Al-Rafidain J Med Sci. 2026;10(1):276-284.
DOI: https://doi.org/10.54133/ajms.v10i1.2746

AJMS
Online ISSN (3219-2789)

Research Article

Smartwatch-Based Multidimensional Training Program to Improve Holistic Health Outcomes in Sedentary Adults

Hariadi Hariadi[1]*, Imran Ahkmad[1], Andarias Ginting[2], Khairul Usman[3], Syed Kamaruzaman Bin Syed Ali[4], Randi Kurniawan[5]

[1]Department of Physical Education, Health, and Recreation, Faculty of Sports Science, Universitas Negeri Medan, Indonesia; [2]Department of Sports Coaching Education, Faculty of Sports Science, Universitas Negeri Medan, Indonesia; [3]Department of Preschool and Elementary School Education, Faculty of Education, Universitas Negeri Medan, Indonesia; [4]Department of Educational Foundations and Humanities, Faculty of Education, University of Malaya, Malaysia; [5]Department of Sports Science, Faculty of Sports Science, Universitas Negeri Medan, Indonesia

Received: 8 January 2026; Revised: 5 March 2026; Accepted: 9 March 2026

Abstract

Background: Sedentary lifestyles are a growing public health concern associated with increased cardiometabolic risk, reduced physical fitness, and impaired psychological well-being. Although smartwatches enable continuous health monitoring, their potential to support structured, multidimensional exercise interventions for holistic health improvement remains underutilized among sedentary adults. ***Objective***: To develop and evaluate the effectiveness of a Smartwatch-Based Multi-Dimensional Training Program (SBMTP) designed to improve holistic fitness, encompassing physical, psychological, and emotional health, in sedentary adults. ***Methods***: Research and development using the ADDIE model was employed to develop the SBMTP application, which integrated real-time smartwatch data to deliver personalized, multidimensional exercise guidance. The six-week intervention in sedentary adults was evaluated using physiological and subjective fitness measures and user surveys, with pre-post changes analysis. ***Results***: The six-week intervention led to substantial enhancements in all fitness metrics, including decreases in resting heart rate and body mass index, as well as increases in running distance, exercise duration, calories expended, and subjective fitness assessments ($p<0.05$). User evaluation demonstrated high feasibility and acceptability, with application suitability rated at 96.6%, program suitability between 89.3% and 90.3%, user satisfaction at 87.5%, and overall positive feedback reaching 91.0%, indicating strong user acceptance and functional effectiveness. ***Conclusions***: The smartwatch-based multidimensional training program represents a feasible and well-accepted digital health intervention that effectively enhances holistic fitness through personalized, data-driven exercise guidance. These findings demonstrate the potential of wearable technology to support preventive health strategies and promote sustainable lifestyle changes among sedentary adults.

Keywords: Holistic fitness; Multidimensional training; Sedentary adults; Smartwatch-based program; Wearable technology.

برنامج تدريب متعدد الأبعاد قائم على الساعة الذكية لتحسين النتائج الصحية الشاملة للبالغين الخاملين

الخلاصة

الخلفية: أنماط الحياة الخاملة هي مشكلة متزايدة في الصحة العامة مرتبطة بزيادة امراض القلب، وانخفاض اللياقة البدنية، وضعف الصحة النفسية. على الرغم من أن الساعات الذكية تتيح المراقبة الصحية المستمرة، إلا أن قدرتها على دعم تدخلات التمارين المنظمة ومتعددة الأبعاد لتحسين الصحة الشاملة لا تزال غير مستغلة بشكل كاف بين البالغين الخاملين. **الهدف**: تطوير وتقييم فعالية برنامج تدريب متعدد الأبعاد قائم على الساعة الذكية (SBMTP) مصمم لتحسين اللياقة الشاملة، التي تشمل الصحة الجسدية والنفسية والعاطفية، لدى البالغين الخاملين. **الطرق**: تم البحث والتطوير باستخدام نموذج ADDIE لتطوير تطبيق SBMTP، الذي دمج بيانات الساعة الذكية في الوقت الحقيقي لتقديم إرشادات شخصية متعددة الأبعاد للتمارين. تم تقييم التدخل الذي استمر ستة أسابيع لدى البالغين الخافتين باستخدام مقاييس اللياقة الفسيولوجية والذاتية واستبيانات المستخدمين، مع تحليل قبل التغييرات بعد التغيير. **النتائج**: أدى التدخل الذي استمر ستة أسابيع إلى تحسينات كبيرة في جميع مقاييس اللياقة البدنية، بما في ذلك انخفاض معدل ضربات القلب أثناء الراحة ومؤشر كتلة الجسم، بالإضافة إلى زيادة في مسافة الجري، ومدة التمرين، والسعرات الحرارية المستهلكة، والتقييمات الذاتية للياقة (ص<0.05). أظهر تقييم المستخدمين جدوى وقبولا عاليين، حيث كانت ملاءمة التطبيق 96.6٪، وملاءمة البرنامج بين 89.3٪ و90.3٪، ورضا المستخدمين بنسبة 87.5٪، ووصول ردود فعل إيجابية إجمالية إلى 91.0٪، مما يشير إلى قبول قوي للمستخدمين وفعاليتهم الوظيفية. **الاستنتاجات**: يمثل برنامج التدريب متعدد الأبعاد القائم على الساعة الذكية تدخلا صحيا رقميا ممكنا ومقبول على نطاق واسع، يعزز اللياقة الشاملة بشكل فعال من خلال إرشادات تمارين مخصصة ومبنية على البيانات. تظهر هذه النتائج إمكانات التكنولوجيا القابلة للارتداء لدعم استراتيجيات الصحة الوقائية وتعزيز تغييرات نمط الحياة المستدامة بين البالغين الخاملين.

* ***Corresponding author***: Hariadi Hariadi. Department of Physical Education, Health, and Recreation, Faculty of Sports Science, Universitas Negeri Medan, Indonesia; Email: hariadi@unimed.ac.id

Article citation: Hariadi H, Ahkmad I, Ginting A, Usman K, Bin Syed Ali SK, Kurniawan R. Smartwatch-Based Multidimensional Training Program to Improve Holistic Health Outcomes in Sedentary Adults. *Al-Rafidain J Med Sci*. 2026;10(1):276-284. doi: https://doi.org/10.54133/ajms.v10i1.2746

INTRODUCTION

Holistic fitness has become an important paradigm in physical education, as it emphasizes the integration of physical, mental, emotional, and social health as a single entity that influences one another [1,2]. This comprehensive understanding aligns with the biopsychosocial model proposed by Hohmann et al. [3], which elucidates that optimal human functioning arises from the dynamic interplay of biological, psychological, and social factors. In line with this perspective, the concept of physical literacy proposed by [4,5] emphasizes that physical competence, motivation, self-confidence, and knowledge are inseparable components that support community involvement in lifelong physical activity. With this framework, various experts emphasize the importance of multidimensional training models to comprehensively improve human adaptation, resilience, and performance [6]. Although the theory of holistic fitness is growing stronger, practices in the field often do not reflect an integrated approach. Various exercise programs still focus on specific physical aspects such as muscle strength or cardiovascular endurance [7], while mental aspects, emotional regulation, and behavioral compliance are often neglected [8]. On the other hand, modern lifestyles full of sedentary activities and digital dependence have reduced physical activity levels and negatively impacted mental health, as reported by [9-11]. Meanwhile, wearable technology such as smartwatches is indeed growing in popularity, but research shows that users generally only utilize basic features such as step counters or heart rate monitors without integrating the data into appropriate exercise decision-making, as described by [12,13]. Thus, the application of the concept of holistic fitness in practice is still not optimal. This condition indicates a significant gap between theoretical expectations and empirical implementation. Several studies have attempted to bridge this gap through the use of digital technology in exercise interventions [14-16]. Mobile phone-based health applications have been shown to increase adherence to physical activity [17]. Gamification strategies have been shown to increase motivation and engagement, as found by [18-20]. Wearable-based monitoring has also been shown to help regulate the intensity of aerobic exercise [21]. However, the literature also notes that there is debate. Some experts [22] emphasize the importance of personalizing exercise based on data generated by wearable sensors, but other experts [23] argue that existing digital interventions lack a strong pedagogical foundation and do not integrate various dimensions of fitness into a coherent exercise model. Critically, there is no systematically constructed and empirically validated learning or instructional model for utilizing smartwatch data in multidimensional exercise programs. In summary, the main issue in the scientific discussion is that there is no smartwatch-based exercise system that can turn real-time health data into flexible and complete exercise recommendations backed by research. Other researchers [24] emphasize the need for personalized, technology-supported training strategies that combine physiological monitoring, cognitive engagement, emotional support, and behavioral reinforcement. The development of SBMTP, a multidimensional smartwatch-based training model, aims to operationalize the principles of holistic fitness. This study uses the ADDIE instructional design approach to make sure that the development of the model is organized, focused on users, and includes ongoing evaluation, which is not commonly seen in research on training with wearables. Therefore, the purpose of this study is to develop and evaluate a smartwatch-based multidimensional training model to improve holistic fitness through a structured instructional approach. This research is highly urgent because it directly addresses the gap between theory and practice, provides technology-based pedagogical innovation in physical education, and offers a model that can meet the community's need for integrated, personalized, and technology-based training solutions.

METHODS

Study Design

This study uses the Research and Development (R&D) method by adopting the ADDIE model, which consists of the Analysis, Design, Development, Implementation, and Evaluation stages. The ADDIE model was chosen based on the need for a systematic and structured approach in developing technology-based training products so that each stage of development can be tested, verified, and revised sequentially [25]. This model is relevant to the research objective, which is to develop a Smartwatch-Based Multidimensional Training Program (SBMTP) as a holistic training model that utilizes real-time data from wearable devices. The ADDIE model provides a framework that allows researchers to analyze needs, design multidimensional training content, develop application prototypes, conduct field trials, and perform comprehensive evaluations of the feasibility of the developed product.

Study participants

Participants in this study were individuals with sedentary characteristics, namely people who had low levels of physical activity, often sat for long periods of time, and were in poor physical condition. Sedentary groups were selected because they were the population most in need of technology-based multidimensional exercise interventions to improve their overall fitness. Participants were recruited using purposive sampling with inclusion criteria of having used a smartwatch for at least the past three months, having low daily physical activity, having an initial fitness index in the poor category, and being willing to consistently follow the SBMTP. The study involved a total of 100 sedentary participants. In the initial small-scale pilot phase, 25 participants were involved to test the initial prototype and provide feedback on the functionality of the application. Subsequently, 75 sedentary participants took part in the full implementation phase for six weeks to assess the practicality and effectiveness of the model in improving holistic fitness. All participants exhibited sedentary lifestyles based on smartwatch data, such as low daily step counts, minimal duration of moderate- to high-intensity activities, and initial physiological fitness parameters that were below standard (Table 1).

Research procedure

This research is a development study that resulted in an application program designed for widespread use as a multi-dimensional training program based on smartwatches, which supports holistic fitness for its users. This research used the ADDIE (Analysis, Design, Development, Implementation, Evaluation) development model. Based on Figure 1, the analysis stage looked at issues causing low overall fitness in inactive people, such as not having personalized training, not using smartwatch features enough, and lacking training models that use health data.

Table 1: Scale and Average Characteristics of Sedentary Participants (n= 100)

Variable	Scale	Result	Category
Age (year)	22 – 50	34.8±7.6	Adult
Daily Steps (steps/day)	2.400 – 3.500	2.980±310	Sedentary (WHO < 5,000 steps)
Sitting duration (hr/day)	8 – 11 hrs	9.6±1.0	High (risk of sedentary lifestyle)
BMI (kg/m²)	24.3 – 32.1	28.4±2.1	Overweight – Class 1 Obesity
Initial fitness level	Insufficient – Not Fit	Majority “Less”	Low fitness level
Stress Level (Smartwatch)	Moderate – High	68.2±9.3	Moderate–High stress
Weekly Activity (minutes of moderate/vigorous activity)	< 60 min	± 35 minutes	Very low (WHO standard ≥ 150 min)
Resting heart rate (Resting HR)	75–95 bpm	84.6±5.8	Tends to be unfit

Values are presented as mean±SD.

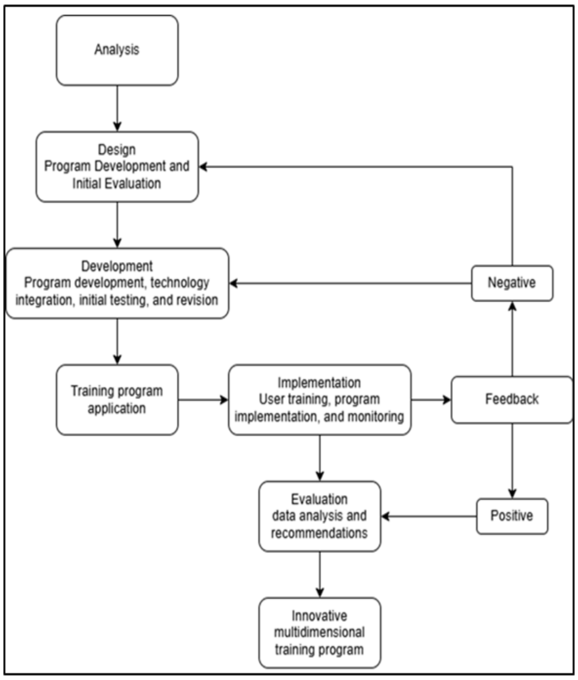

Figure 1: The research procedure used the ADDIE development model.

The needs analysis was performed via a literature review, an examination of smartwatch features, and the identification of user characteristics, including exercise patterns, physical activity intensity, and monitoring requirements. This stage resulted in development objectives and fitness indicators that became the basis for SBMTP design. The design phase focused on formulating exercise goals, developing a multidimensional exercise model framework, and creating an application storyboard. The exercise content included cardiorespiratory, strength, mobility, balance, recovery, and mindfulness components. In addition, research instruments such as expert questionnaires, observation sheets, and evaluation formats were designed to ensure that the validation process could be carried out systematically. During the development phase, a preliminary prototype of the SBMTP was constructed according to the established design, incorporating physiological data captured by a smartwatch. The prototype was tested on 25 participants to assess its functionality, feasibility, and user response. Expert validation of the material and media experts using a Likert scale was conducted to assess the feasibility of the content, appearance, and navigation, which then became the basis for product revisions prior to full-scale implementation. The implementation phase was conducted on 75 sedentary participants over six weeks. Participants were given initial training on the use of the application and smartwatch features. The program was implemented in a real-world context with real-time monitoring of heart rate, daily activity, stress, and sleep quality. The app gave automatic feedback on how to change the intensity of the exercise. The evaluation phase consisted of formative evaluation via expert assessment and initial trials, alongside summative evaluation following complete implementation. The evaluation assessed the effectiveness of SBMTP based on changes in physical fitness, sleep quality, stress regulation, VO_2max improvement, and user perceptions of the benefits and convenience of using the application. The evaluation results were used to determine the final feasibility of this smartwatch-based exercise model.

Ethical considerations

All participants provided written informed consent, and the protocol was approved by the Institutional Review Board of Universitas Negeri Medan (Approval No: 13.02/KEP-UNIMED/11/2025), in accordance with the Declaration of Helsinki.

Statistical analysis

Descriptive statistics were used to summarize the characteristics of sedentary participants and the values of all fitness parameters before and after the intervention, namely Resting Heart Rate (bpm), BMI (kg/m²), Subjective Fitness Score (1–10), running distance (km), exercise duration per session (minutes), and calories burned per session (kcal). The Shapiro–Wilk normality test was used to ensure that the data distribution met the parametric assumptions, while Levene's test of variance homogeneity was used to assess variance uniformity. Changes in each parameter before and after the use of SBMTP were analyzed using a paired sample t-test to determine the effectiveness of the intervention. The level of statistical significance was set at $p < 0.05$. All analyses were performed using SPSS software version 25.0 (IBM Corp., Armonk, NY, USA).

RESULTS

The results of this study describe how the integration of smartwatches as real-time fitness monitoring devices plays an important role in supporting the implementation of the Smartwatch-Based Multidimensional Exercise Program (SBMTP). The use of smartwatches enables the objective collection of physiological data, including heart rate, calories burned, distance traveled, and exercise duration, so that the exercise process can be monitored with precision. Through the use of this technology, all participants can carry out the training program safely, measurably, and in accordance with their individual physical capacities, while researchers obtain accurate data to evaluate holistic fitness changes during the intervention period. A needs analysis was conducted to identify key issues in improving holistic fitness and determine aspects that should be developed in a smartwatch-based exercise program. Data was obtained through questionnaires and interviews with 25 respondents with moderate to low levels of physical activity. The results of the sedentary behavior survey (Table 2) form the basis for formulating program development needs.

Table 2: Results of needs analysis and sedentary behavior profile of 25 respondents

Variables Measured	Category	Respondents n(%)
Gender	Male	12(48)
	Female	13(52)
Age (years)	18–25	10(40)
	26–35	8(32)
	36–45	5(20)
	>45	2(8)
Duration of sitting per day	< 4 hours	3(12)
	4–6 hours	6(24)
	7–9 hours	9(36)
	≥ 10 hours	7(28)
Screen time (TV/mobile phone/computer) per day	< 2 hours	2(8)
	2–4 hours	7(28)
	5–7 hours	10(40)
	> 7 hours	6(24)
Light physical activity (walking, light exercise, etc.)	< 2 day/week	8(32)
	3–4 day/week	10(40)
	≥ 5 day/week	7(28)
Habit of taking breaks from sitting (every hour)	Yes, regularly	9(36)
	Sometimes	11(44)
	Never	5(20)
Main reasons for sedentary behavior	Work/studies	14(56)
	Entertainment (watching TV, playing with my phone)	8(32)
	Laziness	3(12)

The results of the needs analysis show that the majority of respondents have a highly sedentary behavior profile. Most respondents sit for more than 6 hours per day (64%), with 36% sitting for 7–9 hours and 28% sitting for ≥10 hours. Screen time is also quite dominant, with 40% of respondents using digital devices for 5–7 hours per day. The level of light physical activity remains low, as only 28% of respondents are active ≥5 days per week, while 32% are classified as inactive. In addition, 44% of respondents only occasionally took breaks from sitting, and 20% never did so. The main factors contributing to sedentary behavior were work or study (56%), followed by screen-based entertainment activities (32%). These findings indicate the need for technology-based exercise interventions that can increase physical activity and monitor sedentary behavior more effectively. The training program is designed with a progressive approach over 6 weeks. This training program is designed by combining various aerobic movements with rhythmic music, thereby improving movement coordination, muscle endurance, and calorie-burning efficiency. In addition to strengthening the cardiovascular system, this series of exercises also contributes to improved balance, agility, and overall motor skills. Figure 2 shows the interface design and main feature structure of the Smartwatch-Based Multidimensional Training Program (SBMTP) application. This design includes three main components, namely core features for monitoring multidimensional activities such as steps, heart rate, VO_2max, sleep quality, stress, and personalized aerobic exercises through the AI-Coach system. The middle section shows the main display of the application, which displays the Holistic Fitness Index (HFI), daily exercise recommendations, and fitness progress visualization. Meanwhile, the analytics and reporting features provide a holistic fitness dashboard, progress charts, and weekly or monthly reports that can be exported. Integration with various brands of smartwatches, automatic synchronization, real-time monitoring, and data security are shown in the additional section of the system. Overall, this image depicts SBMTP as a wearable technology-based holistic fitness app with smart analytics to support users' multidimensional fitness improvement. The exercise program developed in this study is a program tailored to the needs of its users (Table 3). The development of the SBMTP application was carried out based on the design that had been prepared in the design stage so that all feature components, usage flows, and program structures could be implemented systematically. Regarding the development process, the results of development at this stage show that the SBMTP application has been successfully designed with a systematic and easy-to-use onboarding flow.

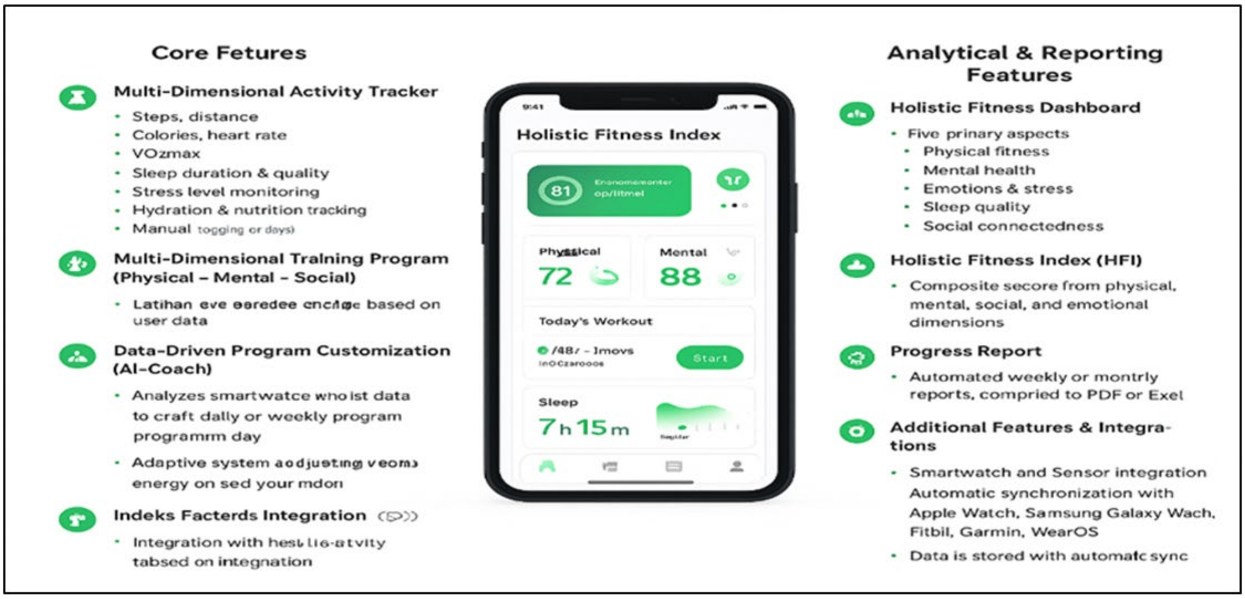

Figure 2: Main Feature Design of the SBMTP Application.

Table 3: Aerobic exercise programs offered can be adjusted to the participants' conditions

Phase	Week	TD	Type of Aerobic Exercise	Intensity	Duration/Set (Repetitions)	Total time (min)	Description
Phase 1	1	Monday	Light jogging	50–60% HRmax	3×8 min (rest 2 min)	24	Focus on cardiovascular adaptation
	1	Wednesday	Skipping (jumping rope)	50–60% HRmax	5×1 min (rest 1 min)	5(active)	Coordination + endurance
	1	Friday	Low-impact aerobic exercise	50–60% HRmax	4×5 min (rest 1 min)	20	Low impact movements
Phase 2	2	Monday	Jogging + brisk walking intervals	55–65% HRmax	4×7 min	28	Variation in tempo
	2	Wednesday	Skipping + jumping jack	55–65% HRmax	6×1 min	6(active)	Combination of movements
	2	Friday	Low-impact aerobics	55–65% HRmax	4×6 minute	24	Increase repetitions of movements
	3	Monday	Moderate jogging	60–70% HRmax	3×10 min	30	Increase duration
	3	Wednesday	Fast skipping	60–70% HRmax	6×1,5 min	9(active)	Increase intensity
	3	Friday	Medium-impact aerobics	60–70% HRmax	4×7 min	28	More dynamic movements
Phase 3	4	Monday	Interval running (2 minutes running + 1 minute walking)	65–75% HRmax	8 siklus	24(active)	Interval training
	4	Wednesday	Skipping + light burpees	65–75% HRmax	6×2 min	12(active)	Increased strength
	4	Friday	Medium-impact aerobic exercise	65–75% HRmax	4×8 min	32	Increased volume
	5	Monday	Moderate running	70–80% HRmax	3×12 min	36	Improved cardiopulmonary capacity
	5	Wednesday	Fast skipping + jumping jacks	70–80% HRmax	8×1.5 min	12(active)	Power training
	5	Friday	High-impact aerobic exercise	70–80% HRmax	4×9 min	36	Intensity surge
Phase 4	6	Monday	Interval running (3 minutes running + 1 minute walking)	75–85% HRmax	8 cycles	32(active)	Peak performance
	6	Wednesday	Fast skipping + burpees	75–85% HRmax	8×2 min	16(active)	Combination of stamina + strength
	6	Friday	High-impact aerobic exercise	75–85% HRmax	4×10 min	40	Maximum intensity

Note: TD = Training day, HRmax = Heart rate maximal

The initial display of the application begins with a splash screen that displays the logo and tagline as the main visual identity. After that, users are directed to the welcome screen, which provides a brief explanation of the holistic wellness concept that forms the basis of SBMTP development so that users understand the purpose and benefits of the application from the start. In the next stage, users enter the registration or login process through several options, namely using email, Google account, or Apple ID. The onboarding system also allows direct synchronization with various types of smartwatches, such as Apple Watch, Fitbit, Garmin, and Samsung, so that users' physiological data can be automatically connected to the application. After the authentication process is complete, users fill in the initial settings, which include personal information such as age, height, weight, gender, and exercise goals, as shown in Figure 3.

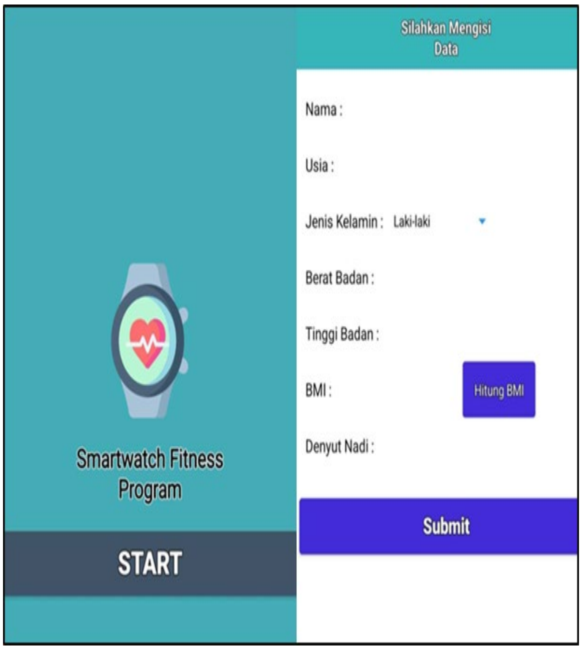

Figure 3: Application home screen.

In addition, users are also asked to select their preferred exercise dimensions to focus on, whether it be physical, mental, social, or the overall dimensions of holistic fitness. The interface development results show that the SBMTP application has a concise and functional navigation structure. The home page displays a summary of the Holistic Fitness Index (HFI) and daily statistics such as heart rate, steps, stress, sleep, and exercise recommendations. The exercise program menu provides an AI-coach-based automatic schedule, thematic programs such as yoga, HIIT, and meditation, as well as weekly progress indicators that connect directly to a smartwatch when a session begins. The Mind and Mood menu contains mood trackers, guided meditations, breathing exercises, reflective journals, and stress statistics. The report's menu displays graphs of physical activity, sleep, stress, and emotions, as well as a comprehensive holistic fitness index with AI-based adaptive recommendations. Meanwhile, the profile menu includes personal data settings, device synchronization, display preferences, privacy, and security. Overall, the app's navigation flow moves from onboarding and login to the main dashboard with access to the Exercise Program, Mind and Mood, Community, and Reports and Profile. The implementation phase was conducted to test the use of the Smartwatch-Based Multidimensional Exercise Program (SBMTP) in a real-world context and assess the program's applicability to sedentary users. The trial was conducted with 75 participants over six weeks, with initial guidance on usage to ensure they understood the main features of the application. The Shapiro–Wilk normality test showed a W value of 0.984 with p= 0.252 (n= 75), indicating that the data were normally distributed (Table 4).

Table 4: Testing for normality and homogeneity

Normality test			Homogeneity test		
Shapiro Wilk			Levene's		
Statistic	n	*p-value*	f	df	*p-value*
0.984	75	0.252	2.225	74	0.342

Note: The data are normally distributed and homogeneous (p> 0.05).

Furthermore, the homogeneity test using Levene's test showed a value of F= 2.225 with p= 0.342 (df= 74), which means that the data variance is homogeneous. Thus, all variables meet the assumptions of normality and homogeneity (p> 0.05), so the analysis can be continued using a paired sample t-test. The results of the analysis shown in Table 5 indicate that the SBMTP program provided a significant improvement in all fitness indicators after six weeks of intervention.

Table 5: Summary of fitness improvements after six weeks of SBMTP-based training

Fitness Indicator	Pretest	Pretest	Δ	*p-value*
RHR (bpm)	84.2±8.5	75.1±7.9	↓ 9.1	0.001
BMI (kg/m²)	27.3±3.1	26.2±2.9	↓ 1.1	0.023
SFS (1–10)	4.6±1.2	7.3±1.4	↑ 2.7	0.012
RD (km)	2.8±0.9	4.3±1.1	↑1.5	0.016
EDpS (min)	22.5±5.8	35.4±6.7	↑12.9	0.001
CBpS (kcal)	178.6±42.3	254.8±51.6	↑76.2	0.001

Values are expressed as mean±SD> Note: Δ: changes; RHR: Resting Heart Rate; SFS: Subjective Fitness Score; RD: Running Distance: EdpS: Exercise Duration per Session: CBpS: Calories Burned per Session.

Resting heart rate decreased by 9.1 bpm (p= 0.001), indicating an improvement in cardiovascular function efficiency. Body mass index also decreased by 1.1 kg/m² (p= 0.023), indicating an improvement in body composition. Subjective fitness scores rose significantly by 2.7 points (p= 0.012), signifying an enhancement in participants' perception of fitness and physical well-being. In terms of physical performance, the distance run increased by 1.5 km (p= 0.016), which shows that aerobic endurance capacity has improved. The duration of exercise per session increased by 12.9 minutes (p= 0.001), indicating an increase in exercise tolerance. In addition, calories burned per session increased by 76.2 kcal (p= 0.001), indicating an increase in energy output and physical activity intensity. Overall, all variables showed significant changes (p< 0.05), so it can be concluded that the SBMTP program is effective in improving various aspects of participants' multidimensional fitness. To evaluate the effectiveness of the smartwatch-based Multi-Dimensional Training Program (SBMTP) application innovation in improving the holistic fitness of users, a survey was conducted among users of the SBMTP application. Based on the research results and Table 6, it can be concluded that the Smartwatch-Based Multi-Dimensional Training Program (SBMTP) innovation is technically and functionally feasible, in line with the needs of modern smartwatch users, and effective in improving holistic fitness that encompasses physical, mental, and emotional aspects. Additionally, this program has received high satisfaction ratings and positive responses from users, indicating excellent implementation quality and acceptance.

Table 6: Summary of overall evaluation statistics

Research Indicators	Average (%)	Category
Application Suitability	96.6	Very Appropriate
Program Suitability	90.3	Very Suitable
Program Suitability	89.3	Appropriate
User Satisfaction	87.5	Very Satisfactory
Positive Feedback	91.0	Very Good

DISCUSSION

The results of the study show that the Smartwatch-Based Multidimensional Exercise Program (SBMTP) is effective in improving various indicators of physical and psychological fitness, including a decrease in resting heart rate, an increase in running distance, an increase in exercise duration, an improvement in fitness perception, and an increase in energy as seen from the increase in calories burned per session. These findings confirm that the integration of wearable technology into structured training systems can have a significant effect on holistic fitness changes. The use of wearable sensors enables real-time monitoring of physiological data, thereby improving the accuracy of exercise supervision and the quality of adaptation to load [19,26,27]. This conclusion is reinforced by a another study, which states that wearable devices can increase motivation, consistency of physical activity, and the quality of users' health self-management [28]. The improvement in physical fitness, especially the lower resting heart rate and longer running distance, supports the idea that exercise programs that adjust intensity can boost aerobic capacity by helping the heart and metabolism work better. In this study, SBMTP uses the AI-Coach feature to adjust exercise intensity based on heart rate data, stress levels, and sleep quality, which is in line with [30] recommendations regarding the importance of exercise personalization in the digital fitness era. Physiologically, a 9.1 bpm decrease in resting heart rate indicates improved cardiac efficiency, which, according to another study, is a direct indicator of improved cardiorespiratory function [31]. Psychologically, the increase in subjective fitness scores and improved stress regulation through the Mind and Mood features support the theory that technology-based interventions can reduce psychological burden and improve mental well-being [32-34]. These findings are in line with the results of Yang *et al*. study [35], which showed that integrating physical exercise with mindfulness components improves emotional balance, sleep quality, and executive function. On the other hand, the mood tracking and daily reflection features in SBMTP were found to provide a cognitive feedback mechanism that increases users' self-awareness [36-38]. This is reinforced by Gerhardsson and Laike's [39] concept of a behavior change support system, which emphasizes the importance of monitoring, positive reinforcement, and adaptive feedback in forming sustainable health habits. Overall, this study confirms the importance of a multidimensional exercise approach that targets not only physical capacity improvement but also stress regulation, sleep quality, and mental well-being. Holistic approaches such as SBMTP are in line with Chao *et al*. [40] view that modern health must include physical, mental, and social dimensions in an integrated manner. Furthermore, the successful use of smartwatches as a data collection medium supports Khan *et al*. [41] findings, which state that quantified self-technology provides great opportunities for health personalization through accurate and continuous data [42-44]. The findings of this study have important implications for the development of technology-based exercise models, where SBMTP has been shown to improve holistic fitness while reinforcing the theory of the effectiveness of multidimensional exercise personalized through real-time physiological data. This program can be applied in the context of modern fitness, education, and health services as an adaptive exercise strategy focused on long-term behavioral change.

Study limitations

This study possesses several limitations, including the lack of a control group, the relatively brief duration of the intervention, the restriction of the sample to a sedentary population from an educational setting, and the reliance on the precision of wearable devices and self-report instruments for psychological variables. These limitations indicate the need for further research with a stronger experimental design, longer duration, and a more diverse population to strengthen the generalization of findings and improve the quality of SBMTP implementation in the future.

Conclusion

We successfully developed and evaluated the Smartwatch-Based Multidimensional Program Training (SBMTP) as a technology-based holistic exercise model capable of improving physical, mental, and emotional fitness in sedentary individuals. The integration of real-time physiological data through smartwatches proved effective in personalizing exercise intensity, monitoring body responses, and providing adaptive feedback. The results of the six-week intervention showed significant improvements in all fitness indicators, including a decrease in resting heart rate, an increase in aerobic capacity, an increase in perceived fitness, and an improvement in body composition. In addition, the Mind and Mood component of the SMWTP also supported improvements in stress regulation, self-awareness, and the psychological well-being of participants. Overall, this study demonstrates that a wearable-based multidimensional exercise approach can effectively integrate holistic fitness theory with practical implementation in the field. These findings make an important contribution to the development of technology-based interventions in the context of modern fitness, physical education, and preventive health services. SBMTP offers a systematic, adaptive, and data-driven training framework that can serve as a reference model for the development of future digital exercise programs. However, this study has limitations, including the absence of a control group, the relatively short duration of the intervention, and the limitation of participants to a specific sedentary population. Therefore, further research is recommended to test the effectiveness of SBMTP in a more diverse population, extend the duration of the intervention, integrate more advanced artificial intelligence algorithms, and evaluate its impact through a more robust experimental design. These developments are expected to strengthen the generalization of results and increase the potential of SBMTP as a holistic technology-based exercise innovation on a broader scale.

ACKNOWLEDGMENTS

The authors thank Universitas Negeri Medan for institutional support and all participants for their voluntary involvement and commitment throughout the study.

Conflict of interests

The authors declared no conflict of interest.

Funding source

The authors did not receive any source of funds.

Data sharing statement

Supplementary data can be shared with the corresponding author upon reasonable request.

REFERENCES

1. Ilham I, Putra RA, Orhan BE, Prasetyo T, Effendi R, Kurniawan R, et al. The effects of ladder drill and plyometric training on agility in futsal players considering body mass index. *Phys Educ Theory Methodol*. 2025;25(4):886–895. doi: 10.17309/tmfv.2025.4.17.
2. Sari AP, Kurniawan R, Indika PM, Wulan TS, Syafrianto D, Sari DN. Exploring the impact of aerobic gymnastics on reducing blood: with hypertension medications vs without hypertension medications. *J Phys Educ Sport*. 2023;23(12):3253–3263. doi: 10.7752/jpes.2023.12372.
3. Hohmann A, Schmid J, Charbonnet B. Toward a differentiated model of athlete performance development (DMAPD): Preliminary version and testing based on a German sample representing six sports. *Psychol Sport Exercise*. 2025;80:102896. doi: 10.1016/j.psychsport.2025.102896.
4. Chifamba C, Lim WM, Vieceli JM. Sports as service: customer engagement in participant sports through the lens of marathons. *Sport Business Manag Int J*. 2025;15(4): 378–405. doi: 10.1108/SBM-10-2024-0155.
5. Foster C, Casado A, Bok D, Hofmann P, Bakken M, Tjelta A, et al. 2025. History and perspectives on interval training in sport, health, and disease. *Appl Physiol Nutr Metab*. 202550:1-16. doi: 10.1139/apnm-2023-0611.
6. Ilham I, Putra RA, Orhan BE, Nusri A, Zulaini Z, Kurniawan R, et al. (2025). The effect of a six-week intervention using small-sided games (SSG), ladder drill, and dynamic balance on agility of young futsal players. *Phys Educ Theory Methodol.* 2025;25(5):1237–1247. doi: 10.17309/tmfv.2025.5.23.
7. Levin C, Baha O, Hater M, Klein-Druyan A, Saban M. Self-efficacy and its effect on step count in patients with intermittent claudication after endovascular interventions: A six-month quantitative study. *J Vasc Nurs*. 2025. doi: 10.1016/j.jvn.2025.08.006.
8. de Vries JD, Scharp YS, Bakker AB. Playful sport design and sport engagement: A diary study among amateur athletes. *Psychol Sport Exercise*. 2025;81:102953. doi: 10.1016/j.psychsport.2025.102953.
9. Akhmad I, Suharjo S, Hariadi H, Dewi R, Supriadi A. The effects of learning strategies on senior high school students' motivation and learning outcomes of overhead passing in volleyball. *Int J Educ Math Sci Technol*. 2022;10(02):458–476. doi: 10.46328/ijemst.2291.
10. Ahmed ME, Yu H, Vassallo M, Koufaki P. Advancing real-world applications: A scoping review on emerging wearable technologies for recognizing activities of daily living. *Smart Health*. 2025;36:100555. doi: 10.1016/j.smhl.2025.100555.
11. Ding Z, Fang W, Zhang J, Fang C, Sun Y. Chapter One - Artificial intelligence in wearable biosensing: Enhancing data analysis and decision-making in Biosensing the Future: Wearable, Ingestible and Implantable Technologies for Health and Wellness Monitoring Part B, vol. 216, In: Mahato K, Pandya A, (Eds.), Molecular Biology and Translational Science Academic Press. 2025;216:1-26. doi: 10.1016/bs.pmbts.2025.06.012.
12. Huo G, Liu X, Chen T. Prediction of physical fitness and performance of Wushus athletes based on machine learning and fuzzy TOPSIS method. *Entertain. Comput*. 2025;55:101017. doi: 10.1016/j.entcom.2025.101017.
13. Ludwig-Walz H, Heinisch S, Siemens W, Niessner C, Eberhardt T, Dannheim I, et al. Trends in physical fitness among children and adolescents in Europe: A systematic review and meta-analyses during and after the COVID-19 pandemic. *J Sport Health Sci*. 2025:101101. doi: 10.1016/j.jshs.2025.101101.
14. Boyle LD, Marty B, Haugarvoll K, Steihaug OM, Patrascu M, Husebo BS. Selecting a smartwatch for trials involving older adults with neurodegenerative diseases: A researcher's framework to avoid hidden pitfalls. *J Biomed Inform*. 2025;162:104781. doi: 10.1016/j.jbi.2025.104781.
15. Al-Emran M, Granić A, Al-Sharafi MA, Ameen N, Sarrab M. Examining the roles of students' beliefs and security concerns for using smartwatches in higher education. *J Enterp Info Manag*. 2020;34(4):1229–1251. doi: 10.1108/JEIM-02-2020-0052.
16. Heckler WF, Feijó LP, de Carvalho JV, Barbosa JLV. Digital phenotyping for mental health based on data analytics: A systematic literature review. *Artif Intell Med*. 2025;163:103094. doi: 10.1016/j.artmed.2025.103094.
17. Özgen C, Kim E, Köse H, Balcı V, Çevik H. How expanded service scape shapes fitness center members' decision-making processes: a stimulus-organism-response (SOR) model perspective. *Int J Sport Mark Spons*. 2025;26(3):489–506. doi: 10.1108/IJSMS-08-2024-0216.
18. Ilham I, Sari AP, Rifki MS, Alnedral A, Welis W, Kurniawan R, et al. The effect of plyometric training (hurdle jumps), body weight training (lunges) and speed on increasing leg muscle explosive power of futsal players: a factorial experimental. *Retos*. 2024;59:497–508. doi: 10.47197/retos.v59.108147.
19. Ilham I, Agus A, Sugiyanto FX, Tirtawirya D, Lumintuarso R, Berhimpong MW, et al. Comparative analysis of adaptations progress in VO2max , leg power , and agility among male and female sports science students. *Retos.* 2024;57:245–257. doi: 10.47197/retos.v57.107053.
20. Ilham I, Putra RA, Agus A, Bahtra R, Kurniawan R, Makadada FA, et al. The effect of combination of cone drill (Zigzag) with core stability, combination of ladder drill (Snake Jump) with core stability, and speed on agility of futsal players: A factorial experimental design. *Retos*. 2024;58:1-11. doi: 10.47197/retos.v58.105462.
21. Liu J. Application of entertainment and fitness robots based on game interaction in sports training data analysis. *Entertain Comput* 2025;52:100837. doi: 10.1016/j.entcom.2024.100837.
22. Su B, Li F, Su B. Wearable sSensors for precise exercise monitoring and analysis. *Biosensors (Basel)*. 2025;15(11):734. doi: 10.3390/bios15110734.
23. da Silva WF, Rocha-Silva R, Viana RB, Morais NS, da Silva HR, Teles Santos DA, et al. Knowledge, perceptions, and attitudes about physical fitness assessment among physical exercise practitioners: A cross-sectional study. *J Bodywork Movement Ther*. 2025. doi: 10.1016/j.jbmt.2025.11.023.
24. Ke N, Yaqin G. Simulation of entertainment interactive robots based on intelligent algorithms in personalized fitness training systems. *Entertain Comput*. 2025;52:100776. doi: 10.1016/j.entcom.2024.100776.
25. Di Gioia G, Ferrera A, Squeo MR, Spera FR, Maestrini V, Monosilio S, et al. Right and left atrial strain by speckle-tracking echocardiography: Sex differences and correlation with cardiorespiratory fitness in olympic athletes. *J Am Soc Echocardiogr*. 2025:S0894-7317(25)00519-X. doi: 10.1016/j.echo.2025.09.002.

26. Anwar M, Rahmawati Y, Yuniarti N, Hidayat H, Sabrina E. Leveraging augmented reality to cultivate higher-order thinking skills and enhance students' academic performance. *Int J Inform Educ Technol*. 2024;14(10):1405–1413. doi: 10.18178/ijiet.2024.14.10.2171.
27. Sari AP, Kurniawan R, Selviani I, Okilanda A, Bafirman B, Sazeli RM. Maumere exercise therapy and low salt diet in hypertension sufferers: an effort to lower blood pressure. *Retos*. 2024;56:1016–1025. doi: 10.47197/retos.v56.106718.
28. Beavers DL, Chung EH. Wearables in sports cardiology. *Clin Sports Med*. 2022;41(3): 405–423. doi: 10.1016/j.csm.2022.02.004.
29. Aksoy NC, Alan AK, Kabadayi ET, Aksoy A. Individuals' intention to use sports wearables: the moderating role of technophobia. *Int J Sport Mark Spons*. 2020;21(2):225–245. doi: 10.1108/IJSMS-08-2019-0083.
30. Lu JK, Wang W, Goh J, Maier AB. A practical guide for selecting continuous monitoring wearable devices for community-dwelling adults. *Heliyon*. 2024;10(13):e33488. doi: 10.1016/j.heliyon.2024.e33488.
31. Maab L, Freye M, Pan CC, Dassow HH, Niess J, Jahnel T. The definitions of health apps and medical apps from the perspective of public health and law: Qualitative analysis of an interdisciplinary literature overview. *JMIR Mhealth Uhealth*. 2022;10(10). doi: 10.2196/37980.
32. Marabita F, James T, Karhu A, Virtanen H, Kettunen K, Stenlund H, et al. Multiomics and digital monitoring during lifestyle changes reveal independent dimensions of human biology and health. *Cell Syst*. 2022;13(3):241-255. doi: 10.1016/j.cels.2021.11.001.
33. Zhang W, Luo Y, Yang X, Shu Y, Du C, Zhang J. Fatigue estimation of OOWs based on eye-tracking technology: A hybrid experimental study. *Ocean Eng*. 2025;341:122536. doi: 10.1016/j.oceaneng.2025.122536.
34. Daniels K, Vonck S, Robijns J, Quadflieg K, Bergs J, Spooren A, et al. Exploring the feasibility of a 5-week mHealth intervention to enhance physical activity and an active, healthy lifestyle in community-dwelling older adults: Mixed methods study. *JMIR Aging*. 2025;8:e63348. doi: 10.2196/63348.
35. Yang Q, Al Mamun A, Reza MNH, Naznen F. Modelling the significance of value-belief-norm framework to predict mass adoption potentials of internet of things-enabled wearable fitness devices. *Heliyon*. 2024;10(9):e30179. doi: 10.1016/j.heliyon.2024.e30179.
36. Fatoum H, Hanna S, Halamka JD, Sicker DC, Spangenberg P, Hashmi SK. Blockchain integration with digital technology and the future of health care ecosystems: Systematic review. *J Med Internet Res*. 2021;23(11). doi: 10.2196/19846.
37. Smith L, Simpson G, Holt S, Dambha-Miller H. Digital applications to support self-management of multimorbidity: A scoping review. *Int J Med Inform*. 2025;202:105988. doi: 10.1016/j.ijmedinf.2025.105988.
38. Radnejad AB, Ziolkowski MF, Osiyevskyy O. Design thinking and radical innovation: enter the smartwatch. *J Bus Strategy*. 2021;42(5):332–342. doi: 10.1108/JBS-02-2020-0044.
39. Gerhardsson KM, Laike T. User acceptance of a personalised home lighting system based on wearable technology. *Appl Ergon*. 2021;96:103480. doi: 10.1016/j.apergo.2021.103480.
40. Chao WC, Huang JC, Young SL, Wu CL, Shih JC, Liao LD, et al. Interplay of yoga, physical activity, and probiotics in irritable bowel syndrome management: A double-blind randomized study. *Complement Ther Clin Pract*. 2024;57:101892. doi: 10.1016/j.ctcp.2024.101892.
41. Khan B, Khalid RT, Wara KU, Masrur MH, Khan S, Wasim Ullah Khan WU, et al. Reshaping the healthcare world by AI-integrated wearable sensors following COVID-19. *Chem Eng J*. 2025;505:159478. doi: 10.1016/j.cej.2025.159478.
42. Acikgoz F, Borulu B, Bölen MC. How does obsolescence risk influence consumer resistance to smartwatches? *Info Technol People.* 2024;38(7):2684–2709. doi: 10.1108/ITP-08-2023-0843.
43. Moorthy P, Weinert L, Schüttler C, Svensson L, Sedlmayr B, Müller J, et al. Attributes, methods, and frameworks used to evaluate wearables and their companion mHealth apps: Scoping review. *JMIR Mhealth Uhealth*. 2024;12:e52179. doi: 10.2196/52179.
44. Searle BL, Potapov K, Ayobi A. Using self-tracking technologies to manage energy for health and wellbeing. *Int J Hum Comput Stud*. 2025;203:103581. doi: 10.1016/j.ijhcs.2025.103581.