.149 \ t(504) = -1.192,$ $P = 0.234$</td>
<td>Tot = 0.131</td>
<td>Ind1 = 0.088, [0.035 to 0.168]; Ind2 = 0.031, [0.012 to 0.063]</td>
</tr>
</tbody>
</table>

Abbreviations: QoL, Quality of Life; PA, physical activity. Notes: Ind1 = $X \rightarrow M1 \rightarrow Y$; Ind2 = $X \rightarrow M1 \rightarrow M2 \rightarrow Y$; Ind3 = $X \rightarrow M2 \rightarrow Y$. ¥ The 95% CI of the Bias and Corrected and Accelerated estimate indicate a significant indirect effect because does not include zero.

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Serial mediation effects of SS and BR on QoL and PA.
positively and significantly associated with child PA [45]. On the other hand, a systematic review, targeting the efficacy of PA interventions on potential mediators of 5–12-year-old children, observed that only two, of six studies, reported PA outcomes of parental support (all with effect sizes <0.2), and only one examined peer support (with no significant effects) [33]. When considering the positive changes in QoL, our results are in line with the work of Reis et al. [46], on demonstrating that for these age groups, in a school context, perceived social support plays a very important role on behavior, with an impact on a broad number of QoL domains [47].

We acknowledge that the adolescents in the intervention group perceived their parents and their friends more ready to exercise or play sports with them, and we suggest that this was one of the mechanisms through which PESSOA program influenced the increase of PA and QoL scores.

The positive effect of the intervention on PA and QoL was also explained by the increase on peer (and in some models, parental) support in serial with the increase in intrinsic motivation. Despite the intervention did not exert direct influence on behavior regulations toward exercise (path $a_2$), indirect effects of intervention on PA and QoL were exerted...
through social support and intrinsic motivation in serial, supporting our theory-driven hypothesis. These findings are in agreement with a consistent body of research, sustained on SDT [25], indicating that interventions that promote social environments in which more autonomous forms of motivation are developed, predicts exercise participation across a range of samples and settings [48], improves mental/physical health [49] and health-related QoL [46, 50]. It is our belief that one of the reasons that explained why intervened adolescents increased their PA and QoL was because they perceived more support to exercise and play sports from their parents and friends, which in turn influenced their enjoyment when exercising or playing.

In Models 1 and 2, the intervention exerted positive indirect effects on QoL and PA only through parental support, despite the significant serial influence showed on external regulation (path $d_{21}$). These results showed that parental support might lead to an increase on external motivation to exercise, which buffered the positive effect of the intervention. We hypothesize that the instrumental nature of parent support, added to the school-based setting, applied an extra pressure that thwarted the quality of the motivation promoted by the intervention. Examples of extra parental pressure might include: ‘if you do not bring me better tests-scores I will cancel your tennis lessons’ or ‘if you do not lose weight I will be very sad.’ An extra argument to this discussion, as noted before, is the fact that intrinsic motivation was the only behavior regulation that contributed to the increase of PA and QoL (Models 3, 4, 7 and 8), bringing to this discussion the importance of the quality of motivation when promoting lifelong habits [51].

This study is subject to some limitations. First, an objectively direct measure of PA would grant a much greater ability to detect associations between PA and the others variables. Second, the questionnaire used to assess QoL, in is short version (KidScreen-10), may lack sensitivity to measure changes associated to one of the major goals of PESSOA intervention (increase PA), because of its generic nature. Finally, we think that an intervention with of nature and dimension should have included a process evaluation to better understand how the intervention worked and to evaluate the implementation of the intervention. Furthermore, future research in this area should aim to assess how other sources of support (e.g. teacher) can help to increase PA and to promote higher QoL.

Our findings demonstrated the increased parental and peer support and the nurture of more autonomous forms of motivation toward exercise represented mechanisms associated with greater levels of PA and QoL. These results add support to the claim that peer support plays an important role in the PA behavior of adolescents [52] and it is our belief that this is a fundamental path to target the promotion of more active lifestyles among adolescents.

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Conflict of interest statement

None declared.

References


