

Autonomy-supportive Physical Education and Physical Activity Among Chinese Vocational College Students: A Cluster Randomized Controlled Trial Based on an Integrated Self-determination Theory and Theory of Planned Behavior Model

Ni Liu*, Mohd Firdaus Bin Abdulah

Faculty of Education and Liberal Studies, City University, Petaling Jaya 46100, Malaysia

*Corresponding email: 2660143547@qq.com

Abstract

Physical inactivity is a major public health issue for young adults, and vocational college students are especially at risk due to occupation-focused curricula and limited chances for regular physical activity. This study evaluated an autonomy-supportive physical education (PE) intervention to promote physical activity among Chinese vocational college students, testing a sequential pathway involving basic psychological need satisfaction and theory of planned behavior (TPB) variables. A 12-week cluster randomized controlled trial recruited 240 first-year students across eight classes, randomized into an autonomy-supportive intervention group ($n=120$) or a conventional skill-focused control group ($n=120$). Both groups attended two weekly 45-minute PE lessons. Measurements took place at baseline (T0), post-intervention (T1), and 3-month follow-up (T2), covering need satisfaction, physical activity attitude, subjective norm, perceived behavioral control, intention, and weekly moderate-to-vigorous physical activity (MVPA). Repeated-measures analyses tested longitudinal group differences, while structural equation modeling and bootstrap analysis examined the integrated self-determination theory (SDT)-TPB mediation model. In total, 229 students finished T1 assessments and 218 completed T2. Significant group $\times$ time interactions emerged for all outcomes (all $p<0.001$): need satisfaction ($F=112.45$, $\eta^2p=0.341$), attitude ($F=89.63$, $\eta^2p=0.292$), subjective norm ($F=67.28$, $\eta^2p=0.238$), perceived behavioral control ($F=78.59$, $\eta^2p=0.267$), intention ($F=95.17$, $\eta^2p=0.305$), and weekly MVPA ($F=72.34$, $\eta^2p=0.250$). At T1, the intervention group's MVPA rose from 128.42 ± 45.73 to 215.68 ± 52.41 min/week, versus a modest rise (131.56 ± 47.21 to 142.39 ± 49.65 min/week) in controls. At T2, intervention-group MVPA stayed elevated (203.17 ± 50.86 min/week) relative to controls (138.74 ± 48.92 min/week). The model confirmed that autonomy-supportive teaching predicted higher need satisfaction, which sequentially predicted positive TPB beliefs, stronger intention, and greater MVPA. Bootstrap results validated this significant indirect mediating pathway. Autonomy-supportive PE is therefore a viable strategy to boost physical activity in this student population; psychological need satisfaction and TPB cognitions explain key intervention mechanisms.

Keywords

Physical education, Physical activity, Self-determination theory, Theory of planned behavior, Vocational education

Introduction

Global and national context of physical inactivity

Physical inactivity has become an important global public health concern and is associated with an increased risk of non-communicable diseases, including cardiovascular disease, type 2 diabetes, and certain cancers. Insufficient physical activity is also recognized as an important modifiable risk factor for premature morbidity and mortality. Young people are a key group

for physical activity promotion. Behavioral patterns formed in adolescence and early adulthood can shape people's physical activity habits. These habits further affect long-term health outcomes.

Educational institutions provide an important setting for promoting physical activity because students spend a substantial proportion of their time within structured educational environments [1]. However, participation in

physical education classes does not necessarily translate into regular physical activity outside the classroom. Students may complete required physical education activities while remaining insufficiently active during the rest of the week. Therefore, identifying instructional approaches that can promote both participation during physical education and continued engagement in physical activity beyond formal classes is an important research and practical priority.

Vocational college students warrant particular attention in this context. Their educational experience commonly combines occupation-oriented academic learning with practical and technical skills training. Such demands may limit opportunities for regular physical activity and may make the physical education environment particularly important for developing sustainable exercise-related habits. Nevertheless, most studies about physical activity promotion target general university students, adolescents, or young athletes. Vocational college students, by contrast, have attracted relatively little research attention. This population is also important from a health-promotion perspective because vocational college students are preparing to enter the workforce, and the physical activity habits developed during this period may extend into their subsequent occupational lives. Consequently, physical education in vocational education should not be viewed solely as a context for developing sport-specific skills or meeting fitness requirements. It may also serve as an opportunity to cultivate students' motivation, confidence, and intention to engage in regular physical activity.

Accordingly, research is needed to identify instructional strategies that can create more supportive physical education environments and facilitate the transition from compulsory participation in physical education classes to self-directed physical activity behavior. An autonomy-supportive instructional approach may provide one theoretically grounded means of addressing this challenge.

Limitations of traditional physical education in vocational education

Physical education in educational settings has traditionally placed considerable emphasis on teacher-led instruction, standardized skill practice, physical performance, and normative assessment. Such practices can be effective for organizing classroom activities and

developing basic motor skills. However, some instructional environments prioritize compliance and performance. They pay insufficient attention to students' psychological experiences. Such environments can only offer limited support for the development of autonomous motivation.

SDT proposes that the quality of the social environment is an important determinant of motivation and behavioral engagement. In particular, environments that support students' needs for autonomy, competence, and relatedness are more likely to facilitate autonomous forms of motivation and sustained engagement. In physical education settings, autonomy-supportive teaching covers several key practices [2]. It means acknowledging students' perspectives, providing meaningful rationales, giving proper chances for students to make choices, refraining from controlling language, and delivering informative feedback instead of controlling feedback.

From this perspective, an autonomy-supportive physical education environment can shape students' physical activity engagement. Its effect does not merely lie in boosting in-class activity volume. Instead, it fosters more positive psychological and motivational experiences for students, and these experiences can persist outside the classroom. Providing students with meaningful choices may strengthen their sense of autonomy. Constructive feedback may enhance perceived competence, and cooperative activities may promote relatedness. Together, these experiences may create conditions that are more conducive to continued engagement in physical activity. Despite increasing attention to autonomy-supportive teaching in physical education and sport contexts, its application among Chinese vocational college students remains insufficiently examined. Previous research has often focused on general university students, adolescents, or organized sport participants, and relatively fewer intervention studies have investigated whether autonomy-supportive physical education can produce sustained changes in physical activity among vocational college students.

Moreover, demonstrating that autonomy-supportive teaching is associated with greater physical activity is only part of the theoretical question. It is also important to understand how an instructional environment may influence subsequent physical activity behavior. SDT

offers a robust framework for understanding motivational processes [3]. Even so, other theoretical constructs can help clarify the cognitive pathways. These pathways describe how motivational experiences turn into behavioral intentions and real physical activity. The TPB provides a complementary framework for addressing this issue.

Theoretical framework and research gaps

SDT and the TPB are two influential theoretical frameworks for explaining health-related behavior, including physical activity. These theories originate from different theoretical traditions. Even so, it is possible to integrate their constructs. Such integration yields a fuller explanation of how social environments, motivation, behavioral cognition, and physical activity behavior connect with one another.

The SDT emphasizes the role of social-contextual factors in the satisfaction of three basic psychological needs: autonomy, competence, and relatedness. When individuals perceive their social environment as autonomy-supportive, they are more likely to experience satisfaction of these needs and develop more autonomous forms of motivation. In the context of physical education, autonomy-supportive teaching may therefore provide an upstream social-contextual condition that facilitates favorable motivational experiences.

The TPB, in contrast, focuses on the cognitive determinants of behavioral intention and behavior. According to this framework, attitude toward the behavior, subjective norm, and perceived behavioral control jointly contribute to behavioral intention, while intention represents a proximal determinant of behavior. The TPB has been widely applied to the study of physical activity. It provides a structured explanation of how individuals' evaluations, perceived social expectations, and perceived control may influence their intention to engage in physical activity.

Although the TPB provides a detailed account of behavioral cognition, it gives less explicit attention to the motivational and social-contextual processes through which these cognitions may develop. Conversely, SDT offers a detailed explanation of motivational processes but provides less specification of the cognitive pathway linking motivation to behavioral intention and subsequent action. Integrating the two frameworks may therefore help connect the motivational processes

emphasized by SDT with the proximal cognitive processes emphasized by the TPB.

Building on these complementary perspectives, the present study proposes an integrated pathway in which autonomy-supportive teaching represents an upstream social-contextual factor, basic psychological need satisfaction represents a motivational mechanism. TPB constructs represent subsequent behavioral cognitions, and behavioral intention represents a proximal determinant of physical activity behavior [4]. More specifically, the proposed framework suggests that an autonomy-supportive physical education environment may facilitate students' satisfaction of their needs for autonomy, competence, and relatedness.

Greater need satisfaction may subsequently be associated with more favorable attitudes toward physical activity, stronger perceived social support or subjective norms, and greater perceived behavioral control. These cognitive evaluations may contribute to stronger behavioral intention, which may in turn be associated with greater engagement in moderate-to-vigorous physical activity.

The proposed integration is theoretically meaningful, but the temporal and causal ordering of these constructs requires empirical examination. Existing studies have provided preliminary support for associations between autonomy-supportive environments, psychological need satisfaction, TPB constructs, and physical activity. However, much of this evidence has been derived from cross-sectional or observational designs. Such designs are limited in their ability to establish whether changes in the teaching environment precede changes in psychological need satisfaction, behavioral cognition, intention, and subsequent physical activity [5].

Three research gaps are particularly relevant. First, vocational college students remain relatively underrepresented in intervention research on autonomy-supportive physical education and physical activity behavior. Their distinctive educational and training environment warrants direct empirical investigation rather than assuming that findings from general university students or youth athletes can be directly generalized to this population.

Second, although the SDT and the TPB have each been widely used in physical activity research, empirical studies examining their integrated application remain

comparatively limited, particularly in the Chinese vocational education context. The Chinese educational environment forms a meaningful research context. Within this setting, interpersonal relationships, peer influences, teacher expectations, and social norms can shape students' behavioral decision-making [6]. However, the specific contribution of these factors within an integrated SDT-TPB framework requires further empirical examination.

Third, relatively few studies have used a randomized intervention design to examine whether autonomy-supportive physical education produces changes in both psychological and behavioral outcomes and whether the proposed theoretical pathway can help explain these changes. A cluster randomized controlled trial is particularly appropriate for physical education research because instructional interventions are commonly implemented at the class level rather than independently for individual students.

To address these gaps, the present study conducted a 12-week cluster randomized controlled trial among Chinese vocational college students. Classes were randomly assigned to either an autonomy-supportive physical education intervention or a traditional skill-focused physical education condition. Outcomes were assessed at baseline, immediately following the intervention, and at a 3-month follow-up [7].

The study examined whether the autonomy-supportive intervention was associated with changes in basic psychological need satisfaction, TPB-related cognitions, behavioral intention, and moderate-to-vigorous physical activity. In addition, structural equation modeling and bootstrap analysis were adopted for model testing. The analysis aimed to check whether the hypothesized pathway fitted the collected data. This pathway runs from autonomy support, via psychological need satisfaction and TPB-related cognitions, to behavioral intention and physical activity (in Figure 1).

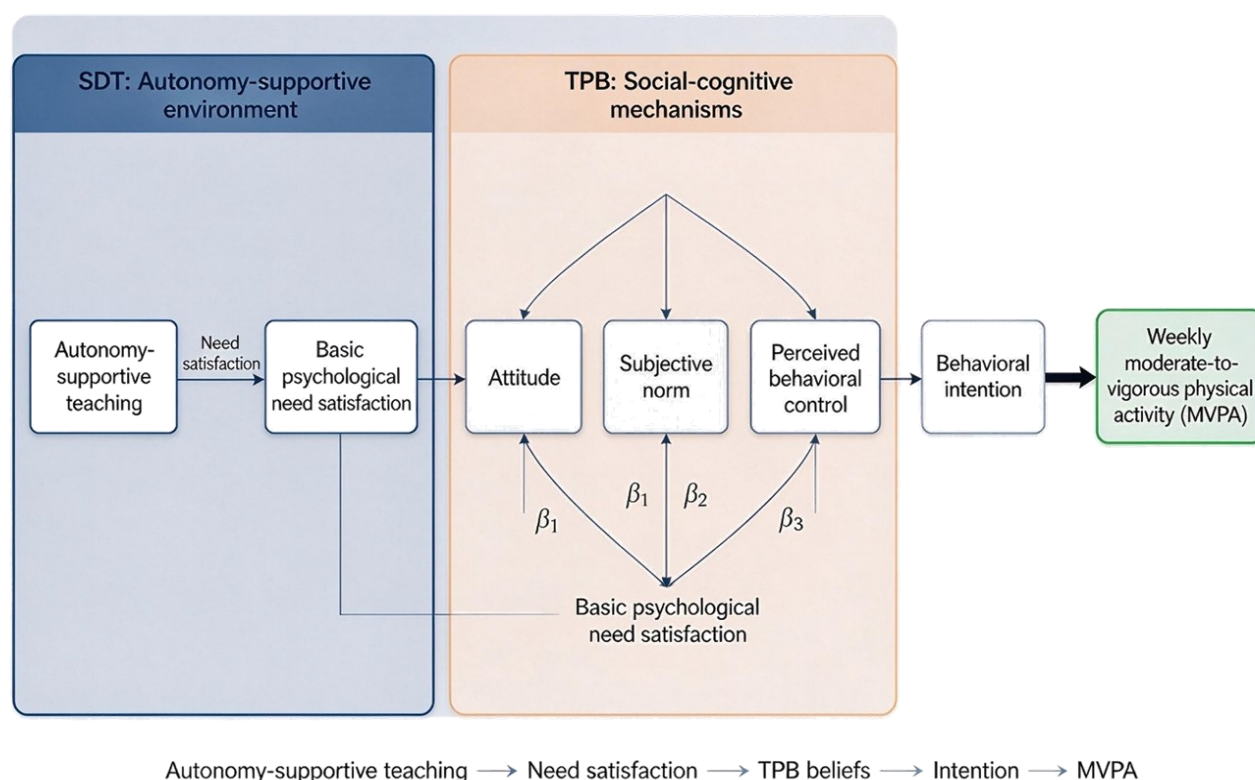


Figure 1. Conceptual integrated research framework combining SDT and TPB.

Research methodology

Study design and participants

This study employed a 12-week cluster randomized controlled trial among first-year vocational college students in eastern China. Eight intact classes were

recruited for this study to avoid contamination between participants within the same classroom context.

They were randomly allocated to two groups: an autonomy-supportive physical education intervention group and a traditional skill-focused physical education

control group. Each group contained four classes, ensuring balanced class-level clustering for subsequent statistical analysis.

A total of 240 students participated at baseline, including 120 students in the intervention group and 120 in the control group. Eligible participants were between 16 and 20 years old. They had no physical disabilities or medical conditions that would limit their participation in regular physical education sessions arranged by the college. Students who maintained regular structured exercise habits prior to college enrollment were excluded from the study, as pre-existing stable activity patterns might confound the intervention's observed effects on moderate-to-vigorous physical activity.

Participants were informed about the study procedures before enrollment and provided written informed consent. Assessments were conducted at T0, T1, and T2. Of the 240 participants, 229 completed the T1 assessment and 218 completed the T2 assessment.

Intervention protocol

Both groups participated in two 45-minute physical education sessions per week for 12 consecutive weeks to guarantee equal exposure to PE time across study arms. The same instructor taught both conditions to minimize differences attributable to teaching personnel, such as inconsistent teaching enthusiasm or coaching style.

The control group received traditional skill-focused instruction based on the standard physical education curriculum. Teaching in this condition mainly relied on instructor demonstrations, standardized skill drills, teacher-led activities, and performance-oriented assessment, with limited room for students to make independent decisions during class. The intervention group followed an autonomy-supportive physical education curriculum. This program was developed based on SDT, namely self-determination theory. The instructor offered students meaningful choices within the set curriculum. The teacher also explained the rationale and practical value of learning tasks, acknowledged students' viewpoints, and reduced the use of controlling language to satisfy students' basic psychological needs in physical education.

Informational feedback focused on individual progress and personal competence instead of comparisons with peers. Cooperative activities were also incorporated to

facilitate positive interpersonal interaction and relatedness.

The content and duration of physical education classes were comparable between the two conditions. The principal difference between groups was the instructional approach used to deliver the curriculum.

Measures

Measurements were collected at T0, T1, and T2. Basic psychological need satisfaction was assessed across the three dimensions of autonomy, competence, and relatedness. Higher scores indicated greater satisfaction of students' basic psychological needs in the physical education context.

Attitude toward physical activity, subjective norm, perceived behavioral control, and behavioral intention were assessed using physical activity-related measures based on the TPB [8]. Higher scores represented more favorable attitudes, stronger perceived social expectations, greater perceived behavioral control, and stronger intentions to engage in physical activity, respectively.

Physical activity was assessed using the International Physical Activity Questionnaire-short Form. Weekly moderate-to-vigorous physical activity (MVPA) was calculated in minutes per week and used as the primary behavioral outcome.

Data analysis

Statistical analyses were conducted using the Statistical Package for the Social Sciences (SPSS) 26.0 and Analysis of Moment Structures (AMOS) 24.0. Descriptive statistics were calculated for all variables, and baseline characteristics were examined between the intervention and control groups.

Because participants were nested within classes and randomization occurred at the class level, longitudinal intervention effects were examined using linear mixed-effects models [9]. Group, measurement time, and the group $\times$ time interaction was specified as fixed effects, while class was included as a random effect to account for within-class dependence. Baseline outcome values were included as covariates. The primary parameter of interest was the group $\times$ time interaction, which represented the differential change in outcomes between the two intervention conditions.

Estimated marginal means and 95.00% confidence intervals were used to describe changes over time.

Statistical significance was evaluated using a two-sided α level of 0.05.

Structural equation modeling was subsequently used to examine the proposed integrated SDT and TPB framework [10]. The model included autonomy-supportive teaching, basic psychological need satisfaction, attitude, subjective norm, perceived behavioral control, behavioral intention, and weekly MVPA.

Model adequacy was evaluated using χ^2/df , comparative fit index (CFI), Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR).

Indirect effects were examined using 5,000 bootstrap resamples. An indirect effect was considered statistically significant when the corresponding 95.00% bias-

corrected confidence interval did not include zero. The structural model was interpreted as evidence of statistical associations among the proposed constructs rather than definitive proof of causal mediation.

Results

Participant flow and baseline characteristics

A total of 240 first-year vocational college students from eight classes were enrolled at baseline, with 120 students assigned to the autonomy-supportive intervention group and 120 to the traditional skill-focused control group for this study. Of these participants, 229 completed the post-intervention assessment and 218 completed the 3-month follow-up survey. The overall retention rates were 95.42% at T1 and 90.83% at T2. Detailed descriptive statistics are shown in Table 2.

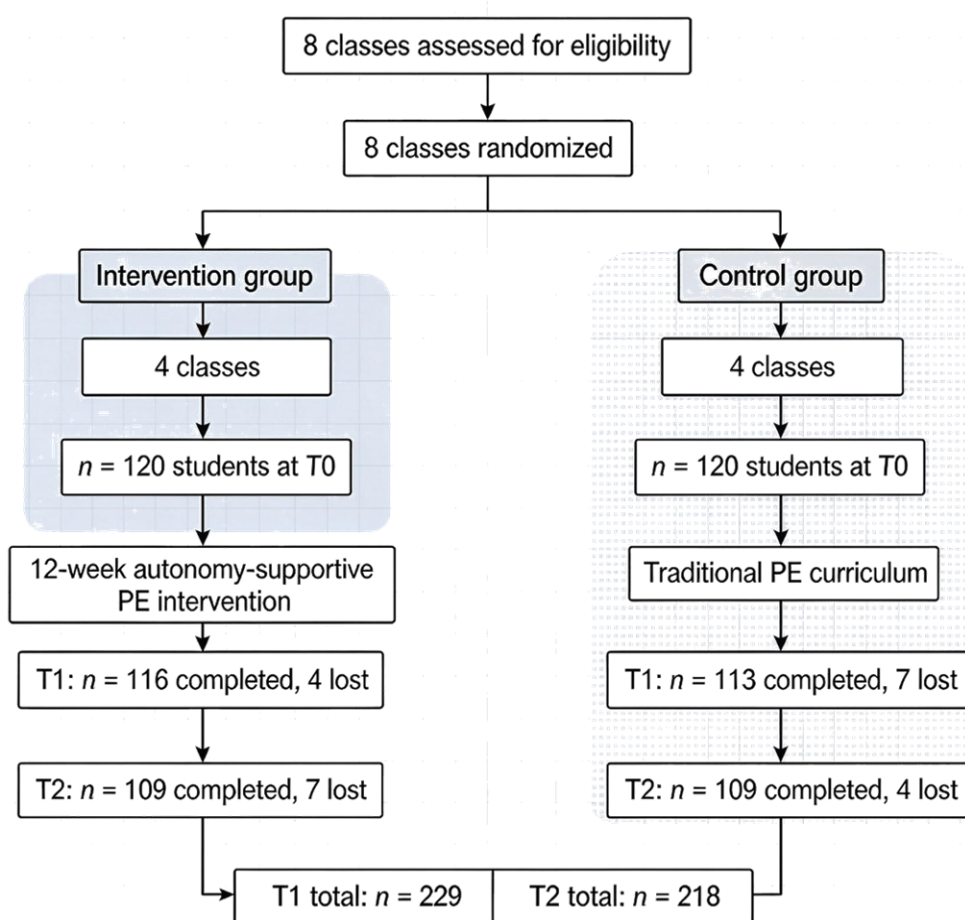


Figure 2. CONSORT flow diagram of the cluster-randomized controlled trial.

The intervention and control groups were comparable at baseline. No statistically significant differences were observed between groups in age, sex, academic major, basic psychological need satisfaction, attitude, subjective norm, perceived behavioral control, behavioral intention,

or weekly moderate-to-vigorous physical activity (in Table 1).

The mean age was 18.24 ± 0.71 years in the intervention group and 18.31 ± 0.68 years in the control group. Baseline weekly MVPA was 128.42 ± 45.73 min/week in

the intervention group and 131.56 ± 47.21 min/week in the control group.

Table 1. Baseline characteristics of participants by study group.

Variable	Intervention group (n=120)	Control group (n=120)
Age (years), mean $\pm$ SD	18.24 $\pm$ 0.71	18.31 $\pm$ 0.68
Sex (male/female), n	/	/
Academic major, n (%)	/	/
Basic psychological need satisfaction, mean $\pm$ SD	52.36 $\pm$ 8.15	51.89 $\pm$ 7.92
Attitude toward physical activity, mean $\pm$ SD	32.15 $\pm$ 5.47	31.82 $\pm$ 5.61
Subjective norm, mean $\pm$ SD	28.64 $\pm$ 6.03	29.01 $\pm$ 5.87
Perceived behavioral control, mean $\pm$ SD	30.27 $\pm$ 5.82	30.51 $\pm$ 5.64
Behavioral intention, mean $\pm$ SD	31.84 $\pm$ 5.96	32.17 $\pm$ 5.81
Weekly MVPA (min/week), mean $\pm$ SD	128.42 $\pm$ 45.73	131.56 $\pm$ 47.21

Intervention effects

Linear mixed-effects models were used to examine changes in study outcomes over time, with measurement time, intervention condition, and their interaction

included as fixed effects and class included as a random effect (in Table 2). Baseline outcome values were included as covariates to adjust for initial differences across participants.

Table 2. Mixed-effects model results for primary outcomes: group-by-time interaction.

Outcome	β	SE	95.00% CI	p	η^2p
Basic psychological need satisfaction	12.84	1.96	[8.99, 16.69]	<0.001	0.341
Attitude toward physical activity	9.61	1.47	[6.73, 12.49]	<0.001	0.292
Subjective norm	7.08	1.34	[4.46, 9.70]	<0.001	0.238
Perceived behavioral control	8.36	1.42	[5.58, 11.14]	<0.001	0.267
Behavioral intention	9.72	1.51	[6.76, 12.68]	<0.001	0.305
Weekly MVPA	74.65	11.84	[51.45, 97.85]	<0.001	0.250

Significant group $\times$ time interactions were observed for all six primary outcomes (in Figure 3). The interaction effect was significant for basic psychological need satisfaction ($\beta=12.84$, $SE=1.96$, 95.00% CI [8.99, 16.69], $p<0.001$), attitude toward physical activity ($\beta=9.61$, $SE=1.47$, 95.00% CI [6.73, 12.49], $p<0.001$), subjective norm ($\beta=7.08$, $SE=1.34$, 95.00% CI [4.46, 9.70], $p<0.001$), perceived behavioral control ($\beta=8.36$, $SE=1.42$, 95.00% CI [5.58, 11.14], $p<0.001$), behavioral intention ($\beta=9.72$, $SE=1.51$, 95.00% CI [6.76, 12.68], $p<0.001$), and weekly MVPA ($\beta=74.65$, $SE=11.84$, 95.00% CI [51.45, 97.85], $p<0.001$).

The intervention group showed greater improvements across the study period than the control group. Basic psychological need satisfaction increased from 52.36 ± 8.15 at T0 to 68.72 ± 7.64 at T1 and remained relatively high at 66.19 ± 8.03 at T2. In comparison, the control group increased from 51.89 ± 7.92 at T0 to 54.17 ± 7.85 at T1 and 53.62 ± 8.11 at T2.

Attitude toward physical activity increased from 32.15 ± 5.47 at T0 to 43.58 ± 4.92 at T1 and 41.76 ± 5.13 at T2 in the intervention group, whereas the control group changed from 31.82 ± 5.61 at T0 to 33.94 ± 5.37 at T1 and 33.25 ± 5.58 at T2.

Subjective norm increased from 28.64 ± 6.03 at T0 to 38.21 ± 5.46 at T1 and 36.87 ± 5.72 at T2 in the intervention group. The corresponding values in the control group were 29.01 ± 5.87 , 31.15 ± 5.69 , and 30.73 ± 5.94 .

Perceived behavioral control increased from 30.27 ± 5.82 at T0 to 40.16 ± 5.21 at T1 and 38.74 ± 5.48 at T2 in the intervention group, compared with 30.51 ± 5.64 , 32.67 ± 5.53 , and 32.18 ± 5.71 in the control group.

Behavioral intention increased from 31.84 ± 5.96 at T0 to 42.73 ± 5.32 at T1 and 40.91 ± 5.57 at T2 in the intervention group. In the control group, behavioral intention increased from 32.17 ± 5.81 at T0 to 34.58 ± 5.62 at T1 and 34.01 ± 5.74 at T2.

Weekly MVPA increased substantially in the intervention group, from 128.42 ± 45.73 min/week at T0 to 215.68 ± 52.41 min/week at T1. Although MVPA declined slightly at follow-up, it remained at 203.17 ± 50.86 min/week at T2. In the control group, MVPA increased from 131.56 ± 47.21 min/week at T0 to 142.39 ± 49.65 min/week at T1 and decreased slightly to 138.74 ± 48.92 min/week at T2.

The estimated marginal means indicated that the intervention-related differences were largest T1 and

remained evident at T2. These findings suggest that the autonomy-supportive PE intervention was associated

with improvements in both psychological determinants and physical activity behavior.

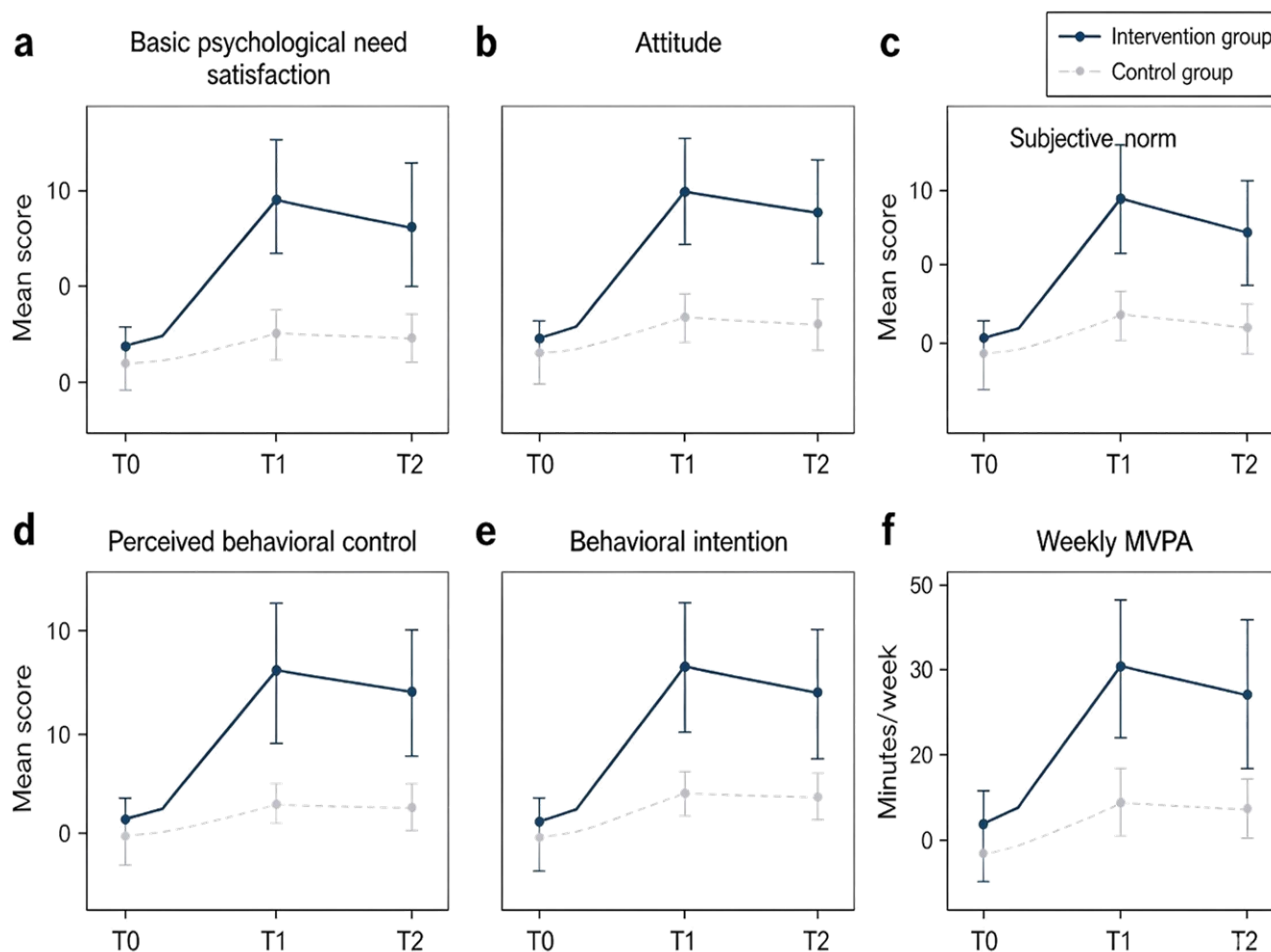


Figure 3. Changes in primary outcome variables across three time-points (T0; T1; T2) for autonomy-supportive intervention group and traditional control group.

Structural model testing

Structural equation modeling was conducted to examine the proposed integrated SDT-TPB framework. The hypothesized model demonstrated an acceptable overall fit to the observed data, with $\chi^2/df=2.31$, CFI=0.952, TLI=0.941, RMSEA=0.074, and SRMR=0.048.

Autonomy-supportive teaching was positively associated with basic psychological need satisfaction ($\beta=0.68$, $p<0.001$). Basic psychological need satisfaction was positively associated with attitude ($\beta=0.54$, $p<0.001$), subjective norm ($\beta=0.42$, $p<0.001$), and perceived behavioral control ($\beta=0.57$, $p<0.001$).

Among the TPB constructs, attitude ($\beta=0.31$, $p<0.001$), subjective norm ($\beta=0.18$, $p=0.012$), and perceived behavioral control ($\beta=0.39$, $p<0.001$) were positively associated with behavioral intention. Behavioral intention was positively associated with weekly MVPA

($\beta=0.36$, $p<0.001$).

The direct association between autonomy-supportive teaching and weekly MVPA was substantially reduced after the proposed mediating variables were included in the model ($\beta=0.08$, $p=0.214$), whereas the sequential indirect pathway remained statistically significant in this integrated SDT-TPB model.

The results presented in former correspond to the parallel direct effect model, while Figure 4 illustrates a chained sequential mediation model. These represent two distinct analytical models rather than a single one. Figure 4 is not a visual presentation of the model reported in this section. Instead, it reports SEM results obtained after respecifying paths to test the theoretically hypothesized sequential mediation, which accounts for the divergence in path coefficients between the two outputs. Detailed results are shown in Figure 4 below.

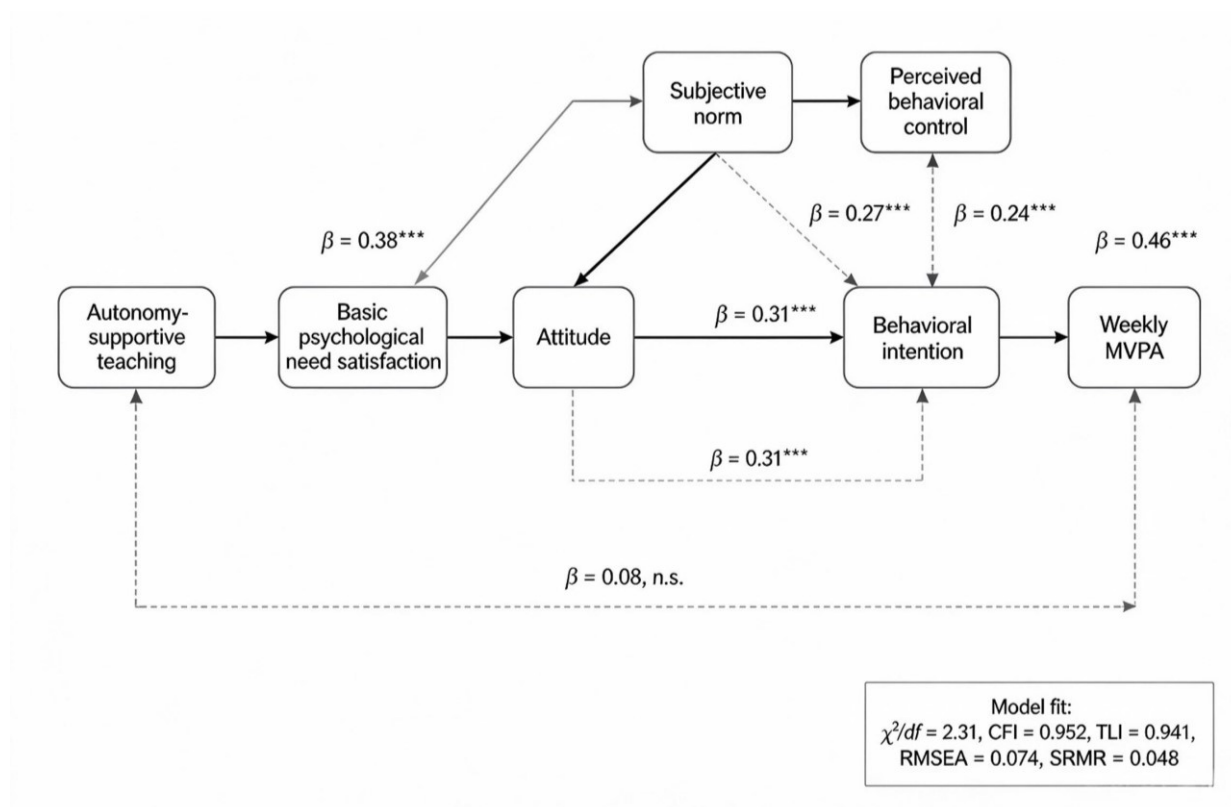


Figure 4. Structural equation model of the integrated SDT-TPB model with standardized path coefficients.

Note: This sequential-chain mediation model is re-specified for testing the study's sequential hypothesis and differs from the parallel-path model whose coefficients are reported in Structural model testing.

Sequential mediation analysis

Bootstrap analysis with 5,000 resamples was used to examine the proposed indirect pathways. Autonomy-supportive teaching exerted a sequential indirect effect on weekly MVPA. This effect was mediated sequentially by basic psychological need satisfaction, TPB-related cognitions and behavioral intention. The pathway reached statistical significance (indirect effect=0.052, 95.00% CI [0.024, 0.089]).

The pathway through basic psychological need satisfaction and perceived behavioral control was also significant (indirect effect=0.071, 95.00% CI [0.038, 0.116]). In addition, the indirect pathway through basic psychological need satisfaction, attitude, and behavioral intention was significant (indirect effect=0.038, 95.00% CI [0.016, 0.069]).

Taken together, these findings provide evidence that the relationship between autonomy-supportive teaching and physical activity was statistically associated with the proposed motivational and cognitive processes. The results are consistent with an integrated SDT-TPB framework in which psychological need satisfaction is associated with subsequent behavioral cognitions and

intention, which are in turn related to physical activity behavior.

Discussion

Summary of findings

This study examined whether a 12-week autonomy-supportive physical education intervention could improve physical activity and related psychological determinants among Chinese vocational college students. The findings showed significant group $\times$ time effects for basic psychological need satisfaction, attitude, subjective norm, perceived behavioral control, behavioral intention, and weekly MVPA. Students in the autonomy-supportive instruction group showed larger improvements during the intervention. These gains were greater than those observed in the traditional skill-focused group. Moreover, such differences were still detectable at the 3-month follow-up.

The most substantial behavioral change was observed in weekly MVPA. In the intervention group, MVPA increased from 128.42 min/week at baseline to 215.68 min/week immediately after the intervention and remained at 203.17 min/week at follow-up.

In contrast, MVPA in the control group changed from 131.56 to 142.39 and 138.74 min/week across the three assessment points. These findings carry an important implication. An autonomy-supportive instructional environment can foster more positive psychological responses toward physical activity. It can also promote physical activity beyond PE lessons.

The structural model revealed positive links between autonomy-supportive teaching and basic psychological need satisfaction. In turn, basic psychological need satisfaction was positively associated with TPB-related cognitions, behavioral intention, and MVPA. The significant indirect effects were consistent with the proposed integrated SDT-TPB framework.

Effects of autonomy-supportive physical education

The significant group $\times$ time effects across all primary outcomes indicate that the instructional approach was associated with meaningful changes in students' psychological and behavioral responses. The findings are consistent with the central proposition of SDT that supportive social environments can facilitate the satisfaction of autonomy, competence, and relatedness needs.

The intervention was designed to provide students with meaningful choices while maintaining the required curriculum structure. Rather than simply allowing students to choose activities freely, the instructor provided rationales, acknowledged students' perspectives, used less controlling communication, and emphasized individual progress. Such practices may have helped students perceive PE as more personally meaningful and manageable.

The improvement in basic psychological need satisfaction is particularly important because need satisfaction represents a central psychological mechanism within SDT. When students experience higher levels of autonomy, competence, and relatedness, they tend to form positive experiences with physical activity. They are also more willing to take part in physical activity beyond externally imposed requirements.

The sustained differences at the 3-month follow-up are also noteworthy. Although some outcomes declined slightly after the intervention, the intervention group generally remained above its baseline level and

continued to show better outcomes than the control group. This pattern suggests that the intervention may have produced changes that were not limited to the classroom period.

Changes in TPB constructs

The intervention was also associated with improvements in attitude, subjective norm, perceived behavioral control, and behavioral intention. These findings suggest that autonomy-supportive teaching may influence physical activity not only through motivational experiences but also through students' subsequent behavioral cognitions. The increase in attitude indicates that students may have developed more favorable evaluations of physical activity following the intervention. Autonomy-supportive teaching may contribute to this change by shifting PE experiences from externally controlled participation toward more personally meaningful engagement.

Perceived behavioral control also increased substantially in the intervention group. This may reflect greater confidence in students' ability to participate in physical activity and manage potential barriers. Providing appropriate choices, progressive tasks, and competence-oriented feedback may help students develop a stronger sense that physical activity is both achievable and controllable.

Subjective norm showed a similar pattern. Cooperative activities and supportive teacher-student interactions may have increased students' perception that physical activity was socially valued and supported. In a college environment, peer interaction may be particularly relevant because students' behavioral decisions are embedded within a broader social context.

Behavioral intention increased concurrently with these TPB constructs. Because intention represents a proximal cognitive determinant of behavior within the TPB framework, the improvement in intention provides a plausible explanation for part of the observed increase in MVPA.

Integration of SDT and TPB

One contribution of this study is the examination of SDT and TPB within a single explanatory framework. The structural model indicated that autonomy-supportive teaching was positively linked to basic psychological need satisfaction. In turn, need satisfaction had positive associations with attitude, subjective norm, and

perceived behavioral control. These TPB-related constructs were subsequently associated with behavioral intention, which was positively related to weekly MVPA. The findings therefore provide empirical support for the proposed statistical pathway linking social context, psychological need satisfaction, behavioral cognition, intention, and physical activity. The significant sequential indirect effect further suggests that the relationship between autonomy-supportive teaching and MVPA may operate partly through these motivational and cognitive processes.

Importantly, these findings should be interpreted as evidence of statistical mediation within the observed model rather than definitive proof of a causal psychological sequence. This randomized intervention supports the inference that the intervention led to changes in the outcome variables. Even so, the mediation model alone cannot confirm that each mediating construct causally affects the subsequent one.

Nevertheless, the integrated framework provides a useful theoretical perspective for understanding why autonomy-supportive PE may be effective. SDT explains how the instructional environment shapes students' psychological experiences. TPB, by contrast, accounts for how these experiences connect with later behavioral intentions and physical activity.

Conclusion

This study examines the effects of a 12-week autonomy-supportive physical education intervention on physical activity and related psychological determinants among Chinese vocational college students. This study adopts a cluster randomized controlled design. It compares an autonomy-supportive instructional approach with traditional skill-focused physical education. Data are collected at three time points: baseline, post-intervention, and the 3-month follow-up.

Students in the autonomy-supportive physical education group achieve larger gains than those receiving traditional skill-focused instruction. These improvements cover basic psychological need satisfaction, attitude toward physical activity, subjective norm, perceived behavioral control, behavioral intention, and weekly moderate-to-vigorous physical activity. The intervention-related differences remain evident at the 3-month follow-up, although some outcomes showed a modest decline after the intervention.

The structural equation model is consistent with the proposed integration of SDT and the TPB. Autonomy-supportive teaching is positively associated with basic psychological need satisfaction, which is subsequently associated with more favorable TPB-related cognitions and stronger behavioral intention. Behavioral intention is positively associated with weekly MVPA. The significant bootstrap indirect effects further support the proposed statistical mediation pathways.

Overall, the findings suggest that autonomy-supportive physical education may be a useful approach for promoting physical activity among vocational college students. Its potential value has two dimensions. It does not merely raise physical activity levels directly. More importantly, it builds a supportive learning environment that can strengthen students' psychological resources and behavioral motivation. The study therefore provides preliminary empirical support for applying an integrated SDT-TPB perspective to physical activity promotion in vocational education.

Future research should replicate these findings across multiple vocational colleges and regions, recruit a larger number of classes, and incorporate objective measures of physical activity. Longer follow-up durations and repeated longitudinal assessments are recommended. This data would help clarify whether changes unfold in the hypothesized temporal order. The changes refer to basic psychological need satisfaction, TPB constructs, behavioral intention, and physical activity.

Funding

This research was not supported by any funds.

Acknowledgements

The authors would like to show sincere thanks to those technicians who have contributed to this research.

Conflicts of Interest

The authors declare no conflict of interest.

References

- [1] Abula, K., Beckmann, J., He, Z., Cheong, C., Lu, F., Gröpel, P. (2020) Autonomy support in physical education promotes autonomous motivation towards leisure-time physical activity: evidence from a sample of Chinese college students. *Health Promotion International*, 35(1), e1-e10.
- [2] Guthold, R., Stevens, G. A., Riley, L. M., Bull, F.

- C. (2020) Global trends in insufficient physical activity among adolescents: a pooled analysis of 298 population-based surveys with 16 million participants. *The Lancet Child and Adolescent Health*, 4(1), 23-35.
- [3] Raabe, J., Schmidt, K., Carl, J., Höner, O. (2019) The effectiveness of autonomy support interventions with physical education teachers and youth sport coaches: a systematic review. *Journal of Sport and Exercise Psychology*, 41(6), 345-355.
- [4] Deci, E. L., Olafsen, A. H., Ryan, R. M. (2017) Self-determination theory in work organizations: the state of a science. *Annual Review of Organizational Psychology and Organizational Behavior*, 4, 19-43.
- [5] McAnally, K., Hagger, M. S. (2024) Self-determination theory and workplace outcomes: a conceptual review and future research directions. *Behavioral Sciences*, 14(6), 428.
- [6] Wang, Y., Wang, H., Wang, S., Wind, S. A., Gill, C. (2024) A systematic review and meta-analysis of self-determination-theory-based interventions in the education context. *Learning and Motivation*, 87, 102015.
- [7] Zhong, Q., Jiang, J., Bai, W., Yin, Z., Liao, Z., Zhong, X. (2025) Application of digital-intelligent technologies in physical education: a systematic review. *Frontiers in Public Health*, 13, 1626603.
- [8] Martín-Rodríguez, A., Madrigal-Cerezo, R. (2025) Technology-enhanced pedagogy in physical education: Bridging engagement, learning, and lifelong activity. *Education Sciences*, 15(4), 409.
- [9] Zhou, T., Wu, X., Wang, Y., Wang, Y., Zhang, S. (2024) Application of artificial intelligence in physical education: a systematic review. *Education and Information Technologies*, 29(7), 8203-8220.
- [10] Hagger, M. S., Hamilton, K. (2024) Longitudinal tests of the theory of planned behaviour: a meta-analysis. *European Review of Social Psychology*, 35(1), 198-254.