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AI-driven personalized exercise prescription: effects on university students' fitness adaptation and exercise adherence

Prescripción personalizada de ejercicio basada en IA: efectos en la adaptación física y la adherencia al ejercicio de estudiantes universitarios

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Abstract

Artificial intelligence has increasingly been used to support personalized health and fitness interventions, particularly in designing exercise programs that respond to individual fitness levels and training needs. This study examined the effects of AI-driven personalized exercise prescription on fitness adaptation and exercise adherence among university students. A quasi-experimental pretest-posttest control group design was employed, involving 120 undergraduate students randomly assigned to an experimental group receiving AI-driven personalized exercise prescriptions or a control group following a standard physical education exercise program. The intervention lasted eight weeks, with three exercise sessions per week. Results showed that both groups significantly improved in health-related fitness after the intervention; however, the experimental group demonstrated greater improvements in cardiovascular endurance, muscular endurance, muscular strength, and flexibility compared with the control group. Posttest comparisons significantly favored the experimental group in cardiovascular endurance, muscular endurance, muscular strength, and flexibility, while exercise adherence was also higher in the experimental group than in the control group, with adherence rates of 90.0% and 75.4%, respectively. These findings indicate that AI-driven personalized exercise prescription can improve students' fitness adaptation and exercise adherence more effectively than a standard physical education exercise program. The integration of AI-based personalized exercise technologies may help strengthen university physical education by promoting health-related fitness and sustained participation in physical activity.

Keywords: artificial intelligence; personalized exercise prescription; fitness adaptation; exercise adherence

Resumen

La inteligencia artificial se utiliza cada vez más para apoyar intervenciones personalizadas de salud y condición física mediante programas de ejercicio adaptados al nivel físico y a las necesidades de entrenamiento de los estudiantes. Este estudio examinó los efectos de la prescripción personalizada de ejercicio basada en IA sobre la adaptación física y la adherencia al ejercicio en estudiantes universitarios. Se empleó un diseño cuasi experimental con preprueba y posprueba con grupo control. Participaron 120 estudiantes universitarios asignados aleatoriamente a un grupo experimental, que recibió prescripciones personalizadas de ejercicio basadas en IA, o a un grupo control, que siguió un programa estándar de educación física. La intervención duró ocho semanas, con tres sesiones de ejercicio por semana. Los resultados mostraron mejoras significativas en ambos grupos; sin embargo, el grupo experimental presentó mayores avances en resistencia cardiovascular, resistencia muscular, fuerza muscular y flexibilidad. Las comparaciones posteriores favorecieron significativamente al grupo experimental en dichas variables, mientras que la adherencia al ejercicio fue mayor en el grupo experimental que en el grupo control, con tasas de 90,0 % y 75,4 %, respectivamente. Estos hallazgos indican que la prescripción personalizada de ejercicio basada en IA mejora la adaptación física y la adherencia al ejercicio con mayor eficacia que un programa estándar de educación física. Su integración puede fortalecer la educación física universitaria al promover la condición física y la participación sostenida en actividad física.



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Palabras clave: inteligencia artificial; prescripción personalizada de ejercicio; adaptación física; adherencia al ejercicio

Introduction

Engaging in regular physical activity is recognized as critical in promoting physical fitness and supporting health and wellbeing in university students. In university settings, exercise adherence is an important measure of the success of physical education programs in promoting continuous participation in an active lifestyle. However, exercise adherence is a significant issue in university student populations. Despite the overwhelming benefits of exercise, many students do not engage in the recommended levels of activity. For example, Shannon et al. (2022) found that 59% of university students do not engage in sufficient levels of activity, even though those who meet the guidelines for aerobic and muscle-strengthening activity report higher levels of happiness and a positive body image. This concern supports the need for broader and more flexible strategies to increase physical activity opportunities among students. In addition to these concerns, studies show that adherence behavior is impacted by a range of psychosocial factors, including exercise self-efficacy and emotional self-regulation, that determine the extent of students' sustained involvement in physical activity programs (An et al., 2024). In addition, the presence of social and physical factors in the exercise environment can support or limit participation, as exercise commitment and a positive exercise environment are among the key predictors of adherence behaviors in university students (Li et al., 2024). Given these factors, technology has introduced new ways to facilitate exercise behavior. Recent studies show that digital fitness platforms may improve exercise adherence by creating a positive exercise experience and increasing perceived control over exercise behavior (Zhang et al., 2023).

International literature has longevity research about exercise adherence within students at higher education institutes. Specifically, the literature focuses on the persistence of students' exercise engagement. Psychological, social, and environmental factors influence students' engagement. Eynon et al. (2019) elucidate the role of intrinsic and social motivation in support of exercise program engagement. Subsequently, in the documentation of higher education populations' exercise engagement, self-determining motivation is a major contributor in program persistence. Rojo-Ramos et al. (2025)

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reported that interventions targeting students' motivations toward physical activity can improve exercise adherence and promote healthier lifestyle behaviors among university populations. In a similar vein, Peng et al. (2023) provide documentation of self-monitoring exercise equipment engagement. Although, it has not been documented the contraption within a population of students has been shown to influence long term exercise adherence. The impact of social support systems constructs, social exercise engagement and educational attainment systems. Gao et al. (2024) social support within and outside of educational attainment systems documented and with positive influence on exercise social support. Environmental and structural systems to educational systems continue to impact the participation of exercise systems. Silva et al. research. Murphy et al. (2024) has shown that even though students are aware of the advantages of exercising, the academic workload, the number of hours they can work, and the prioritization of other activities tend to inhibit students from taking part in physical activity. This aligns with Murphy et al.'s (2024) assertion that program inaccessibility and poorly structured in-program exercise opportunities diminish students' ability to exercise.

University students in the Philippines continue to face challenges in maintaining adequate levels of physical fitness and regular physical activity. Evidence from Philippine college populations suggests that although some students may fall within acceptable body composition classifications, weaknesses remain in specific health-related fitness components, particularly muscular strength and muscular endurance. Santiago and Ibarra (2023), for instance, reported that although most freshmen students were classified as physically fit, approximately 30% were not physically fit, and many failed to meet expected standards in strength-related tests such as curl-ups and push-ups. Institutional assessments have also shown that several health-related fitness components, including cardiovascular endurance, muscular strength, and muscular endurance, remain below desired standards among university students, reinforcing the need for more effective physical education interventions (Gula, 2024). Furthermore, Pineda et al. (2024) emphasized that the implementation of PATHFIT courses in Philippine universities may be affected by differences in institutional readiness, facilities, resources, and support systems. These concerns highlight the need for more responsive and individualized approaches that can improve students' fitness levels and promote sustained participation



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in physical activity. Recent evidence also supports the potential of technology-assisted physical activity programs in the Philippine university context. Martin (2026) found that an eight-week gamified digital physical activity intervention among PATHFIT2 students improved moderate-to-vigorous physical activity, autonomous motivation, adherence stability, and selected fitness outcomes compared with a standard digital intervention.

Recent advancements in artificial intelligence technology allow for the creation of individualized exercise prescriptions that personalize training plans based on an individual's unique physical attributes, goals, and behavioral trends. Notably, AI-based exercise systems have been found to improve health and fitness by providing individualized training guidance based on user behavioral and physiological data. Sun et al. (2021) found that middle-aged and older adults who used intelligent exercise prescription systems showed improvements in health outcomes such as heart rate and body composition, exemplifying how personalization from technology can improve how the body responds to exercise. Based on Zeng et al. (2020) study, it showed breast cancer survivors who used personalized exercise plans and wearable fitness trackers based on artificial intelligent systems improved their functional fitness as well as their metabolic health. This shows that exercise plans are adaptable to improving fitness health (even to a clinical population). Based on the first smart fitness technology, users can anticipate the real-time adaptations and changes of their training programs to better respond to their physiological needs. This is a concept that Lin et al. (2023) showed when outlining the benefits of AI-based exercise prescription systems on muscular strength, flexibility and aerobic endurance. Continuous adjustment of training loads to the user is also supported by Barricelli et al. (2020) stated that new smart fitness ecosystems like digital twins and smart monitoring systems can identify performance trends and direction customized training strategies to maximize improvements in physical fitness. Although the implementation of AI in exercise prescriptions is on the rise, there are still concerns about the accuracy and contextual relevance of these recommendations. Dergaa et al. (2024) suggested that although AI models can outline training plans, these plans are likely to be missing the necessary adjustments and refinements to be safe and effective considering the individual's health status and training objectives, absent the involvement of a qualified professional.

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Aside from advancements in technology, physical education programs at universities are also very important in influencing student engagement in physical activity and the development of physical fitness. Evaluated teaching methods used in physical education have shown to increase students' health-related fitness. For instance, Juric et al. (2023) say that structured high-intensity interval training (HIIT) in the classroom increased students' cardiorespiratory fitness, demonstrating that training strategies integrated into the physical education curriculum can lead to cardiorespiratory improvements. Additionally, individualized programs are valuable in achieving fitness goals. This was shown by Masters et al. (2023) as they evaluated university wellness programs and found individualized exercise programs increased positive outcomes in body composition and cardiorespiratory fitness. In addition to structured training programs, curriculum innovations have also contributed to improved student participation and learning experiences. The study by Chen et al. (2024) revealed that the use of blended learning, which combines traditional and digital methods of teaching, can positively influence students' attitudes toward exercise and the acquisition of psychosocial skills. Furthermore, collaboratively designed programs have also proved to be a useful means of enhancing participants' interest and engagement in physical activity. Goncalves et al. (2023) noted that after the COVID-19 pandemic, the development of co-constructed physical activity programs with student involvement increased motivational and health-related outcomes in university populations. Supporting this, Yu (2024) noted that the use of multimedia in fitness classes improves teaching effectiveness and student satisfaction while fostering more interactive and engaging educational settings.

The current research is anchored in Self-Determination Theory (SDT), which explains motivation and sustained engagement in behavioral activities through the satisfaction of three basic psychological needs: autonomy, competence, and relatedness. In physical education, learning environments that provide opportunities for choice, appropriate challenge, feedback, and social interaction may foster more sustained participation in physical activity. This perspective is consistent with Arufe-Giráldez et al. (2024), who emphasized that increasing physical activity among children and young people requires multi-context strategies involving school, extracurricular, family, and socio-community environments. Their review highlighted physical education, active



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breaks, movement breaks, active transport, family-based activity, wearable technologies, and accessible community spaces as complementary strategies for increasing physical activity levels. Although the present study is situated within university physical education, this multi-context perspective supports the need for flexible and adaptive approaches that extend beyond uniform exercise programming. Personalized exercise prescription technology, particularly AI, may support students' autonomy and competence because participants receive exercise programs adjusted to their fitness levels, preferences, and progress. When students exercise according to their capabilities and goals, they may experience greater confidence, perceived control, and motivation to remain physically active. In this study, AI-driven personalized exercise prescription is conceptualized as a technology-supported strategy that may enhance exercise adherence while promoting physiological fitness adaptation among university students.

The use of artificial intelligence within university physical education programs has potential, but gaps in existing research are most of risks associated with integrating technology into health and fitness. First, while research into personalized exercise prescription systems has taken place in clinical and recreational fitness, there is little research into the uses of these technologies for structured physical education programs in postsecondary settings. Second, digital fitness studies focus on participation and motivation as a primary behavioral outcome with little research in the areas of physiological fitness changes and exercise adherence, and even less as interconnected outcomes. Third, the research that exists on the personalization of exercise prescriptions has focused on the general fitness and clinical populations. There is little research on the use of artificial intelligence training prescriptions and how university students respond to them within an educational context. Additionally, while physical education programs have a focus of fostering habitual exercise, teaching styles likely do not address variations in students' physical capabilities, preferences, and motivation. These factors increase the consideration of innovative approaches to personalizing exercise in a way that optimizes the engagement and fitness of university students. This study addresses the gap by evaluating the use of artificial intelligence technology that personalizes exercise prescriptions in university health education. This research aims to address the following

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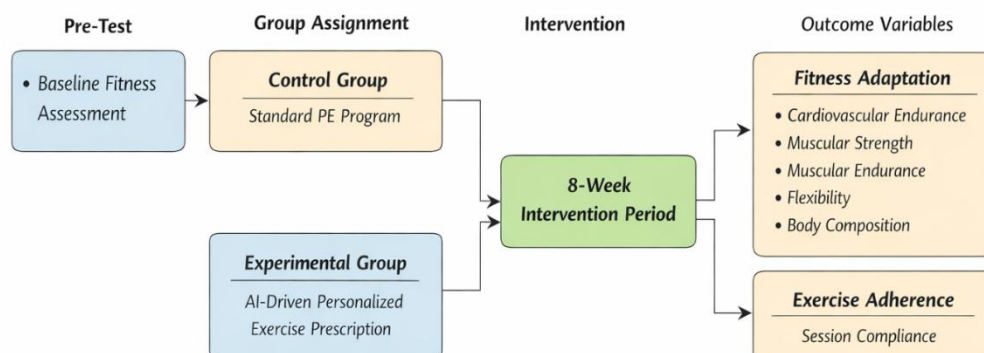
question: What is the impact of implementing AI-based personalized exercise prescriptions on university students' fitness adaptation and exercise adherence?

Conceptual Framework

The study's conceptual framework maps the impacts of artificial intelligence-driven personalized exercise prescription on the fitness adaptation and exercise adherence of university students taking PATHFIT 2. The exercise prescription generated by AI is the independent variable of the study and fitness adaptation and exercise adherence are the dependent variables. Improvements in health-related fitness components (cardiovascular endurance, muscular endurance, muscular strength, flexibility, and body composition) constitute fitness adaptation. The framework posits that AI exercise prescriptions positively affect students' physiological fitness development and the adherence to the exercise prescriptions.

Figure 1

Conceptual Framework of the Study



Methods

Research Design

This study used a quantitative research method with a quasi-experimental design of pretest-posttest control groups to analyze the impact of artificial intelligence personalized exercise prescription on fitness adaptation and exercise adherence of university students taking physical education courses. Given the nature of the study, quantitative research is fitting because it focuses on the collection and statistical breakdown of numerical data to determine patterns, variances, and impacts within defined measurements (Creswell &



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Creswell, 2018). When researchers apply an interventional design, they do so to assess how outcomes change as a result of a particular treatment.

The quasi-experimental pretest–posttest control group design allows comparison of results from participants who received an intervention and those who adhered to a standard program while looking at changes before and after the intervention period (Shadish et al., 2002). Regarding this study, the participants in the experimental group were offered AI-based individualized exercise prescriptions, while those in the control group were given standard exercise routines as part of the university physical education course. Pretest and posttest evaluations were done to analyze the intervention's impacts on the fitness adaptability and exercise adherence of university students.

Respondents and Sampling

The study respondents are students who were enrolled in the Physical Activity Toward Health & Fitness 2 (PATHFIT 2) course in the semester when the study was conducted. PATHFIT 2 forms a part of the university physical education and aims at developing health-related fitness through the use of a structured physical activity and exercise program.

Out of the entire population of students enrolled in PATHFIT 2, 120 students were chosen through simple random sampling, meaning that every student was equally likely to be chosen for the study. After participant selection, the students were assigned to the experimental and control groups through computer-based random group assignment to eliminate assignment bias. The experimental group (n = 60) was involved in the AI-based tailored exercise prescription program, and the control group (n = 60) was involved in the usual exercise activities mandated by the PATHFIT 2 course.

The subjects in the study included students who were PATHFIT 2 and able to take part in some form of moderate physical activity. The participants who had medical conditions that limited their ability to engage in exercise were not included in the study. Based on the sensitivity power analysis using G*Power 3.1, a sample size of 34 is required to identify a medium effect size of ($d = 0.50$) with an alpha of 0.05 and power of 0.8. Since 120 participants were included in the study, the sample size was more than adequate to provide statistically powerful estimates for the group comparison analyses.



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Research Instrument

To achieve methodical rigor, as well as accurate measurement of the variables, assessments of health-related physical fitness, and tools for monitoring adherence were utilized. Adaptation to fitness was gauged using the accepted health-related fitness components as utilized in physical education and exercise science.

Cardiovascular endurance was measured using the 3-Minute Step Test, which assesses recovery heart rate following the completion of a standardized stepping protocol. Muscular endurance was assessed through the Push-Up Test, which assesses the maximum number of push-ups that a participant can complete, with correct form, without any rest, and while maintaining proper form. Flexibility was evaluated using the Sit-and-Reach Test, which assesses the range of motion pertaining to the lower back and the hamstring muscles.

On body composition, assessment was conducted using the Asian-Pacific Body Mass Index, which is a classification that defines body weight status according to the height-weight measurement ratio. Muscular strength assessment was conducted using the Bench Press One-Repetition Maximum (1RM) Test, which assesses the maximum weight a participant can lift for one repetition using correct lifting form. All bench press assessments were conducted by trained personnel, with proper warm-up and safety spots to minimize the risk of injury. Exercise adherence was demonstrated by the collection of digital exercise logs and a structured exercise participation monitoring sheet. Each of the participants manually documented every exercise session that was completed in the exercise intervention. Exercise adherence was defined as the ratio of completed exercise sessions to prescribed exercise sessions and was calculated as a percentage over the eight-week program. To confirm the validity of the logs and the exercise participation records the monitoring logs were reviewed by the researchers at periodic intervals.

Intervention Protocol

The intervention spanned eight weeks, during which participants in the experimental group were given AI-assisted, individualized exercise prescriptions. The guides were developed based on a rule-based algorithm that examines individual fitness assessments.



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The algorithm used guided decision-making rules based on the theory of exercise science to prescribe a given individual the optimal intensity, frequency, duration, and progression of exercise. The system would automatically generate exercise prescriptions to match individual fitness levels, maintaining optimal fitness levels for participants.

The exercises prescribed also addressed the most important disease-preventing fitness-type components of exercise, including cardiovascular endurance, muscular strength and endurance, and flexibility. Changes to the exercise prescription were also employed during the intervention to help participants attain an optimal fitness level, focusing on progressive overload to aid fitness level improvement.

The control group participants all took part in the PATHFIT 2 course, which provided participants generic aerobic, calisthenic, and stretching exercises; all exercise prescriptions were the same. All groups completed exercise for 30-45 minutes on 3 days a week. The digital monitoring system allowed researchers to analyze compliance with prescribed exercise programs, as participants documented each exercise session.

Data Collection Procedure

Participants proceeded through a pretest, implemented an intervention, and completed a posttest to structure data collection. Participants completed baseline physical assessments concerning cardiovascular endurance, muscular endurance, flexibility, muscular strength, and body composition prior to the intervention. These assessments established participants' initial fitness levels and served as pretest measures.

After pretest assessments, participants were divided into an experimental group and a control group. The experimental group was assigned AI-generated, individualized exercise prescriptions while the control group participated in a standard physical education exercise program. Participants were required to document each exercise session throughout the 8-week intervention period in a digital monitoring exercise compliance system.

To establish posttest measures, participants completed the same physical fitness assessments a second time. These data answered the research question regarding changes in fitness adaptation and exercise compliance post participation in the exercise programs.



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Statistical Analysis

Both descriptive and inferential statistical techniques were used to analyze the collected data. Descriptive statistics including mean, standard deviation, and frequency distribution were computed to summarize the demographic characteristics of the respondents as well as their baseline levels of physical fitness and exercise adherence.

To determine changes in fitness adaptation before and after the intervention, paired-samples t-tests were conducted to compare the pretest and posttest scores within each group. To determine whether the AI-driven personalized exercise prescription produced greater improvements compared with the traditional exercise program, independent-samples t-tests were used to compare the posttest scores of the experimental and control groups.

Effect sizes (Cohen's d) were also calculated to determine the magnitude of the observed differences between groups. Exercise adherence levels were analyzed using descriptive statistics and group comparison tests. All statistical analyses were performed using statistical software, and the level of statistical significance was set at $p < .05$.

Ethical Considerations

This research did not violate any ethical principles relating to research involving human participants. Data collection began after obtaining ethical approval from the institutional research ethics committee. All participants were informed about the purpose of the study, the procedures involved, and the potential risks and benefits of participation before data collection began.

Participants were asked to sign an informed consent form indicating their voluntary participation in the study. They were also informed that they had the right to withdraw from the study at any time without any consequences. All collected data were treated with strict confidentiality and were used solely for research purposes.

Results

Table 1 presents the descriptive statistics for the baseline fitness levels of participants in the control and experimental groups prior to the implementation of the intervention. The variables include cardiovascular endurance, muscular endurance,



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muscular strength, flexibility, and body composition measured using Body Mass Index interpreted according to the Asian-Pacific BMI classification.

Table 1

Baseline Fitness Levels of Participants in the Control and Experimental Groups (Pretest)

Fitness Variable	Control Group (n=60) Mean $\pm$ SD	Experimental Group (n=60) Mean $\pm$ SD	t-value	p-value
Cardiovascular Endurance (Recovery HR BPM)	96.4 $\pm$ 8.5	95.8 $\pm$ 8.7	0.39	.698
Muscular Endurance (Push-ups)	18.7 $\pm$ 6.3	19.1 $\pm$ 6.5	-0.34	.732
Muscular Strength (Bench Press 1RM)	42.8 $\pm$ 9.6	43.2 $\pm$ 9.4	-0.23	.817
Flexibility (Sit-and-Reach)	21.4 $\pm$ 6.1	21.8 $\pm$ 6.0	-0.36	.720
Body Composition (BMI)	23.7 $\pm$ 3.4	23.5 $\pm$ 3.5	0.32	.748

The results indicate that there were no statistically significant differences between the control and experimental groups at baseline ($p > .05$) across all fitness variables. Based on the Asian-Pacific BMI classification, the mean BMI scores of both groups fall within the “Overweight (At Risk)” category (23.0–24.9), indicating that the participants began the study with comparable body composition levels.

Changes in Fitness Adaptation within the Control Group

Table 2 presents the comparison of pretest and posttest fitness scores for participants in the control group following the eight-week standard physical education exercise program.

Table 2

Pretest and Posttest Fitness Scores of the Control Group

Fitness Variable	Pretest Mean $\pm$ SD	Posttest Mean $\pm$ SD	Mean Difference	t-value	p-value
Cardiovascular Endurance (Recovery HR BPM)	96.4 $\pm$ 8.5	90.1 $\pm$ 7.9	-6.3	5.11	< .001
Muscular Endurance (Push-ups)	18.7 $\pm$ 6.3	22.9 $\pm$ 6.4	+4.2	6.24	< .001
Muscular Strength (Bench Press 1RM)	42.8 $\pm$ 9.6	47.6 $\pm$ 9.8	+4.8	5.89	< .001
Flexibility (Sit-and-Reach)	21.4 $\pm$ 6.1	24.8 $\pm$ 6.2	+3.4	4.76	< .001
Body Composition (BMI)	23.7 $\pm$ 3.4	23.2 $\pm$ 3.2	-0.5	2.41	.019

The results show that the control group experienced significant improvements across all measured fitness variables following the eight-week exercise program. Although BMI decreased slightly from 23.7 to 23.2, the group average remained within



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the “Overweight (At Risk)” category according to the Asian-Pacific BMI standard, suggesting only modest changes in body composition.

Changes in Fitness Adaptation within the Experimental Group

Table 3 presents the comparison of pretest and posttest fitness scores for participants in the experimental group who followed the AI-driven personalized exercise prescription program.

Table 3

Pretest and Posttest Fitness Scores of the Experimental Group

Fitness Variable	Pretest Mean $\pm$ SD	Posttest Mean $\pm$ SD	Mean Difference	t-value	p-value
Cardiovascular Endurance (Recovery HR BPM)	95.8 $\pm$ 8.7	84.2 $\pm$ 7.3	-11.6	8.34	< .001
Muscular Endurance (Push-ups)	19.1 $\pm$ 6.5	28.4 $\pm$ 7.1	+9.3	9.12	< .001
Muscular Strength (Bench Press 1RM)	43.2 $\pm$ 9.4	54.3 $\pm$ 10.1	+11.1	8.67	< .001
Flexibility (Sit-and-Reach)	21.8 $\pm$ 6.0	29.1 $\pm$ 6.5	+7.3	7.44	< .001
Body Composition (BMI)	23.5 $\pm$ 3.5	22.7 $\pm$ 3.1	-0.8	3.12	.003

The results indicate that the experimental group demonstrated significant improvements in all health-related fitness components after the eight-week AI-driven personalized exercise program. Notably, the mean BMI decreased from 23.5 to 22.7, which shifted the group average from the “Overweight (At Risk)” category to the “Normal” BMI classification (18.5–22.9) according to the Asian-Pacific BMI standard.

Posttest Comparison Between Control and Experimental Groups

Table 4 presents the comparison of posttest fitness scores between the control group and experimental group after the eight-week intervention period.

Table 4

Comparison of Posttest Fitness Outcomes Between Control and Experimental Groups

Fitness Variable	Control Mean $\pm$ SD	Experimental Mean $\pm$ SD	t-value	p-value	Effect Size (Cohen's d)
Cardiovascular Endurance (Recovery HR BPM)	90.1 $\pm$ 7.9	84.2 $\pm$ 7.3	4.18	< .001	0.76
Muscular Endurance (Push-ups)	22.9 $\pm$ 6.4	28.4 $\pm$ 7.1	4.41	< .001	0.80
Muscular Strength (Bench Press 1RM)	47.6 $\pm$ 9.8	54.3 $\pm$ 10.1	3.65	< .001	0.67
Flexibility (Sit-and-Reach)	24.8 $\pm$ 6.2	29.1 $\pm$ 6.5	3.27	.001	0.59
Body Composition (BMI)	23.2 $\pm$ 3.2	22.7 $\pm$ 3.1	1.12	.264	0.20



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The results indicate that the experimental group achieved significantly better outcomes in cardiovascular endurance, muscular endurance, muscular strength, and flexibility compared with the control group. However, no statistically significant difference was observed in BMI between the two groups. Based on the Asian-Pacific BMI classification, the experimental group reached the normal BMI category, whereas the control group remained within the overweight (at risk) range.

Exercise Adherence During the Intervention

Table 5 presents the comparison of exercise adherence levels between the control group and the experimental group throughout the eight-week intervention.

Table 5

Comparison of Exercise Adherence Between Control and Experimental Groups

Group	Mean Sessions Completed	Adherence Percentage	SD	t-value	p-value
Control Group	18.1	75.4%	3.2	7.02	< .001
Experimental Group	21.6	90.0%	2.1		

The results show that students in the experimental group demonstrated significantly higher exercise adherence compared with those in the control group. Participants who received AI-driven personalized exercise prescriptions completed a larger proportion of the prescribed exercise sessions, resulting in a higher adherence rate. This suggests that personalized exercise programming may enhance students' engagement and consistency in participating in physical activity programs within university physical education.

Discussion

Baseline Fitness Levels of Participants

Both control and experimental groups have shown to have similar cardiovascular endurance, muscular endurance, muscular strength, flexibility, and body composition prior to the intervention, according to the baseline assessment. Matched pair random assignment showed to have worked well as there were no statistically significant differences in physical fitness. This type of equivalence is essential in intervention research to show physical changes in the subjects are due to the program and not from the



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physiological differences of the subjects prior to the exercise program. For research in physical education, the equivalence in baseline condition has been shown to enhance the internal validity for research and shows where the impact of research will be evaluated for impact.

In addition, the baseline BMI results show that the average body composition of the students in both groups is in the 'overweight' (at risk) category (by the Asian-Pacific BMI classification). This is similar to the average body composition situation of the student population in the university, which is characterized by a majority of students with moderate levels of fitness and numerous body composition and physical fitness problems. Such results point to the need for more formalized exercise instruction in the university physical education curriculum. Students with fairly similar and moderately conditioned fitness levels to each other, fitness-focused curricula can help achieve beneficial changes in health-related fitness levels.

These findings are in line with the body of work focusing on the importance of organized physical activity programs on the students' minimum physical fitness levels on which they start. Mohammed (2016) found that organized physical activities such as basketball and swimming offered in university settings lead to positive changes in students' body composition, and levels of cardiorespiratory and muscular endurance. The study showed that structured sports activities, even in university physical education programs, can create a base level of fitness on which further fitness training can be built.

Fang et al. (2024) noted that physical activity programs targeting university students showed positive changes in students' overall physical activity, moderate and vigorous physical activities, and the number of steps students take in a day. The authors explained that students continue participating in a program and, over time, students develop a foundation where they are better able to perform the program's exercises. This means university students who take a physical activity course likely have the same fitness level.

Huang and Luo (2024) reported that university students' scores on fitness tests measuring following physical fitness components: flexibility, endurance, and lung capacity, are improved by taking elective physical education classes that feature basketball, aerobics, and badminton. This means university physical education classes



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often create the same fitness level in students. Students who take the same or types of physical education classes and have a similar fitness level often receive the same fitness stimuli. This means the (fitness) test results of the participants reflect the availability of physical activity on campus.

AI-Driven Personalized Exercise Prescription and Fitness Adaptation

The current study reveals that participants of the AI-driven individualized exercise prescription program vastly outperformed participants of the conventional physical education program in terms of cardiovascular endurance, muscular endurance, muscular strength, and flexibility. These findings indicate that the AI-driven individualized training prescriptions optimize the physiological adaptations of exercise. Unlike conventional physical education programs that provide the same exercise routine for all participants, individualized prescriptions provide the flexibility to adjust exercise intensity, volume, and progression based on the individual's starting fitness level and their response to training. Thus, students may receive training stimuli that are more appropriate for their physical potential, and more physiological adaptations may be realized during the intervention period.

Among recipients of AI-generated exercise prescriptions, behavioral engagement has been positively impacted as shown by the improved exercise adherence. This initiative has sparked the notion that exercise prescriptions may be positively correlated with behavior modification processes. When exercise prescriptions are designed with the end-user in mind by incorporating their specific needs and defined objectives, motivation to exercise may strengthen. In university physical education, students come from diverse fitness backgrounds and exercise preferences and the use of these unique strategies may be the solution to the problems facing typical exercise prescriptions. Ultimately, personalized solutions may enhance training effectiveness and foster a more positive environment that encourages engagement in physical activity.

Both AI exercise guidelines and the positive impacts of personalized exercise prescriptions have been explored in current literature. Tan et al. (2024) stated that AI exercise prescription frameworks and personalized exercise prescriptions yield positive health benefits. This is because of the system developing and modifying individualized exercise prescriptions that are aligned with the specific needs of the participant. In



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addition, the authors found that the AI-supported exercise prescription group reported improved health, higher participation, and more active participants than the standard care group. This study also posits that personalized exercise guidance, via AI, is a move away from general exercise prescriptions, which are not aligned with the needs of the participant, toward more individualized and adaptive exercise guidelines.

The same argument applies to Doherty et al. (2024), who state that user satisfaction and exercise intensity can be improved if the training recommendations are modified as users engage with the exercise app and provide feedback. They also claim that with the appropriate use of machine learning, the exercise prescription(s) will be able to vary as the individual(s) continue to (or complete) the training program (s) and assist the individuals to reach their fitness goals at the program(s) desired level of difficulty. This is especially the case for university students as their fitness levels vary and they respond to training at different rates throughout the semester.

Likewise, in a study by Lin et al. (2023), participants who used adaptive exercise programs (i.e. exercise programs that change based on the user's individual performance) improved in muscular strength, flexibility, and aerobic endurance. The authors noted that smart fitness technology's adaptive exercise programs lead to a better individual physiological response of the participants. The same explanation may justify why the participants in the current study achieved better performance when compared to traditional PE programs, especially when AI-powered personalized exercise routines are implemented.

Exercise Adherence and Technology

According to the current study, students that took part in the AI-based customized exercise prescription developed far greater exercise adherence than those that took part in the regular physical education classes. This particular study suggests that personalized exercise prescriptions, facilitated by digital monitoring, may help students focus on fully completing each exercise session. Physical education classes are taught with the expectation that all students will complete the same exercises, but this does not take into consideration the students' individual physical capabilities, motivational factors, or specific fitness goals. Conversely, individual exercise prescriptions allow students to complete exercise goals that are more appropriate to their abilities and developmental



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level. This perception of the exercise goal will increase their likelihood of engaging with the exercise sessions while the intervention is active.

Another reason the experimental group may be so highly adhered could be the motivational input that the students get from the technology-based monitoring. For the students, keeping track of their physical activities could have them feel responsible for tracking their activities, and may also provide feedback on their activities. The students may have developed positive feelings about physical activity and therefore, chose to stay in the program. Technology provides the students the feedback that is necessary for them to develop the exercise habit that is the ultimate goal of the program. In university settings where the program is scheduled and may compete for the time that students could be using their time for exercising, the technological support may function to the greatest extent to keep the students in the program.

The current study also supports the previous findings on the impact of the students' physical activity in relation to the technology used. College students who used a fitness app adhered to the exercise program more than any of the other students. The students that used digital platforms for their fitness increased their exercise commitment and felt more in control to exercise and also had a better experience when they exercised. When students regularly used the fitness app that also gave them support and feedback, they also increased their commitment to exercising and were more likely to stick to their exercise goals.

Parker et al. (2021) discussed digital platforms and how they help maintain physical activity behavior when an individual exercise environment is unavailable. According to their study, those engaging with digital fitness platforms were more likely to reach the recommended level of activity compared to those who did not engage with fitness technology. This indicates that technology-assisted exercise systems are a viable option to help those who are not active by removing barriers to physical activity.

Psychological factors, in addition to technology, are also important for sustaining exercise adherence among university students. An et al. (2024) identified that the exercise adherence is impacted by sports emotional intelligence and self-efficacy, which were also found to be mediators of the relationship between exercise participation and exercise



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adherence. Confidence in an individual's ability to perform an exercise and the subsequent positive emotional response, are predictors of an individual's ability to maintain engagement in a structured exercise program. This is one reason why sustained engagement in exercise programs is often seen with the combination of personalized exercise prescriptions and supportive monitoring systems.

Self-Determination Theory and Exercise Participation

The Self-Determination Theory may serve as another explanation for the elevated exercise adherence among students who utilized the AI-based personalized exercise prescription. Since students possess highly variable exercise and motivational profiles within university physical education classes, responsive and individualized exercise programming can provide students with the opportunity to feel a greater sense of autonomy and competence. This may change students' perception of the exercise from being a mandatory requirement to a valuable endeavor, and therefore, increase retention for physical activity programs when students perceive a positive alignment between the exercise experience and their goals and abilities.

Furthermore, personalized exercise prescriptions can also help to create a positive learning environment by enhancing students' psychological involvement with exercise. A psychologically positive involvement can occur when students have their exercise programs personalized and participate in a program that is flexible and adapts to their performance and allows for modifications as they progress. When students can adapt their exercise program and continue to meet the goals they have set for themselves, they may feel a greater sense of mastery, leading to increased confidence in their physical abilities, increased enjoyment in physical activity and effortless participation. A positive psychological involvement may also be the reason why exercise behavior is progressively improved over the course of the program, even when students' motivation is diminished by the stresses of their academic responsibilities.

These assertions are consistent with studies focusing on self-determined motivation and its role in the maintenance of physical activity behaviors. Klain et al. (2015) observed that participants with stronger satisfactions of the psychological needs of autonomy, competence, and relatedness, showed superior engagement in structured exercise programs. This implies that participants are likely to internalize exercise

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behaviors and keep practicing physical activity, when exercise settings promote a sense of control and capability.

In the same sense, Teixeira et al. (2024) showed that when exercise programs are designed with rationality and complexity in mind, users' motivation will increase through the layers of the program. It is well understood that the motivational gap of program participants will be minimized. This underscores the assumption that in educational settings, individualized exercise prescriptions are utilized, especially when the participants are heterogeneous in terms of their level of available physical activities and motivation.

Building on these perspectives, McMillan et al., (2023), noted that the most impactful psychological factor that drives physically active university students to sustain exercise participation is the sense of competence. As per their study, students who viewed themselves as competent enough to carry out the exercise-related tasks were more inclined to sustain their participation in physical activity over a prolonged period. The focus on perceived competence offers additional reasoning, for the likely retention of students in university physical education classes that incorporate personalized exercise prescriptions, as students tend to comply more with exercise prescriptions that involve adjustable training difficulty in accordance with their performance.

Personalized Training and Fitness Adaptation

The present study indicates AI-enabled personalized exercise prescriptions produced better improvements in multiple health-related fitness components than the standard physical education curriculum. This helps in understanding how the construction of exercise prescriptions according to the individual physiological capabilities and evolution of each student can allow for more optimal training adaptations. Most traditional physical education curricula require students to perform the same physical activities. The purpose of this is to ensure every participant, irrespective of the initial fitness level, achieves some improvement in their overall fitness. However, exercise stimulus is often necessary for individuals with higher levels of fitness. On the other hand, personalized exercise prescriptions can adjust training intensity, volume, and progressive overload according to individual responses. Thus, they can provide more effective exercise stimuli required for physiological improvements.



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In addition, there is the question of how consistency in response to the exercise-training program is perceived. For those undertaking the same exercise program, the capacity, recovery, and individual physiological variables lead to differing adaptations. Systems for prescribing exercise in a more personalized manner have attempted to capture this phenomenon by adjusting the exercise variables to the individual's capacity and progress over time. Personalized programs may therefore help to bridge the gap between the difficulty of the exercise and the ability of the participant. This may allow students to train within their most optimal zone of proximal development. Adaptive exercise strategies may also explain the improvements in cardiovascular endurance, muscular strength, and muscular endurance of study participants receiving AI exercise prescription in the current study.

Individualized strategies have also been proven in endurance training studies. The study by Nuuttila et al. (2022) showed improvement of endurance performance of recreational runners undertaking individual exercise training (IT) based on physiological guides vis a vis those executing the same training program (ST). Participants of the IT have shown most significant decrease in their running times. They also had a high ratio of high responders to training which reinforced the idea of exercise prescription based on individualized physiological traits for optimal training response.

Düking et al. (2020) described how training guided by physiological factors (e.g., heart rate variability) led to greater improvements in running and submaximal physiological parameters, as opposed to training that is based on fixed prescriptions. This study argues that because physiological factors can be monitored, training intensity can be changed on the go to optimize adaptations and minimize the risk of overtraining. This evidence reinforces the idea that exercise prescriptions that take the individual's physiological factors into account produce better training outcomes than standard exercise prescriptions.

Another example of individualized exercise prescription is provided by Weatherwax et al. (2024) who showed that individualized ventilatory threshold cardiorespiratory training programs won in the race of the aided victories of VO_2max and muscular fitness improvements against the traditional training methods that were based on generalized heart rate zones. Their study confirms the importance of individually



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tailored exercise prescription to cardiorespiratory and muscular fitness. In the light of all studies, the AI-powered exercise prescriptions in this study are targeted to be the most productive training prescriptions in the improvement of fitness adaptations for students in physical education classes.

Practical Implications

The analysis of this study shows that university physical education instructors could benefit from the use of AI-generated personalized exercise prescriptions, as this could improve students' level of engagement and overall fitness. Unlike standard exercise programs, which do not account for the differing exercise needs of students, personalized programs offer instructors the opportunity to customize improvement plans for individual students that fit their progress and exercise goals. Most university students possess a wide range of exercise abilities, and this focus could increase participation. Digital monitoring and personalized exercise recommendations may help instructors offer a greater variety of physical education classes that encourage higher levels of activity and greater emphasis on exercise for students.

Conclusions

This study focused on how an AI-based personalized exercise prescription impacts fitness and adherence to exercise plans within university physical education students. The AI-generated personalized exercise program showed better progress in various health-related fitness components, while also showing a higher exercise adherence in comparison to traditional physical education exercise programs. These findings suggest that the use of technology for personalized exercise programs can effectively customize physical education programs for different levels of fitness and varying levels of motivation. Therefore, the use of AI exercise prescription technology in physical education programs at the university level can positively influence students' fitness levels and maintain students' engagement in physical activities.

Limitations of the Study

Along with the informative discoveries made in this research, there are some shortcomings that must be noted first. Because the duration of the intervention period in question was eight weeks, this might not be long enough to account for the significant long term physiological changes that can be observed, especially in body composition.



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The study also included participants from only one university, therefore, this also contributes to the little flexibility to which the results can be assigned to other student bodies or schools of different university educational levels. During the study, to assess the participants' body composition, only the Body Mass Index was utilized, therefore, this may not be enough to account for the changes, even slight of body fat, or the lean muscle mass which may also be affected. The AI-based exercise prescription system did recommend an exercise plan designed for each individual user; however, the algorithm just implemented some rules without a system of feedback in order to learn from user interactions, which may also be a factor in the lack of personalization.

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