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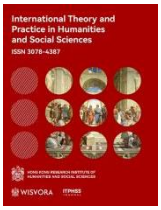

Intervention for disease-based students improving perceived physical literacy in university required physical education： PBL model

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Abstract

The development of physical literacy is critical to the long-term health of individuals, and quality can be described as someone willing to use the potential of movement to contribute to the quality of life in terms of motivation and ability. Physical education programs in higher education are key to developing physical literacy, and it is necessary to help students with a disease base that prevents them from participating in strenuous exercise to engage in physical activity and promote mental health. The present study was a 10-week curricular intervention based on the basic strategies of physical literacy using the PBL teaching model for college students with a disease in a compulsory physical education course. The results showed that the intervention group had significantly higher physical literacy scores and physical education learning interest scores after 10 weeks, while the control group followed the traditional curriculum model. Although there was some improvement, the differences were not statistically significant. The curriculum intervention program in this study not only provides a reference for physical education in higher education institutions but also provides a feasible program to promote the development of physical literacy among adolescents and to establish a quality school physical education curriculum.

1. Introduction

Physical literacy(PL) is a health determinant of an individual's participation in physical activity(PA)(K. W. Sum et al., 2022)and includes the motivation, confidence, physical ability, knowledge, and understanding needed to value and undertake PA throughout one's life(Whitehead ME 2010). As a key concept in advancing human health, it not only promotes the multifaceted development of human health but also enables individuals to develop and enjoy lifelong PA(Faigenbaum & Rial Rebullido, 2018). Many countries such as Canada, the United States, and Australia are actively promoting this concept(Jurbala, 2015). The concept of PL suggests that PA should include not only an individual's participation in various exercises, but

also psychological, cognitive, and social development(Faigenbaum & Rial Rebullido, 2018). When students are physically literate, they have a higher interest in PA and are more likely to participate regularly, which plays a crucial role in preventing chronic diseases and promoting mental health(Alipour-Anbarani et al., 2022).

College students are in the transition from compulsory secondary education to a more self-reliant adult approach to PA(Choi et al., 2018). This highlights the importance of cultivating college students' PL(Melby et al., 2023). In China, the Ministry of Education (MOE) requires every college student to take 144 hours of physical education (PE) within four years, which is generally required to be completed within the first to second year of college(Ministry of Education of the People's Republic of China, 2014). This mandatory PE program is mainly carried out in the traditional physical education mode, where students participate in various PA and are assessed on them. Mode, in which students participate in various PA and are assessed, and students tend to have lower enthusiasm for learning because of mandatory content(Ma, Sum, Li, et al., 2020). On the other hand, many students with underlying medical conditions who are not suited to strenuous PA are more likely to face a variety of barriers(Hassani et al., 2022). Due to physical limitations, lack of supportive environments, and mental health issues, they tend to be less likely to participate in PA than their peers(Bopp et al., 2019). Such inactivity can exacerbate existing health conditions and lead to a cycle of declining physical and mental health(Lee et al., 2012). Incorporating regular exercise into the lives of these students is essential for improving their overall health and managing disease symptoms(Holler et al., 2021).

Each of the disease-based students has different physical conditions and a large proportion in each university, for example, diabetes, congenital heart disease, asthma, major depression, epilepsy, post-surgical recovery, etc(Yan Y.H.2024). These students were unable to participate in uniform PA(Huang et al., 2021a). However, their opportunity to engage in PA cannot be denied, thus helping them to improve their PL, and tailoring different interventions can effectively address physical and psychological barriers to exercise(Castelli et al., 2014), increase participation, and develop an interest in PA. Notably, improving the PL of college students struggling with illness will not only benefit the individual but also contribute to the health of society as a whole.

The PBL model is short of problem based learning(Almulla, 2019). Compared with the traditional PE teaching model, the PBL model places more emphasis on cooperation between theory and practice and gives play to students' autonomy(Kolmos et al., 2021). After the teacher puts forward the general requirements, students will formulate a detailed implementation plan and evaluation criteria at different stages based on their own physical conditions and personal goals, and they will continue to modify, improve, and conclude the plan according to the teacher's opinions and learning situation during the process of implementation. According to the teacher's comments and learning situation, they constantly modified and improved. PBL model places more emphasis on student autonomy and, at the same time, has been more individually targeted(Gil-Galvan et al., 2021).The individual condition of each student was different, and the intensity of the exercise that each person could accept was different. If the teacher unifies the development of the intensity of the activity, not only is it susceptible to student resistance, but it is also prone to further damage to student health. PBL teaching mode can help students guide themselves in carrying out lifelong PA.

2. Methodology and Procedures

2.1 Research design

This study first summarized the extensive literature, developed a preliminary instructional design, conducted two rounds of pilot interventions, and modified and adjusted the instructional protocol. The second step was to determine the intervention program and review the information of the students who participated in the formal study. Students with a disease basis must have a doctor's prescription issued by a formal hospital within the last three months, which proves that they cannot exercise strenuously and that they generally suffer from congenital heart disease, asthma, severe psychological disorders, and post-surgical rehabilitation. The third step was a 10-week instructional intervention in the PBL physical education program for students with a disease base, with one class per week of 90 minutes. Before the start of the course, the teacher will present the general requirements of the course, and students will think about their physical activity goals for the semester based on their physical disease conditions, such as physical rehabilitation, functional training, fitness, and health enhancement, and will develop and implement an exercise program of no less than 10 weeks. Meanwhile, the teacher will explain one knowledge point in each class, and students need to complete different tasks based on the content of the knowledge point and summarize the theory into their exercise program so that the program will be more scientific. At the end of the course, in addition to submitting their own exercise program and exercise record report, each student must write a summary of the exercise, describing their gains and shortcomings in the process to help other students with the same needs for reference. Before the beginning and after the end of the program, each student filled out a questionnaire, including data on basic personal information, PL, and interest in physical activity.

2.2 Participants

This study was conducted at a university selected in Shanghai, China, where students are required by the Chinese Ministry of Education to take a mandatory 2-year physical education course upon admission to the university. Students with a disease base submit an application through the system at the beginning of the semester, which requires that they must have a prescription from a doctor in a regular hospital within the last three months stating that they are not suitable for strenuous exercise, and the teacher audits each student's physical condition, which is generally congenital heart disease, asthma, disability, mental illness, and post-surgical rehabilitation period. In this study, sophomores were selected for a non-randomized controlled intervention, with the control group being 87 out of 2,500 sophomores in 2023, who passed the review after the student submitted a doctor's note in the system, from October 2023-December to 2023, and attended class in the traditional mode for light physical activity. The intervention group comprised 93 students who passed the review in 2024 out of 2300 sophomores, from October to December 2024 and were taught all processes by the same teacher to avoid interference from teacher factors.

2.3 Data analysis

IBM SPSS was used for all data analysis, and after collecting data through questionnaires, descriptive statistics were calculated for all students on age and gender demographic variables. A

one-way analysis of variance (ANOVA) was conducted to determine the differences between the groups in terms of students' perceived PL and interest in PA prior to the start of the experiment. At the end of the intervention, post-hoc Scheffe analysis was used to identify factors influencing significant F-values based on ANOVA. The significance level for all analyses was set at a 95% confidence interval.

2.4 Instruments

2.4.1 Perceived physical literacy instrument(PPLI)

Participants' PL was assessed using the PPLI, which was designed based on the core attributes of Whitehead's conceptualization of PL and consists of three dimensions: motivation, confidence and physical competence, and environmental interactions(R. K. W. Sum et al., 2018). Participants responded on a 5-point Likert scale (1 = Strongly Disagree, 5 = Strongly Agree). The PPLI proved to be a reliable and valid questionnaire, which was analyzed by exploratory factor analysis (factor loadings ranging from 0.68 to 0.93) and validation factor analysis (factor loadings ranging from 0.60 to 0.92)(Ma, Sum, Hu, et al., 2020).

2.4.2 Sports learning interest scale （SLIS）

Participants' interest in learning PE was assessed using the SLIS, with five dimensions: positivity, negativity, skill acquisition, hobbies, and sports concern, the cumulative contribution of 72.358% for each of the five factors of the scale, and a reliability coefficient of 0.903(Gu H-Y.et al.2012) . Participants responded on a 5-point Likert scale (1 = Strongly Agree, 5 = Strongly Disagree).

2.5 Pilot research

To ensure the effectiveness of the intervention, two pilot interventions were conducted prior to the current round of research: the pilot research was based on previous relevant research on the instructional design and two rounds of implementation, which involved 75 disease-based students in the experiment (April 2023-June 2023), and the second round involved 83 students (April 2024-June 2024). Based on data collection, in-depth interviews were conducted with students to obtain their feedback on the questionnaire collection and course content for further modifications, which were also reviewed by experts in the field of study and found to be effective in terms of content.

2.6 Intervention program

Based on the dimensions of PL(Whitehead ME 2010;K. W. Sum et al., 2022), the strategies for the development of PL in adolescents (Jurbala, 2015), and based on fully respecting the students' physical conditions and actively utilizing their initiative, this study developed an intervention plan. By the teaching objectives, the teacher will tell the students what they will accomplish in the semester and the weekly tasks in the first class, and the students will need to complete the tasks weekly by the final objectives and in their situation, and obtain the weekly process scores and the final overall grade. Each class is 90 minutes in total, including three parts: theory, exercise practice, and after-class tasks, in which part of the exercise practice content is to

be completed by students after class, advocating that they should complete it with their peers or family members and submit their assignments in the form of filming vlogs. Table 1 shows each week.

Table 1 PBL Intervention plan

Week	Content	Request
1	Theory: benefits of physical activity? How can I guide myself in physical activity? Exercise: Gentle cardio training	Think about the purpose of your exercise, set goals and tasks, form an exercise plan for at least 10 weeks, and began to implement it
2	Theory: basic methods and principles of physical activity for different sports purposes Exercise: Gentle cardio training.	The details of the exercise program should be modified to further dismantle goals, refine tasks, and implement them in conjunction with classroom theoretical knowledge.
3	Theory: physical activity and mental health Exercise: Sports games.	Modifications were made based on the issues encountered during the implementation of the exercise program.
4	Theory: Nutritional intake and consumption, nutritional program development for different sports goals. Exercise: Finding partners, accomplishing sports tasks together and shooting vlog.	Gathering information about dietary intake and combining it with class content to create a nutritional plan that matches your exercise program.
5	Theory:Sports nutrition program for people with different diseases. Exercise: Participating in outdoor sports with peers and shooting vlog (e.g. climbing, walking, etc.)	Modifying Nutritional Program Details in Exercise Plans
6	Theory: Exercise and changes in body functions, methods and significance of preparatory activities Exercise: Engage preparatory exercises	Incorporate general and specific preparatory activities into exercise programs
7	Theory: Principles and methods of stretching and relaxation activities Exercise: Engage in stretching and relaxation exercises	Add relaxation organizing and stretching to your exercise program
8	Theory: Prevention and emergency treatment of common sports injuries Exercise: Eentle cardio training and	Summarize possible sports injuries in your exercise program and how to deal with them in an emergency.

	shoot vlog	
9	Theory: Special people's exercise precautions Exercise: Record the implementation of the exercise program and shoot a vlog	Summarize the gains and shortcomings of the exercise program implementation process,and develop the next phase of the program.
10	Summarizing and reporting	

To help students continue to improve their exercise program and increase participation, throughout the process, students will be given feedback on their grades after completing the content each week, as well as a summary of problems in the next class to help students make corrections. At the end of the 10-week program, students were required to submit a complete exercise plan, including a personal situation analysis, exercise goals and objectives, exercise content, preparatory activities, stretching activities, relaxation activities, nutritional programs, and recommendations, prevention of sports injuries, emergency treatment methods, exercise record reports, and personal summaries.

3. Results and Discussion

3.1 Results

There were 93 and 87 people in the intervention and control groups, respectively, all of whom were sophomores, comprising 15% of the total number of males and 85% of the total number of females. The significance in the ANOVA chi-square test was 0.724 and 0.944, respectively, indicating that ANOVA could be performed.

One-way ANOVA was used to test the effect of pre-and post-intervention on PL and interest in learning PE in both groups. The results showed a statistically significant in PPLI scores, $F(3,289)=5.26$, $p<0.05$, and showed a statistically significant in SLIS scores, $F(3,289)=4.66$, $p<0.05$. Table 2 shows the detailed data from ANOVA.

Table 2 ANOVA of variables for different groups

		SS	df	MS	F	P
PPLI	Among groups	5.833	3	1.944	5.263	0.002
	With-in groups	106.772	289	0.369		
	Amounts	112.605	292			
SLIS	Among groups	6.284	3	2.095	4.657	0.003
	With-in groups	129.995	289	0.450		
	Amounts	136.280	292			

Note. SS = sum of squares; df = degrees of freedom; MS = mean squares; F = F ratio

Scheffe's post hoc comparisons revealed that in terms of physical literacy, post-intervention (M=3.59, SD=0.63) was higher than baseline (M=3.28, SD=0.53) in the intervention group, and there was a significant difference in achievement. In terms of interest in physical education learning, post-intervention (M=3.27, SD=0.66) was higher than the baseline (M=3.34, SD=0.59) in the intervention group, with a significant difference in achievement. Although the control group's post-intervention scores were higher than the baseline in both the PPLI and SLIS, there was no limiting difference. Table 3 and Figure 1 show the detailed data.

Table 3 Scheffe post hoc comparisons

Variable	Mean	SD	Mean	SD	Scheffe		
	Baseline		Post intervention		Mean deviation	Standard error	p
Intervention group （n=93）							
PPLI	3.28	0.53	3.59	0.63	-.31925*	.09855	0.008
SLIS	3.01	0.70	3.34	0.68	-.32611*	.10874	0.018
Control group (n=87)							
PPLI	3.27	0.66	3.34	0.59	-0.06674	0.10402	1.000
SLIS	3.01	0.69	3.22	0.61	-0.21857	0.11478	0.347

Note：SD=standard deviation

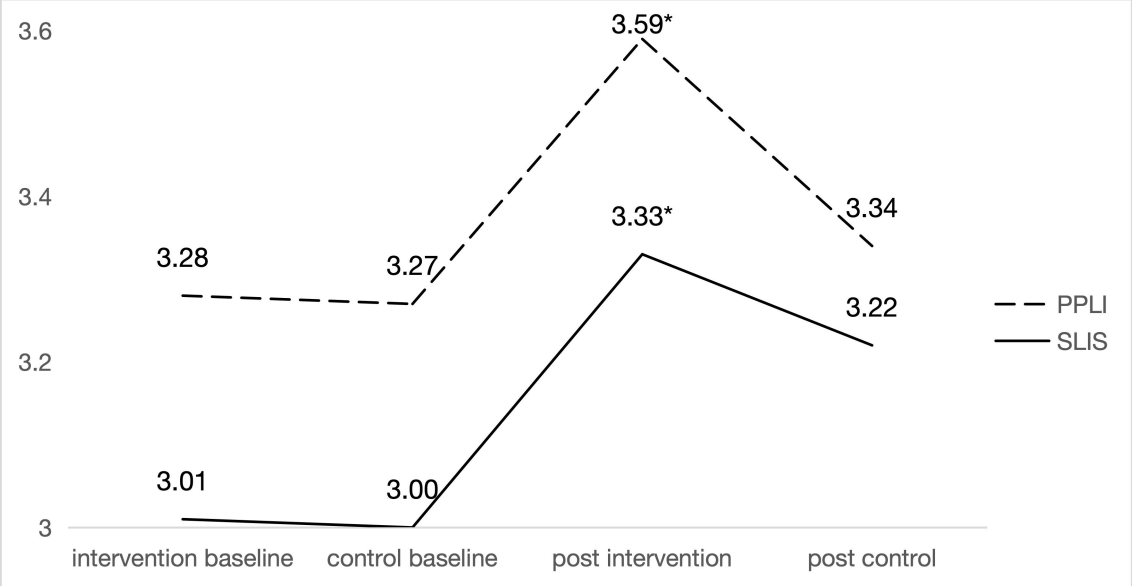

Figure 1 The mean of perceived physical literacy instrument(PPLI)score, and Sports learning interest scale（SLIS）score.

3.2 Discussion

The results of this study suggest that a PBL teaching model based on a physical literacy strategy can be effective in increasing PL and PA interest among disease-based college students. In previous studies based on the dimension of PL, there have been different intervention programs for PE teachers(Holler et al., 2019), adolescent children(Alipour-Anbarani et al., 2022), older adults(Babak et al., 2022), and chronically ill populations12. The present study is the first known case of an intervention program based on PL strategies for college students with a disease. A PE program is an element of activity that every student should and must participate in, but how to make a quality PE class, is important to help them feel more accessible and engaging(Rukavina & Gremillion-Burdge, 2024).

In this study, teaching using the PBL model based on physical literacy intervention can be divided into three main parts: theoretical knowledge learning, which requires students to collect information from the environment and choose different actions.In (process) information collection and decision making, which reflects the individual's viewpoint and depth of learning. People with a good PL maturity inherently need to have the ability to sift through a wide range of information and make decisions(Yang et al., 2024) .Through deep self-involvement, students' acceptance of and initiative to engage in PA is increased(Choi et al., 2021;Taylor & MacLeod, 2024). Through continuous practice and revision, a spiral of development and understanding has been developed. Teachers play an important role in providing feedback, setting goals, and theoretical depth, which also influences student autonomy(Houser & Kriellaars, 2023).

The second component was the specificity of the physical activity goal. Disease-based students tend to have low self-esteem and self-efficacy in PA(Huang et al., 2021b). People with good exercise habits and healthy activity levels tend to have higher self-esteem and self-concept(Woolley et al., 2024). Similarly, high self-esteem will in turn increase PA(Yan et al., 2023). When positive feedback is not provided for PA, it can make it easier for disease-based students to drop out of physical activity(Ladd, 2023a). Goal setting and dismantling can help students more easily have a sense of acquisition and accomplishment(Choi et al., 2024a).

The third section emphasizes interactions with society, both with people and the social environment. Based on self-actualization and self-determination theory, there is a strong focus on facilitating social interactions through peer practice, which is a common source of motivation(Yan et al., 2022). People are more likely to engage in physical activity and enjoy social interaction(Ozturk et al., 2023a).

Each student in the control group submitted details of his or her exercise program, exercise record report, and personal summary at the end of the intervention. By analyzing the above, the students' exercise programs mainly consisted of training programs for health, rehabilitation training, and weight loss, indicating that this was the main focus of the students' learning. In their summaries, many students mentioned that they would continue to extend their exercise programs and continue to implement them because the specific programs they had developed gave them actionable steps to follow(Stoddart & Humbert, 2017), while the weekly goals not only urged them to complete their training programs(Choi et al., 2024b) but also improved their sense of personal achievement in the process(Pinilla et al., 2024).

Physical literacy is the cornerstone of lifelong health and well-being(Lin et al., 2025). It includes the skills, knowledge, and confidence needed to participate in physical activity at all stages of life(Wang et al., 2024). When students are physically literate, they are more likely to participate in regular exercise(Ladd, 2023b), which plays a crucial role in facilitating physical recovery and promoting mental health in students with an underlying medical condition(Ozturk et al., 2023b). This highlights the importance and foundational importance of college students developing physical literacy as they transition into adulthood, a critical time for establishing long-term healthy behaviors(Wilkie et al., 2024).

Unfortunately, disease-based students often face varying barriers to physical activity(Talebi et al., 2022). Physical limitations, psychological challenges or lack of a supportive environment, and low motivation are often cited in students' descriptions of their reasons for not participating in physical activity. As a result, their participation in physical activity is often significantly lower than that of their peers, and this inactivity may exacerbate existing health conditions and create a cycle of declining physical and mental health(Kwan et al., 2020).

Incorporating regular exercise into the lives of disease-based students is critical to improving their overall health and managing disease symptoms(Wu et al., 2024). Interventions tailored by each participant to help address their own physical or psychological barriers can help students develop motivation and engagement, with activity components that emphasize progression, peer support, and enjoyment of physical activity being particularly effective in fostering positive individual relationships with exercise. Encouraging disease-based college students to be physically active not only improves their current quality of life but also provides them with the tools to maintain a healthier lifestyle in the future.

Although this study was based on college students with a disease base, it will provide a learning idea for all individuals with physical activity challenges. Lack of PA has become a major global issue in recent years, with research suggesting that more than 1/3 of adolescents face challenges in performing basic motor skills owing to being overweight or obese(Bopp et al., 2019) , and developing PL in adolescents will provide a foundation for them to participate in lifelong PA.

3.3 Limitations

As an intervention in a new field, this study provided a mandatory PE program for college students on a disease basis. Although the number of groups with a disease basis that prevented them from participating in PA on a regular basis was relatively large for each academic year, the school's requirements for curriculum planning meant that the intervention and control groups needed to be kept separate, and the entire intervention process lasted a long time. On the other hand, PL is a concept that promotes lifelong physical activity; the effect of the intervention of a 10-week program on the students may not be long enough, and the failure of this study to follow up with the students. Although previous studies have shown that male students may have better indices of PA and PL than female students(Liu et al., 2021), there was no male-female subgroup in this intervention because there were fewer male students participating in the current intervention. Despite these shortcomings, this study provides new ideas for the development of physical education programs in higher education, and a feasible solution for building a quality PE program.

4. Conclusion

This study is the first known attempt to develop a PL-based PE curriculum intervention program for disease-based college students, an intervention that focuses not on getting students to repeat as much of the PA as possible in the allotted time, but rather on helping themselves get back into PA with reasonable means and a high level of enthusiasm that promotes both physical recovery and psychological well-being, which is important for the development of society.

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