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Original Article

Effects of an Educational Intervention based on the Theory of Planned Behavior on Physical Activity Behavior of Male Teenagers: An Accelerometer-Based Study

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Abstract

Introduction: This initiative is motivated by the previously highlighted concerns regarding inactivity and the essential importance of physical activity (PA) in the lives of young individuals.
Objective: The aim of this study was to evaluate the effects of a training intervention based on the theory of planned behavior (TPB) on PA levels in adolescent males.
Methods: This study is characterized as a semi-experimental study involving a control group. A total of 44 male high-school students, aged between 16 and 18 years, were recruited for participation in this research and then were randomly allocated into the intervention and control groups. PA was assessed utilizing a modern accelerometer. The duration of four-week intervention, three times a week, was structured for the intervention group. Data analysis was conducted using both paired and independent t-tests.
Results: The mean daily duration of moderate to vigorous PA (MVPA) was recorded at 20.34 minutes for the intervention group and 20.72 minutes for the control group. Furthermore, significant differences were observed between the groups in relation to all patterns of PA($P<0.05$).
Conclusion: Addressing the adverse effects of inactivity, the intervention enhanced the adolescents' sense of personal control over their PA choices, which in turn motivated them to engage in more PA. The results indicate that the TPB is instrumental in influencing both the intentions to engage in actual PA behaviors.

Keywords: Exercise, Sedentary Behavior, Adolescent, Theory of Planned Behavior, Motivation

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1. Introduction

Physical activity (PA) encompasses all forms of bodily movement that arise from the contraction and relaxation of skeletal muscles, requiring energy expenditure (1,2). Consistent participation in PA is a vital factor influencing health and has been identified as one of the 15 essential behavioral modifications needed for enhancing health outcomes (3-5). The Healthy Human report, up to the year 2010, prioritized the enhancement of PA as a foremost health objective (2,6). It constitutes a vital element of a healthy lifestyle, recommended for the enhancement of public health and for its potential to alleviate the burden of disease and healthcare costs within communities. Consistent PA, recognized as a significant health-promoting behavior, contributes to increased muscle tone, improved balance, enhanced body proportions, and better cognitive function (3,5,7,8). Additionally, it reduces the likelihood of developing chronic illnesses such as diabetes, cardiovascular diseases, and osteoporosis. It also acts as a preventive strategy against adolescent inclinations toward addiction, delinquency, and unhealthy activities, consequently alleviating stress and promoting self-esteem among young individuals (1,2,9,10).

Conversely, a sedentary lifestyle combined with poor nutrition is linked to a rise in chronic diseases, particularly diabetes and osteoporosis (11,12). Regular PA is particularly beneficial for women's health, as it can prevent various conditions and diseases that are leading causes of disability and mortality among women globally (13,14). Furthermore, it contributes positively to women's mental health by mitigating anxiety and depression, lowering stress levels, and enhancing self-esteem (11,14-16). The World Health Organization (WHO) has recognized physical inactivity as one of the leading factors contributing to mortality and disability, estimating that it accounts for more than 2.3% of deaths each year due to inadequate levels of PA (17). Globally, it is reported that 60% to 80% of individuals who engage in 30 to 70 minutes of daily walking do not experience a 20% to 25% reduction in PA levels (17-19). These findings underscore the necessity for adults to maintain an active lifestyle to promote their health effectively. Each year, approximately 2.3

million individuals succumb to the consequences of insufficient PA (18). This deficiency is associated with more than one million early fatalities and is acknowledged as a major factor in numerous health issues. Research suggests that insufficient PA is responsible for approximately 30% of all diseases, 21% of cardiac ischemia cases, 31% of breast and colon cancer occurrences, and 27% of diabetes cases (3,7,16,18). Overall, one in three adults globally fails to engage in sufficient PA (17). The prevalence of inactivity tends to increase with age, being more pronounced among overweight females compared to their male counterparts (6,19). Evidence suggests a decline in regular PA during late adolescence and early adulthood, marking this trend as a pressing public health concern in numerous countries (9,10). Adolescence represents a critical transitional phase from childhood to adulthood, during which many health-related habits, including regular exercise, ideally take root and persist (17). Regrettably, the level of PA consistently diminishes throughout this developmental stage. In the last two decades, a significant decline in PA has been observed across various age groups, with studies revealing that over 90% of adolescents globally fail to achieve the suggested levels of PA (17-19). Hence, due to the numerous health benefits of engaging in regular PA, it is necessary to find out the strategies to increase the health-related PA among youth.

Behavior can be defined as an observable action that may occur either consciously or unconsciously (20). Given the intricate nature of behavior, an increase in awareness typically results in a corresponding shift in attitude; however, a change in attitude does not necessarily guarantee a modification in behavior (21,22). This discrepancy can arise from environmental constraints that inhibit the expression of certain behaviors. In this regard, theoretical frameworks are essential for scrutinizing assumptions and hypotheses in alignment with the strategies and objectives of interventions (23,24). Consequently, it has become nearly imperative for specialists in health promotion and education to incorporate theoretical perspectives into their practice. The success of physical education initiatives is contingent upon their effectiveness, which in turn relies on the appropriate application of theories and models in health education programs (25). A notable illustration of this theoretical framework is the theory of planned behavior (TPB).

The TPB serves as a crucial framework for comprehending and forecasting changes in behavior, especially regarding women's participation in PA (20,22,26). This theoretical framework suggests that the foremost determinant of a person's behavior is their intention to perform that behavior. This intention is shaped by the individual's motivation and readiness to take action (25-27). Behavioral intention is fundamentally influenced by three primary elements: the individual's attitude towards the behavior, which includes their positive or negative assessments of the potential outcomes; subjective norms, which indicate the perceived expectations of important others; and perceived behavioral control, which relates to the individual's confidence in their capacity to perform the behavior (23-25,27,28). Recognizing the predictors of behavioral intention is crucial for fostering both the intention and actual participation in PA. Understanding these determinants is vital for identifying essential elements that can inform the development of effective educational interventions.

Numerous studies have demonstrated a significant and robust correlation between the components of the TPB and PA behaviors (29-33). TPB accounts for 24-36% of the variance in behavioral intentions. Research in the field of sports has further validated the theory's predictive capacity regarding sports-related behaviors (32-36). To comprehend the psychological factors influencing sports behavior, it is crucial to identify individual beliefs that are closely associated with TPB's elements. Findings from various surveys indicate that beliefs concerning PA, as well as social and physical environments, are key factors that can lead to a decrease in sports participation (29,30,32,34,36). Moreover, social-ecological models emphasize the critical role of environmental factors in health-related behaviors (33-35). Since health and PA behaviors arise from the interplay between individuals and their environments, the physical environment can either facilitate opportunities or pose barriers to maintaining an active lifestyle (29,33).

Given the significance of participating in regular PA, it is essential to identify effective strategies to promote health-related PA among young individuals. The present research was designed and implemented with the goal of evaluating the effects of a training intervention based on the TPB, which seeks to improve PA levels in adolescent males. This initiative is rooted in the previously highlighted concerns regarding inactivity and the vital importance of PA in the lives of young people. In this investigation, modern accelerometers were utilized to analyze the PA patterns of adolescents, with the intention of improving the accuracy of measuring their PA levels.

2. Methods

2.1. Design and Participants

This investigation is characterized as a semi-experimental study featuring a control group, focusing on male adolescents. A total of 44 high school students, aged between 16 and 18 years, were recruited for participation in this research and then were randomly allocated into the intervention and control groups. The sample size was determined using G*Power software and taking into account the confidence level of 0.95 and the test power of 0.80. Inclusion criteria for the study encompassed the presence of a physical issue or a medical restriction that would impede participation in PA, as well as the participants' willingness to engage in the research. Additionally, participants who expressed a reluctance to continue their involvement or who had medical restrictions against PA were excluded from the study.

2.2. Accelerometer Device

PA was assessed utilizing the ActiGraph wGT3X-BT accelerometer, which was set to operate at a frequency of 30 Hz. This device employs a 3-axis accelerometer to capture and document high-resolution data regarding human activity. This device provides objective measurements of 24-hour PA and sedentary behavior (SB), encompassing aspects such as frequency, intensity, duration of PA, SB, and energy expenditure. In recent years, the accelerometer has emerged as the most commonly employed device in research,

demonstrating robust validity and reliability across numerous studies (37-39).

2.3. Intervention

Following the establishment of necessary arrangements with pertinent officials and a verbal explanation of the program's objectives and implementation strategies, the researcher proceeded to the schools. There, he introduced himself to the students and articulated the study's aims, ensuring that he obtained their consent for participation. The completion of the accelerometer protocol adhered to ethical standards and maintained the confidentiality of the information provided. Upon gathering data from two distinct groups (i.e., pretest), the educational intervention, grounded in the TPB, commenced with the intervention group (four-week, three times a week, with each session lasting 45 minutes). The content and training sessions were meticulously designed to target the components of the TPB, which are fundamental to behavior modification in this study (31). The control group, in contrast, did not receive any specialized training. The primary objective of the program was to foster changes in behaviors associated with PA. To motivate students, posters and slogans promoting PA were displayed on the sports board, school notice board, and within the classrooms of the intervention group. The inaugural educational session was conducted as a lecture, utilizing PowerPoint and slides. The post-test was conducted at end of the intervention.

2.4. Data Analysis

Subsequent to the data collection process, a statistical analysis was performed using SPSS version 26 software. To meet the research objectives, descriptive statistical tests were employed to summarize quantitative variables through mean and standard deviation, as well as to characterize qualitative variables using frequency counts and percentage distributions. Additionally, inferential statistics, including independent t-test, chi-square test, and analysis of covariance were applied, with a significance threshold set at >0.05.

3. Results

3.1. Demographic Data

The demographic information is displayed in Table 1. It is evident that there were no significant differences in BMI among the groups (P>0.05). Moreover, less than 35% of parents had completed high school. Importantly, there were no illiterate fathers or mothers in either group. Furthermore, most of fathers (around 60%) were involved in free occupations, while most of mothers (around 65%) were homemakers. The findings revealed that there were no significant differences across any of the demographic variables examined (P>0.05).

Table 1. Demographic Data.

	Age	Weight	Height	BMI
Intervention	17.03±0.23	67.12±2.57	176.96±5.45	21.4±0.52
Control	17.01±0.21	66.49±2.86	175.84±4.55	21.5±0.48
Comparison	t=0.032 P=0.973	t=0.214 P=0.783	t=0.093 P=0.893	t=0.074 P=0.846

3.2. Baseline Physical Activity Pattern

Table 2 presents the mean and SD of PA patterns, along with the comparative results between the groups. Results indicated that there was no significant difference in SB between groups (P=0.547). Furthermore, the findings demonstrated that there were no significant differences in light PA, moderate PA, and vigorous PA between groups (P>0.05). On average, the daily duration of moderate to vigorous PA (MVPA) was 20.34 minutes for the intervention group and 20.72 minutes for the control group, both of which fall short of the WHO's recommendation of at least 60 minutes of MVPA per day. Additionally, the results indicated no significant differences in daily MVPA between groups (P>0.05). Lastly, there were no significant differences observed in energy expenditure between groups (P>0.05).

Table 2. Physical Activity Pattern.

Variables	Intervention (n=22)		Control (n=22)		Comparison
% Sedentary Behavior	66.58	2.96	66.05	2.87	t=0.529 P=0.547
% Light PA	23.54	0.76	23.22	0.70	t=-0.634 P=0.395
% Moderate PA	6.63	0.21	6.67	0.30	t=-0.582 P=0.309
% Vigorous PA	3.25	0.09	3.06	0.09	t=0.741 P=0.493
% MVPA	9.88	0.08	9.73	0.06	t=0.631 P=0.339
Total MVPA	142.41	21.55	145.09	20.23	t=0.749 P=0.285
MVPA (minutes per day)	20.34	2.85	20.72	2.74	t=-0.869 P=0.149
Energy Expenditure (Kcal per day)	2258.53	203.84	2250.41	207.95	t=0.635 P=0.329

*P<0.05; **P<0.01; ***P<0.001

3.3. Comparison of the Intervention and Control Groups

The analysis conducted at the conclusion of the four-week period revealed significant differences among the groups concerning all assessed parameters, which encompassed SB, light PA, moderate PA, vigorous PA, MVPA, and energy expenditure (P<0.05), as illustrated in Table 3. This indicates that the

intervention grounded in the TPB was an effective strategy for increasing participation in PA and decreasing SB.

Table 3. Comparison of the Intervention and Control Groups.

Variables	Mean Difference Intervention	Mean Difference Control	F Value	P-Value
% Sedentary Behavior	-6.85	0.12	12.526	<0.001
% Light PA	3.59	0.01	7.459	<0.001
% Moderate PA	2.22	0.03	8.719	<0.001
% Vigorous PA	1.04	0.01	6.352	<0.001
% MVPA	3.26	0.04	7.415	<0.001
Total MVPA	10.27	1.24	6.928	<0.001
MVPA (minutes per day)	1.46	0.17	5.784	<0.001
Energy Expenditure (Kcals per day)	105.47	5.96	7.963	<0.001

4. Discussion

The purpose of this study was to investigate the effects of a training intervention based on the TPB, which seeks to improve PA levels among adolescent males. This initiative is rooted in previously identified concerns regarding inactivity and underscores the essential role of PA in the lives of young individuals. In this research, modern accelerometers were utilized to analyze the PA patterns of adolescents, with the goal of enhancing the accuracy of measuring their activity levels. Initial findings indicated that the male students involved in this study did not achieve the recommended 60 minutes of MVPA per day. These results are consistent with earlier studies and point to a concerningly low level of PA among boys (1,3,4,7,9,12,13). Therefore, it can be inferred that a lack of mobility is a common challenge faced by this demographic. Factors contributing to this issue may encompass educational limitations, restricted access to sports facilities and equipment, the financial burdens associated with specific sports, and existing cultural norms (17-19). Therefore, PA behaviors of male students warrant particular attention within the framework of health-related interventions and programs.

Moreover, the analysis conducted at the conclusion of the four-week period revealed significant differences among the groups concerning all assessed parameters. This indicates that the intervention grounded in the TPB was an effective strategy for increasing participation in PA and decreasing SB among boy students. Numerous studies indicate that engagement in PA is positively correlated with enhancements in individual attitudes, social influences, and self-efficacy (2,5,7,10). Also, other studies demonstrated that educational training provided to employees in the orthopedic ward and physiotherapists significantly influenced their health perceptions, leading to increased PA levels and lifestyle improvements (24,25,27,28). These findings align with the results observed in the current study. The organization of meetings and the distribution of educational materials for educators and the families of students appear to have a notably positive impact on the promotion of abstract norms concerning PA (29,31). By providing education and information on PA to individuals who are significant to the person, the likelihood of these individuals endorsing the relevant behaviors is enhanced (34-36). It appears that implementing educational programs grounded in the TPB to enhance students' perceived behavioral control regarding PA may be effective in increasing their financial investment in such activities (30,32,33). Furthermore, engaging in discussions and providing education on the physical and psychological effects of participating in PA, as well as addressing the facilitators, barriers, and inhibitors associated with this behavior, can yield significant benefits (31,34,35). Offering solutions to overcome these challenges and fostering motivation in this area is also likely to be advantageous (29,32,36).

The TPB is a cognitive-social framework that emphasizes the influence of an individual's beliefs on their anticipated behaviors (22,23,25,28). According to this theory, the likelihood of future behaviors is determined by the individual's desires (22). Intentions are viewed as motivational constructs that indicate the degree to which individuals plan to engage in a specific behavior. Consequently, students who possess a more favorable attitude towards PA are more inclined to express an intention to engage in such activities compared to those with less favorable attitudes (24,26,27). Furthermore, students who feel confident in their ability to participate in PA, along with having the opportunity to do so, are more likely to demonstrate a stronger intention to engage in PA. Consequently, while all three constructs of the TPB influence intentions in various contexts, it is possible that certain constructs exhibit greater predictive power than others (23-25). Therefore, even if individuals perceive that their significant others desire them to engage in a specific behavior, they are not compelled to adhere to these expectations (22,24,25). These observations suggest that, although favorable attitudes, self-efficacy, and available opportunities are significant motivators of students' PA, social influence may not play a predominant role in their decision-making processes (23,26,27).

The primary strength of this research lies in the employment of an accelerometer for the assessment of PA. This method is characterized by its high level of accuracy, thereby mitigating the biases commonly associated with self-reported measures of PA. Conversely, a significant limitation of this study is the exclusive focus on male participants, which poses challenges in extrapolating the findings to female populations.

4.1. Conclusion

A significant finding from the study was that the intervention based on the TPB led to a reduction in SB and an increase in PA. Notably, addressing the adverse effects of inactivity, the intervention enhanced the adolescents' sense of personal control over their PA choices, which in turn motivated them to engage in more PA. The findings suggest that the TPB plays a crucial role in shaping actual PA behaviors. Consequently, these elements should be prioritized in educational planning.

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Footnotes

Authors' Contribution: This study was carried out solely by the corresponding author.

Conflict of Interests: The researcher confirms that there is no conflict of interests in this study with any participant.

Data Availability: The data that support the findings of this study are openly available upon request from the corresponding author.

Ethical Approval: The author confirms that all steps and requirements of this study comply with ethical guidelines. Participants were informed about the characteristics of the study and gave written informed consent.

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