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Development and exploratory cluster-randomised opportunistic trial of a theory-based intervention to enhance physical activity among adolescents

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Abstract

This paper reports the development and exploratory test of a school-based intervention programme designed to enhance levels of physical activity in adolescents. The intervention is based on social cognitive theory (SCT), self-regulation theory (SRT) and planning as evidence-based mediators of physical activity changes. Two classes, paired on social-economic variables, were selected from each of eight Portuguese schools and randomly assigned to an intervention or control group (N=291). Primary outcome was 'moderate to vigorous physical activity' (International Physical Activity Questionnaire) measured pre and post intervention and at three and nine months follow-ups. SCT, SRT and planning variables were secondary outcomes measured pre and post intervention.

At post test, participants in the intervention group reported 18 minutes per week more physical activity (PA), adjusted for pre-intervention, age and sex , than those in the control group (95% confidence interval -10 to 46; p = .249). This difference increased to 33 minutes (95% CI – 4 to 71; p = .082) at three months and to 57 minutes (95% CI 13 to 101, p= .008) at nine month follow-up. Moreover, the intervention resulted in changes of some of the theoretical target variables, including outcome expectancies and coping planning. However, no evidence was found for the changes in theoretical moderators to mediate the intervention effects on behaviour. Implications for theory and for future research are discussed.

Keywords: physical activity, adolescents, planning, health promotion, social cognitive models, self-monitoring

A lack of physical activity (PA) is prevalent amongst adolescents (Centers for Disease Control and Prevention, 1997; Varo, et al., 2003) and contributes to a tremendous health burden of obesity, type 2 diabetes and other chronic diseases in adolescence and over the lifespan (Mokdad et al., 2004; Ogden, Flegal, Carroll & Johnston, 2002; Ruiz et al., 2006). Effective interventions to increase (PA) are needed to prevent disease in adolescence and the early development of sedentary lifestyle (Hallal et al., 2006; Marcus et al., 2000).

Previous PA interventions were weakly effective (Dishman & Buckworth, 1996; Kahn et al., 2002; Stone, McKenzie, Welk, & Booth, 1998) and maintenance of effects has been poor (Biddle, Gorely & Stensel, 2004). The majority of previous trials have been based in the United States and little evidence about behaviour change in European adolescents is available (Marcus et al., 2006). Many programs have failed to utilize evidence-based theory to identify key determinants of behaviour change as targets for interventions (Baranowski, Anderson & Carmack, 1998; Dishman, et al., 2004; Marcus et al., 2000). Interventions addressing evidence-supported mediators of behaviour change are more likely to be effective as they build upon accumulative research. Moreover, applications of theory-based interventions present an opportunity to test if an intervention successfully modifies the hypothesised determinants and if these changes mediate behaviour change effects (Baranowski, et al., 1998; Michie & Abraham, 2004). The present paper introduces the development and preliminary test of a theory-based intervention based on social cognitive theory, self-regulation theory and planning designed to enhance PA in adolescents.

Social Cognitive Theory

Social cognitive theory (SCT; Bandura, 1997) assumes that behaviour is guided by beliefs that people acquire in their ongoing interaction with the environment; in particular beliefs about the consequences of behaviour and individual capabilities. In line with other social-cognition theories, outcome expectancies, self-efficacy and goals are conceptualised as proximal causal determinants of behaviour change (Bandura, 1997; Fishbein et al., 1991).

Individuals are more likely set a goal to change their course of action and adopt a new behaviour if this new behaviour is expected to result in more favourable outcomes (action outcome expectancies) than previous behaviour (situation outcome expectancies) and if they feel capable of performing the new behaviour (self-efficacy). A particular strength of SCT is that it theorises about both, the determinants of behaviour change and the factors determining changes in social cognitions, such as mastery experience, vicarious experience, persuasion and physiological feedback (Bandura, 1997). Numerous successful applications of SCT to PA (Dishman et al., 2004; Stone et al., 1998; Winters, Petrosa & Charlton, 2003) and other health behaviours (Holden, Moncher, Schinke, 1990; Schwarzer & Luszczynska, 2006) provide evidence that SCT offers a sound background for PA interventions for adolescents.

Favourable social cognitions and action goals are necessary precursors for behaviour change, but they do not guarantee action. People may fail to implement their intentions or to cope with self-regulatory problems. Recent research has suggested that post-decisional processes of goal pursuit play an important role in translating intentions into behaviour (Abraham, Sheeran & Johnston, 1998; Gollwitzer, 1999; Schwarzer, 2001).

Self-Regulation Theory

Self-regulation theory emphasises *self-monitoring* and ongoing comparisons of current behaviour against individual standards in order to reduce discrepancies (e.g., Carver & Scheier, 1998; Kanfer & Goldstein, 1991). Prompting self-monitoring has been shown to be effective in behaviour modification (Bandura & Cervone, 1983: Lorig, et al., 1999). Moreover, exercising regular self-control improves self-regulatory capacity (Muraven, Baumeister & Tice, 1999). Goal setting and self-monitoring have been key components in many successful health promotion programmes for adolescents (Sallis et al, 1997; Stone et al, 1998; Tell & Vellar, 1987).

If-then Plans in Self-regulation

There is compelling evidence that advance planning of the when, where, and how of goal pursuit facilitates the realization of intentions (Gollwitzer & Sheeran, 2006). If-then planning involves defining the means one will utilise to reach their goals. In SCT, this might be described as a graded hierarchical process of goal setting. Defining means-end relationships may guide individual self-regulation in reducing discrepancies between current behaviour and personal standards (Sniehotta, Scholz & Schwarzer, 2005). Moreover, the prospective if-then link (or *implementation intention*) leads to a cognitive representation that enhances the accessibility of specified cues and allows for swift and effortless initiation of the respective goal-directed responses (Gollwitzer & Sheeran, 2006).

Action Planning refers to the specification of when, where and how to act in accordance with one's intention. *Coping planning* is a barrier-focused strategy to avoid unwanted responses to situational demands or social pressure. Coping plans represent a mental link between anticipated risk situations and suitable coping responses (Sniehotta, Schwarzer, Scholz & Schüz, 2005). Individuals who have planned how to cope with risky situations are more likely to maintain newly adopted behaviour in the face of difficulties (Marlatt, 1996; Simkin & Gross, 1996; Sniehotta, Scholz & Schwarzer, 2006; Ziegelmann, Lippke & Schwarzer, 2006). However, few studies have applied planning as a self-regulation aid in adolescents. Although not conclusive, there is some evidence that similar planning effects may be assumed in adolescents and adults (Araújo-Soares, McIntyre & Sniehotta, in press; Mischel & Patterson, 1978; Gollwitzer & Sheeran, 2006).

The Health Promotion Programme "It's your body – use it well!"

The programme "It's your body – use it well!" was developed to provide theory-based guidelines for school-based health promotion in Portugal. Portuguese adolescents show some of the lowest levels of PA in Europe and an overall high prevalence of health risk behaviours (McIntyre et al., 1998; Riddoch, et al., 2004; WHO, 2000). The overall programme consists

of 12 weekly sessions and addresses health behaviours including PA, diet, physical and psychosexual development, prevention of risk behaviours (sexually transmitted diseases, smoking and alcohol consumption), as well as general life skills such as assertiveness (McIntyre & Araújo-Soares, 2002). The PA programme targeted SCT variables and post-intentional self-regulatory strategies such as planning and self-monitoring. Previous research had shown that adolescents often lead sedentary lifestyles despite good intentions to be active (Araújo-Soares, McIntyre & Sniehotta, in press; McIntyre et al., 1998; Riddoch et al., 2004).

This paper reports findings from an opportunistic cluster-randomised controlled trial of the PA module. The term opportunistic refers to the fact that the sample size was determined by the availability of schools provided by the funder (Health Administration of Northern Portugal) rather than by formal power analyses. Opportunistic trials provide invaluable guidance when considering a potential full-scale trial in the future. They allow testing the feasibility and acceptability of trial procedures, highlighting potential pitfalls to avoid and providing evidence on likely effect sizes to inform power calculations. Although the study was not powered to detect small effects, it allowed estimating the possible effect size, making a contribution by a) detecting possible medium to large effects, b) cumulating evidence towards a full RCT (Campbell, et al., 2000) and c) providing data for systematic reviews. Our research questions were:

1.) What are the estimated group differences in changes of PA in children that received the intervention and those in the control group after the intervention and at three and nine months following the intervention?

2.) What are the estimated group differences in changes in the theoretical mediators (outcome expectancies, self-efficacy, goal commitment, action planning and coping planning) in children that received the intervention and those in the control group?

METHOD

Participants and Procedures

Eight schools from the Northern Portuguese districts of Minho, Trás-os-Montes, and Douro Litoral were available for this study. They fulfilled the following criteria 1) they were not involved in the European Network of Health Promoting Schools in October 2002, 2) they had a school psychologist and a physical activity teacher that could be trained to deliver the intervention and 3) had at least two classes of either 6^{th} or 7^{th} grades. Two classes from each school, ten 6^{th} grade (64.9%) and six 7^{th} grade (35.1%) classes comprising 291 adolescents participated in the study. The mean age of participants in the initial sample was 12.13 years (*SD* = 1.01) with a range from 10 to 16 years, 76.2% of the participants ranged from 10 to 12 years. About half of them were male (n=138, 47.4%), 57.4% lived in rural areas.

The study used a cluster-randomised design. In each school two classes similar in socio-demographic variables were selected and randomly assigned to intervention or control condition after initial assessment. The full intervention consisted of 12 weekly sessions (90 minutes each), consisting of an initial session with parents (90 minutes), a general introduction lesson for the children on the programme goals (90 minutes), and two 90 minute sessions based on a standardised intervention manual in consecutive weeks in a classroom setting. The remainder sessions of the programme covered other goals such as healthy eating, the prevention of sexually transmitted diseases and the prevention of smoking, alcohol and other illicit drugs. Assertiveness was another one of the topics covered.

Physical activity, SCT variables and planning measures were taken at pre-test (3 weeks in advance of the PA intervention) and post-test (two week after completion of the PA intervention). In addition, PA was measured at 3-months and 9-months follow-up.

Measures

The primary outcome measure was *physical activity* assessed with the International Physical Activity Questionnaire (IPAQ; Craig et al, 2003) for adolescents using the seven-day recall method. Children indicated how many sessions of activities they had engaged and how

long each of these activities lasted. From this questionnaire a measure of *general moderate-to-vigorous physical activity and exercise* was derived consisting of a composite score that multiplied the frequency of sessions per week with minutes per session.

Secondary outcomes were SCT and planning measures. SCT measures were developed based on a belief elicitation study and pilot studies (Araújo-Soares, et al., in press; Araújo-Soares, 2006) following the guidelines of leading theorists (Ajzen, 2006; Bandura, 2005). Participants were first introduced to the concept of moderate to vigorous PA. *Situation-outcome expectancies* were assessed by agreement with statements about negative outcomes resulting from the current levels of PA. The stem 'If I continue with my current level of PA…' was followed by 7 statements such as 'I will become overweight'. *Action-outcome expectancies* were assessed by 5 items addressing possible positive consequences of regular moderate to vigorous PA, for example: "If I engage in regular moderate to vigorous PA, I will have more energy and strength". *Self-Efficacy* was assessed by 10 items. The stem 'I am certain that I can engage in regular moderate to vigorous PA in the forthcoming months, even if...' was followed by 10 possible barriers such as a) '…I have to study for an exam'. *Behavioural Intentions* were assessed by 6 items, e.g., 'I intend to engage in regular moderate to vigorous PA at least 2-3 times a week for at least 30 to 45 minutes outside school''. Each item was scored on a five-point Likert scale from *completely disagree* to *completely agree*.

Action planning and *coping planning* were measured using the Action Planning and Coping Planning Scales (Sniehotta, Schwarzer et al., 2005) adapted to adolescence. *Action planning* was assessed by 4 items: 'I have made a detailed plan regarding [when/where/how] to engage in regular moderate to vigorous PA'. *Coping planning* was assessed by 4 items, for example 'I have made a detailed plan regarding...a) what to do when something interferes with my plans (e.g. If I have a test in that week, if my friends want to go out, etc.).

Two pilot studies confirmed the factorial, construct and predictive validity of these scales (Araújo-Soares, 2006). A scale on self-reported self-monitoring was not included in

this study, because the pilot study revealed difficulties in understanding the items of a self-monitoring assessment scale. Mean values, standard deviations and correlations for Time 1 and Time 2 and α-coefficients for all scales are displayed in Table 1.

Intervention

The intervention followed a detailed manual. The manual, materials and a detailed description of the program are available from the corresponding author. The PA intervention consisted of two classroom-based sessions of 90 minutes each and related homework. It was delivered by a trained psychologist assisted by a sports education teacher. The psychologist received manual-based training including a two-day workshop (16 hours training) by the research team. In addition, a member of the research team served as supervisor in preparation of each session. In the week proceeding both PA intervention sessions, adolescents were asked to keep a self-monitoring diary as part of their homework in which they documented their daily physical activities in detail. After the intervention they were encouraged to keep the diary for two more weeks. During the sessions, working sheets and a brief three-minute film were used as additional materials. At the end of the sessions, each student received a leaflet, which emphasized the main topics of the session. Table 2 describes the intervention using a formal taxonomy of behaviour change techniques by Abraham and Michie (in press) along with a concise description of the procedures used to target the theoretical determinants of behaviour change.

Pilot studies

Feasibility and acceptability of the intervention and the training procedures were established in a one-group design with pre, post and 9 months follow up, with 107 students from four different schools in Northern Portugal. A second pilot study tested the feasibility of the trial procedures in a randomised design with matched control condition in 116 adolescents (46% male; Mean age=13.4; SD = 1.6). In the intervention group, the proportion of

participants reporting at least 3 sessions of physical exercise a week increased from 27% at pre test to 48% at post-test in the intervention group (McIntyre & Araújo-Soares, 2002).

Data analyses

Descriptive data for all outcomes are presented as means (standard deviations in parentheses) and correlation coefficients where relevant. Data were analysed using multilevel modelling techniques; a three level random effects analyses of covariance linear regression, adjusting post-intervention PA at each time point for pre-intervention PA, age and sex. We used a nested design with children (level 1) nested within classes (level 2) nested within schools (level 3). Although we have repeated measures within child we used each post intervention time point as an outcome and correct for pre intervention levels of PA because introducing a fourth level to the analyses would complicate the analyses more than desirable given the sample size. Random effects were included for school and class to account for potential intra-cluster correlation (Rabe-Hesketh & Skrondal, 2005). Changes in cognition were also explored using this model. Effect sizes are presented with 95% confidence intervals. Missing data were assumed to be *missing completely at random* because the students discontinuing the study moved to other schools. All analyses were therefore conducted as *complete cases intention-to-treat analyses* (Wood, White & Thompson, 2004; Wood, White, Hillsdon & Carpenter, 2005). To test the robustness of the results to this assumption we also carried out a conservative *sensitivity analysis* imputing the baseline levels of PA for any missing data. Potential mediation was investigated following standard criteria (Baron, & Kenny, 1986) in a three-level multilevel regression framework as above. Stata Version 9.2 was used for all analyses.

RESULTS

Figure 1 shows the CONSORT trial flow chart. Intervention group and control group were similar with regard to age ($\text{mean(SD)}_{\text{intervention}}$= 12.19 (1.1); $\text{mean(SD)}_{\text{control}}$= 12.05

(0.9)), height (mean(SD)$_{intervention}$= 1.49 m (0.1); mean(SD)$_{control}$= 1.50 m (0.1)), weight (mean(SD)$_{intervention}$= 42.5 kg (9.5); mean(SD)$_{control}$= 44.8 kg (9.5)), gender (47% male in the intervention and 48% in the control group) and grade (65% in grade 6 in both groups). Students who dropped out were mostly 6th graders who changed to different schools as the new school year started between Time 3 and Time 4 and could not be followed up. Attrition was unrelated to the intervention and not biased with regard to social-cognitive or behavioural baseline measures.

Estimation of effects

Table 3a shows the point estimates and confidence intervals for PA in the intervention and control groups. At post-test, adolescents in the intervention group report an average of 18 minutes per week more of moderate and vigorous PA than adolescents in the control group (CL: -10- 46, ns). This difference increases to 33 minutes per week at 3-month follow-up and approaches significance (CL: -4- 71; p=.08). At the 9-month follow-up, the difference has increased to a highly significant difference of 57 minutes per week between both groups (CL: 13-101, p<.01).

The random effects regression analyses show that baseline PA (T2: B=.33; SE=.04; p<.001; T3: B=.41; SE=.06; p<.001; T4: B=.27; SE=.05; p<.001) and sex (T2: B=52.5; SE=14.6; p<.001) both account for significant amounts of variance in PA, while age does not contribute to the equation. The intervention only reaches significance at Time 4 (T2: B=18.1; SE=14.2; p=.20; T3: B=33.4; SE=19.2; p=.08; T4: B=57.2; SE=22.5; p=.01). These models account for 24.9% of the variance at Time 2; 29.8% at Time 3 and 36.9% at Time 4.

The sensitivity analysis in Table 3b confirms the findings of the complete case intention to treat analysis. While imputing pre-intervention baseline data for missing values naturally decreases the point estimates of effects, the sensitivity analysis confirms the significant group differences at Time 4 and the trend approaching significance at Time 3. The

intervention seems to facilitate PA with a cumulative effect over nine months following the intervention resulting in a difference of nearly one hour a week at the end of the trial.

Process evaluation

Intervention-effects on theoretical target variables are shown in Table 4. Participants in the intervention group showed significantly higher increases in situation outcome expectancies and coping planning than controls, i.e., they became more aware that their current levels of physical activity might not be sufficient to achieve positive outcomes and developed clearer plans about how to deal with barriers for regular PA. Trends for self-efficacy and action planning favour the intervention group but remain insignificant. Small and insignificant trends favouring the control group were found for action outcome expectancies and intentions. The intervention overall seems to enhance behaviour-related cognitions for physical activity. However, there is no evidence that the effect of the intervention on behaviour is mediated by effects on cognitions as there is no significant group effect on behaviour at Time 2 (Baron, & Kenny, 1986). Explorative analyses of a possible time-lagged mediation of Time 4 effects on behaviour through more immediate Time 2 effects of cognitions found no evidence for mediation.

DISCUSSION

We introduced a classroom-based intervention to increase levels of moderate and vigorous physical activity in adolescents. The intervention was based on social cognitive theory and self-regulation theory and incorporates action planning and coping planning. This is the first report to use a formal taxonomy of behaviour change techniques (Abraham & Michie, in press) to describe a new intervention, which is also available as full intervention manual (McIntyre & Araújo-Soares, 2002). The intervention was found to be acceptable and feasible for delivery by a school psychologist and a physical education teacher.

Two classes matched on socio-economic variables from each of 8 schools were randomly assigned to receive the programme or to a usual-education control condition. The sample size was determined by opportunity and availability rather than by formal power analysis. Findings need to be interpreted with this in mind, as type two errors, (failure to detect existing group differences) are more likely. Random effects multilevel modelling showed that the estimated differences in changes of physical activity between both groups increased over time from 18 minutes a week post intervention, to 33 minutes a week three months later and 57 minutes per week nine months following intervention. The key purpose of the analysis was to gain a point estimation of the possible effect. However, the difference at the 9-months follow-up is highly significant and the difference at the 3-months follow-up approaches statistical significance. Moreover, the point estimates compare to results of much more intensive school-based interventions (e.g., Haerens et al., 2006). Conservative sensitivity analyses confirmed the general pattern of findings while naturally resulting in slightly lower effect size estimates.

The clinical significance of one hour more of moderate to vigorous physical activity per week might be modest (Rizzo et al., 2006). However, there is a growing body of evidence showing linear relationships between physical activity and health (Hallal et al, 2006). An inexpensive classroom-based intervention can potentially reach a large number of adolescents and produce tremendous health promotion effects if a moderate increase in PA can be delivered to a large number of individuals. The intervention studied is of minimal intensity (two 90 minute sessions on physical activity) and thus potentially a highly economic means of health promotion in schools.

Differences in PA between intervention group and control group increased over time. Most behavioural interventions show immediate effects that over time lack sustainability (Marcus et al., 2006; Biddle et al., 2004). The presented data indicate a trend over time suggesting that the effects might become stronger with time. This may be due to group

effects, as the intervention might have changed group norms, creating a culture of mastery and collective self-efficacy (Bandura, 1997). Moreover, there is evidence that collaborative planning interventions might be more effective than individual planning interventions (Prestwich et al., 2005). This could have resulted in a social environment reinforcing of physical activity. Self-regulatory variables such as self-monitoring and coping planning have also been shown to be important in the maintenance of behaviour change (Sniehotta, Scholz & Schwarzer, 2005) and might have enabled participants in the intervention group to develop the skills to keep up regular physical activity. Moreover, seasonal effects might have contributed. Baseline measures were taken in October/November (autumn), post-tests in November/December (winter), 3-months follow-up in March (spring and period for school exams) and the 9-months follow-up took place in September (end of summer vacations).

The underlying rational of a theory-based intervention is that behaviour change is achieved by modifying theory-based determinants of behaviour (Michie & Abraham, 2004). Although a formal mediation analysis was beyond the scope of this paper due to sample size and power considerations, pre-post changes in theoretical target variables were analysed to test if the intervention reached its immediate targets (Table 4). Multilevel analyses indicated that adolescents in the intervention classes perceived more negative outcomes associated with their current levels of physical activity (situation-outcome expectancies) and reported higher levels of coping planning. Trends favouring the intervention group were not significant for self-efficacy and approached significance for action planning. While these findings suggest that the interventions successfully changed the theory-based targets, a non-significant trend for goal intentions in favour of the controls needs further investigation. All theoretical measures at Time 2 were significantly correlated with physical activity, further supporting the rational of targeting these variables in the intervention (Table 1). These findings are also in line with recent evidence that theory-based measures of cognitions mediate the effects of theory-based interventions. In a recent study by Dishman et al. (2004) self-efficacy partly

mediated the effects of a comprehensive school-based physical-activity programme in girls with a similar age to the students in this study. However, in this study, no evidence for mediation was found. More research is needed to understand the process of behaviour change in complex interventions (Kraemer, Wilson, & Fairburn, 2002).

While the SCT and SRT components of the programme "it's your body – use it well" were grounded on compelling evidence in adolescents (Stone et al. 1998), the use of planning interventions in adolescence is a novel component in the programme. The only health psychology study on implementation intentions in an adolescent sample was conducted on smoking cessation (Higgins & Conner, 2004). This study failed to find beneficial effects of planning because few subjects turned out to be smokers. Coping planning interventions had not been applied to health behaviour in adolescents before (cf. Mischel & Patterson, 1978) but there is some evidence that joint action planning and coping planning is predictive of changes in PA amongst adolescents (Araújo-Soares et al., in press). The planning interventions were embedded in a broader strategy of preparing students for risk situations and giving them necessary background information to act on their intentions in the face of impediments. The present study shows that the intervention facilitated coping planning and slightly changed levels of action planning. Both measures show significant correlations with physical activity and the question of mediation requires further research on planning and in children and adolescents.

Limitations and future research

This study provided estimates and confidence intervals of the intervention effects on PA and theoretical mediators. A full, randomised controlled trial is needed to provide conclusive evidence for its effectiveness in changing behaviour and its cost-effectiveness as well as for the process evaluation. This full trial will be informed by the findings of this study.

There is some evidence that interventions including policy and environmental changes together with school-based programmes are more effective than school-based programmes

alone (Timperio, Salmon & Ball, 2004). This intervention mainly focused on individual and social determinants of physical activity and involved the families to support the intervention. The distinction between individual and environmental determinants of behaviour is somewhat misleading. SCT is an evidence-based theory about the interaction of individual and environmental factors and argues that the environment affects behaviour by constraining and changing beliefs (Bandura, 1997). Environmental interventions such as providing facilities for physical activity are likely to affect individual behaviour mediated through cognitions about control and costs. As environments will change over the lifespan, the focus on individual and social determinants has an important rational. Individual and environmental interventions are not contradictory approaches; they augment each other.

Comparing matched control classes with intervention classes in the same schools might have biased the findings due to interaction between adolescents for both classes. Although there is no evidence that casual interaction with individuals undergoing a behaviour change intervention leads to sustainable behaviour change, future studies should randomise classes between schools. If there was a bias in the present study, it would have been in favour of the null hypothesis (no group differences).

Future research should incorporate objective measures of behaviour (e.g., accelerometry), as self-report measures for physical activity are potentially susceptible to bias due to limitations in recall accuracy (Sallis & Saelens, 2000). The use of the ‘last seven days‘ reference-period was chosen to circumvent biases in recall. Children from 10 years and above were shown to be able to report physical activity accurately over this time period (Kohl, Fulton & Caspersen, 2000). The IPAQ is amongst the best-studied self-report measures and validation studies indicate good reliability and acceptable validity with regard to accelerometer measures (Craig et al., 2003). Observational measures and the use of monitoring devices can have strong demand characteristics which might affect self-

monitoring. Since self-monitoring was one of the key components of our intervention, the use of retrospective self-report measures ensured the internal validity of the intervention trial.

In conclusion, this study found significant effects of a theory based classroom-delivered physical activity programme on self-reported physical activity 9 months following the intervention. It provided some insight into possible mechanisms involved in behaviour change. Further health promotion programmes should be systematically developed based on theory and established behaviour change techniques to modify evidenced mediators of physical activity. The present study emphasised the inclusion of volitional factors such as planning and self-monitoring in an adolescent sample.

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Table 1: Intercorrelations, mean values, standard deviations (SD) and Cronbach's α, of social-cognitive measures, planning measures and physical exercise at Time 1 and Time 2

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Situation-outcome expectancies														
1. Time 1		.42**	-.23**	-.25**	.15*	.06	-.22**	-.17**	-.07	-.07	.05	-.02	-.12*	-.21**
2. Time 2			-.17**	-.15**	.18**	.19**	-.07	-.14*	-.07	.00	.05	.04	-.13*	-.16**
Action-outcome expectancies														
3. Time 1				.45**	.24**	.19**	.62**	.30**	.36**	.16**	.21**	.18**	.21**	.17**
4. Time 2					.14*	.26**	.49**	.51**	.24**	.35**	.17**	.34**	.13*	.22**
Self-efficacy														
5. Time 1						.41**	.28**	.21**	.28**	.13*	.27**	.17**	.07	.04
6. Time 2							.31**	.38**	.11	.16**	.11	.24**	.12*	.14*
Behavioural Intentions														
7. Time 1								.49**	.43**	.31**	.29**	.34**	.23**	.28**
8. Time 2									.29**	.37**	.18**	.34**	.20**	.26**
Action Planning														
9. Time 1										.43**	.60**	.39**	.17**	.18**
10. Time 2											.35**	.78**	.01	.16**
Coping Planning														
11. Time 1												.39**	.11	.10
12. Time 2													.06	.20**
Physical Activity (sessions *minutes)														
13. Time 1														.53**
14. Time 2														
Mean	.74	.85	3.14	3.13	1.77	1.89	2.89	2.84	2.39	2.38	2.13	2.32	94.4	93.9
SD	.84	.98	.75	.78	.89	1.03	.85	.87	1.14	1.16	1.10	1.12	101.7	103.8
α	.88	.90	.79	.85	.84	.90	.86	.90	.90	.93	.75	.85	-	-

Table 2. Behaviour change techniques, target variables and procedures of the intervention.

Behaviour Change Technique[1]	Target variables	***Procedures, materials and providers***
Provision of general information	GKN, OE, INT	*Initial parent session* – General introduction to PA & exercise and aims of the project *Session 1*. General introduction to PA definitions and concepts. Information about the PA-health link. *Session 2*. Instruction to governmental recommendations for PA. PSY, PET
Provide Information on consequences	OE, INT	*Initial parent session* – Parents were prompted to reinforce the positive effects of regular PA and to encourage the child to be physically active *Session 1.* Information about physical, psychological and social benefits of PA. Group discussion about pros and cons of PA and exercise vs. sedentary activities. *Session 2.* Provision of leaflet summarising advantages of PA and addressing beliefs about possible disadvantages and barriers. PSY, PET
Provide Information about others' approval	OE, INT	*Session 1*. A 3-minute film with examples of adolescent role models involved in PA is shown. Group discussions and facilitators reinforce social approval of PA. PSY, PET
Prompt Intention formation	INT	*Session 2*. Encouragement to form an intention, make a general and realistic behavioural resolution PSY, PET
Prompt specific goal setting	SE, AP, CP	*Session 2.* Formulation of specific action plans when, where and how to be physically active and coping plans how to deal with barriers (planning sheets). PSY, PET

Set graded tasks	SE, INT, AP, CP	*Session 2.* The importance of grades tasks for goal setting and planning is emphasised. [PSY, PET]
Prompt barrier identification	OE, CP	*Session 2*. Individual barrier identification based on diary intakes prepared between both sessions. Group discussions of possible barriers and means to cope with them. Provision of leaflet summarising barriers and strategies to overcome them. Coping planning (planning sheets). [PET]
Agree behavioural contract	OE, INT	*Session 2*. Each one of the group members sign their own contract and reads it out aloud to the entire group (Behavioural Contract Sheet). [PSY, PET]
Provide instruction	GKN, SE	*Session 2*. Instructions how to undertake aerobic exercise. [PET]
Demonstrate behaviour	GKN, SE	*Session 1*. Demonstration of exercises and instructional 3-minute video. [PSY, PET]
Prompt practice	OE, SE	*Session 1*. Behavioural experiment (Bandura, 1997): Assessment of outcome-expectancies followed by short session of aerobic exercise on treadmill, followed by repeated assessment of expectancies. [PSY, PET]
Prompt self-monitoring of behaviour	SE	*Pre session 1, post session 1 and post session 2.* Record of daily PA in self- monitoring diary after detailed instructions and provision of cues to memorise the entries. [PSY]
Provide feedback on performance	SE	*Post session 2*. Based on the returned diaries pairs of adolescents were prompted to compare entries with goals and they received written feedback on their achievement and advice by the facilitators. [PSY]
Provide general encouragement	SE	Throughout the programme, general encouragement was given and parents and peers were prompted to encourage the adolescents. [PSY]
Provide contingent	SE, INT	Praise and encouragement was given contingent to performance in the behavioural experiment as well as to

rewards		leisure time PA recorded in the diaries. [PSY]
Teach to use prompts/cues	AP	*Session 1 & 2*. Environmental cues were established to remind participants to self-monitor and to act on their intentions their behaviour. A peer would be defined to remind the subject and vice versa. [PSY, PEER]
Use follow up prompts	OE, SE	*Post session 2*. Involved one follow-up meeting where during the first 10 minutes the adolescents were asked about their goal attainment and also received general encouragement. [PSY, PEER]
Provide opportunities for social comparison	OE, SE, AP, CP	*Session 1 & 2.* The intervention was conducted in a group setting and involved peer interactions. [PSY, PEER]
Plan social support/social change	AP, CP	Parental and peer support was prompted (see above). [PSY, PEER]
Prompt identification as role model	OE, SE, AP, CP	Session 2 – Encouragement to act as role model for peers and family. [PSY]
Relapse prevention	SE, CP	Session 2 – Based on the identification of barriers (see above) strategies were suggested by the facilitators and adolescents in group discussion. Individual coping planning (planning sheets). [PSY]

Note. Abbreviations: GKN: general knowledge about PA; OE: outcome expectancies; SE: self-efficacy; INT: behavioural intentions; AP: action planning; CP: coping planning; PSY: delivered by psychologist; PET: delivered by physical education teacher. Behaviour change techniques in accordance to Abraham and Michie, in press.

Table 3. Point estimates of moderate and vigorous physical activity in minutes per week in intervention group and control group (adjusted for age and sex and baseline activity)

a) Complete cases intention to treat analysis

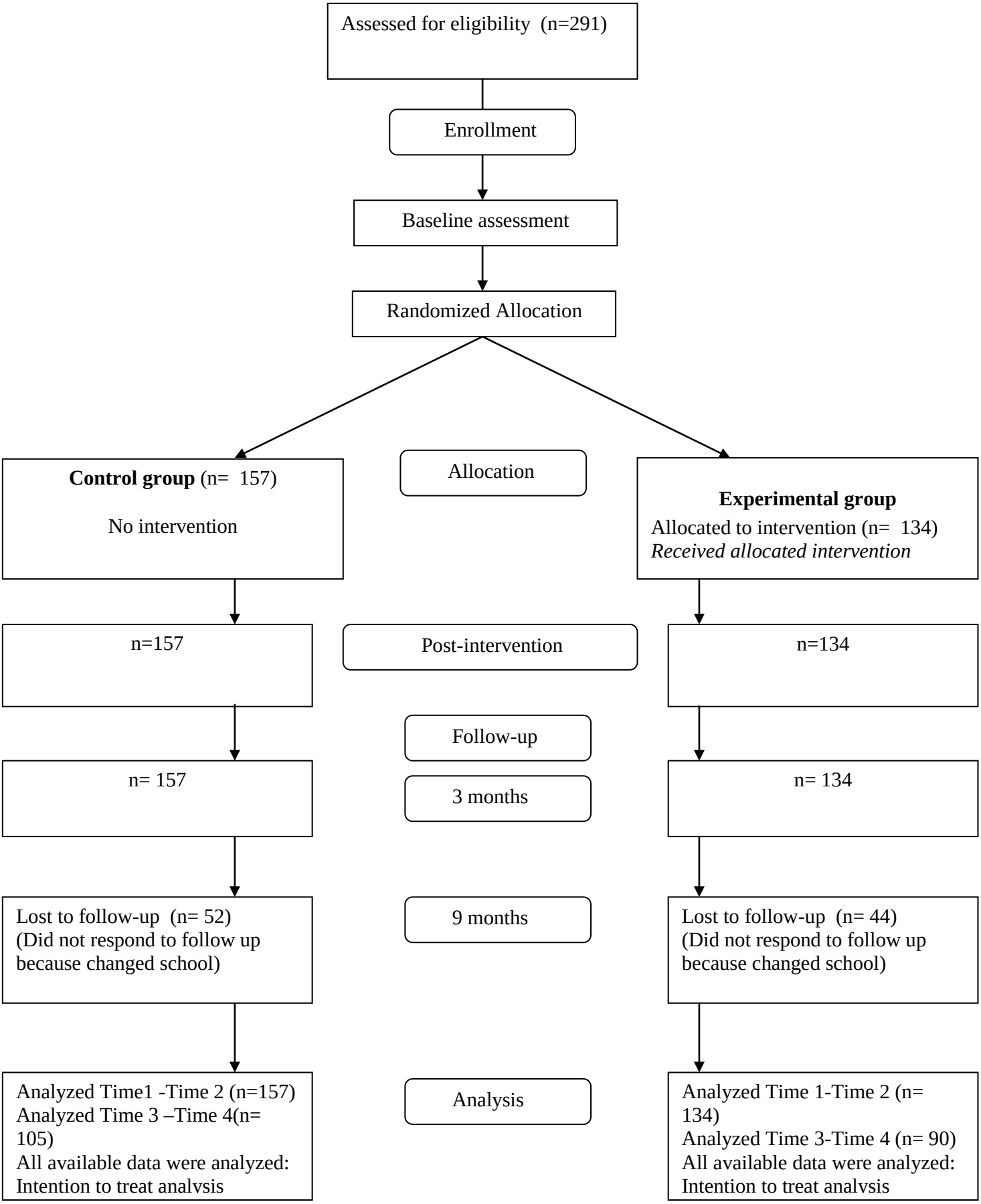
	Moderate to vigorous physical activity in minutes/week mean (SD)				Effect			
	intervention		control		difference	95% CI		p-value
Baseline	122	(173)	115	(175)				
Time 2	119	(134)	100	(143)	18	-10	46	0.202
Time 3	141	(171)	104	(170)	33	-4	71	0.082
Time 4	165	(148)	106	(114)	57	13	101	0.011

b) Baseline imputed analyses

	Moderate to vigorous physical activity in minutes per week mean (SD)				Effect			
	intervention		control		difference	95% CI		p-value
Baseline	122	(173)	115	(175)				
Time 2	119	(134)	100	(143)	18	-10	46	0.202
Time 3	119	(176)	111	(170)	26	-5	57	0.098
Time 4	158	(170)	113	(126)	45	9	82	0.016

Table 4. Point estimates of outcome expectancies, self-efficacy, goal intentions, action planning and coping planning at baseline and post test in intervention group and control group (adjusted of age and sex and baseline cognitions)

	Scale mean (SD)				Effect			
	intervention		control		difference	95% CI		p-value
Situation outcome expectancies (negative)								
Time 1	0.82	(0.87)	0.68	(0.80)				
Time 2	1.03	(1.10)	0.69	(0.83)	0.235	0.024	0.447	0.029
Action outcome expectancies (positive)								
Time 1	3.10	(0.72)	3.17	(0.77)				
Time 2	3.07	(0.77)	3.18	(0.78)	-0.061	-0.217	0.095	0.443
Self-effiacy								
Time 1	1.69	(0.79)	1.84	(0.96)				
Time 2	1.97	(1.01)	1.83	(1.04)	0.172	-0.096	0.440	0.208
Goal intentions								
Time 1	2.87	(0.85)	2.90	(0.85)				
Time 2	2.76	(0.81)	2.90	(0.92)	-0.189	-0.402	0.022	0.079
Action Planning								
Time 1	2.45	(1.11)	2.34	(1.16)				
Time 2	2.52	(0.94)	2.26	(1.30)	0.216	-0.094	0.526	0.172
Coping planning								
Time 1	2.15	(1.08)	2.11	(1.12)				
Time 2	2.53	(0.94)	2.15	(1.23)	0.320	0.077	0.562	0.010


Assessed for eligibility (n=291)
Enrollment
Baseline assessment
Randomized Allocation
Allocation
Control group (n= 157)
No intervention
Experimental group
Allocated to intervention (n= 134)
Received allocated intervention
n=157
Post-intervention
n=134
Follow-up
3 months
n= 157
n= 134
9 months
Lost to follow-up (n= 52)
(Did not respond to follow up because changed school)
Lost to follow-up (n= 44)
(Did not respond to follow up because changed school)
Analysis
Analyzed Time1 -Time 2 (n=157)
Analyzed Time 3 –Time 4(n= 105)
All available data were analyzed: Intention to treat analysis
Analyzed Time 1-Time 2 (n= 134)
Analyzed Time 3-Time 4 (n= 90)
All available data were analyzed: Intention to treat analysis