Computer Fraud and Security
ISSN (online): 1873-7056

Research on Computer System-Based Home Fitness Gamification

Shuai Deng *
Leifeng Avenue, Wangcheng District, Changsha, Hunan Province, 410000, China.
**Corresponding Author Email: 839899820@qq.com.*

Abstract:
With the increasing awareness of health, home fitness has gradually become an important lifestyle. Compared to traditional fitness methods, which are limited by time and space, home fitness offers a more flexible and convenient option. This study aims to explore computer system-based home fitness gamification schemes by reviewing literature, conducting comparative analyses, and analyzing brands to understand the technical characteristics and current usage of existing home fitness systems. By integrating the principles and mechanisms of sports games, we propose innovative home fitness systems. The results indicate that gamification elements significantly enhance users' fitness motivation and effectiveness. Although there are deficiencies in terms of cost, space, and technical support, improvements can be made by optimizing production processes, designing portable equipment, and enhancing technical support, thereby significantly improving user experience. Future research should focus on the application of virtual reality and augmented reality technologies, the development of personalized fitness plans, and the enhancement of social functions to meet diverse user needs. Computer system-based home fitness gamification schemes provide a scientific, efficient, and enjoyable way of fitness for modern households. Through technological innovation and improved user experience, home fitness systems will play a crucial role in the future. It is recommended to further study the application of virtual and augmented reality technologies, develop personalized fitness plans and real-time feedback systems, and integrate more health monitoring functions to provide comprehensive health management solutions, promoting the development and popularization of the home fitness industry.

Keywords: Home Fitness; Computer-Based Fitness Systems; Gamified Exercise; Interactive Fitness Technology; Virtual Fitness Training.

INTRODUCTION

With the increasing awareness of health, home fitness has gradually become an important lifestyle1. Traditional fitness methods are often difficult to adhere to in the long term due to time and space constraints. Home fitness, on the other hand, offers a more convenient and flexible option, allowing users to exercise according to their schedule and needs without being affected by the external environment2. Especially during the global pandemic, the demand for home fitness surged, and the sales of various fitness equipment and systems increased significantly. Home fitness can not only improve cardiopulmonary function, enhance muscle strength, and increase flexibility but also effectively relieve stress and improve mental health.

In the development of home fitness, the application of gamification has shown broad prospects3. Gamification refers to the integration of game elements and mechanisms into non-game contexts to enhance engagement and motivation. In the fitness field, gamification can increase the fun of exercise, attract more users to participate, and motivate users to persist in exercising and continuously improve their level through competition, rewards, and feedback mechanisms. For example, game elements such as virtual coaches, real-time challenges, and point systems can provide users with immediate sense of achievement and feedback during exercise, thereby enhancing their motivation for continuous participation4.

The combination of sports games and home fitness systems is a new research hotspot. By integrating gamification elements into home fitness systems, user engagement and fitness effectiveness can be significantly improved. Studies have shown that gamification can stimulate users' intrinsic motivation, making them more willing to continue participating in exercise. Through real-time feedback, reward mechanisms, and social interaction, users can better track their progress and gain a sense of accomplishment. This positive feedback loop helps establish long-term fitness habits, thereby improving overall health5. Therefore, researching the combination of sports games and home fitness systems and their effects not only has important theoretical value but also has broad practical application prospects.

However, home fitness systems still have some shortcomings in terms of technology and usage, and the market development also shows diverse and rapidly changing trends. The cost of existing home fitness equipment is relatively high, the installation and use complexity is large, and users may encounter problems with technical support and after-sales service in actual use. The space occupied by the equipment and its portability also pose challenges for use in small households.

The purpose of this study is to explore computer system-based home fitness gamification schemes by analyzing the technical characteristics and current usage of existing home fitness systems, integrating the principles and mechanisms of sports games, and introducing gamification elements to enhance user engagement and exercise effectiveness. This study aims to provide a scientific, efficient, and enjoyable way of fitness for modern households, offering theoretical basis and practical references for the design and improvement of home fitness systems, and promoting the development and popularization of the home fitness industry.

METHODS

2.1 Literature Review

To comprehensively understand the current status and development trends of computer-based home fitness systems, we adopted a literature review approach6. Firstly, we collected research literature on computer-based home fitness systems from academic databases such as PubMed, IEEE Xplore, and Google Scholar. Keywords included but were not limited to "home fitness systems," "gamified fitness," "virtual reality fitness," "augmented reality fitness," and "IoT fitness devices" (Table 1). We set the time frame of the literature to the past decade to ensure the acquisition of the latest research results and technological applications. During the literature screening process, priority was given to peer-reviewed journal articles, conference papers, and technical reports to ensure the reliability and academic value of the data.

By comparing different research results, we summarized the evolutionary trajectory of computer-based home fitness systems7. From early simple fitness video playback to modern complex interactive fitness platforms, the functions and user experience of home fitness systems have continuously improved. In recent years, especially with the rapid development of technology, Virtual Reality (VR), Augmented Reality (AR), and Internet of Things (IoT) technologies have been widely applied in home fitness systems8. The introduction of these technologies has not only enhanced user immersion and interactivity but also significantly improved fitness outcomes and user satisfaction. By analyzing the application cases of these technologies, we can better understand their actual effects and potential issues in home fitness systems.

Table 1 Literature search method

Brand	Functionality and Technical Features	User Experience	Advantages	Disadvantages
Peloton	Spin bikes, treadmills, large screen, live and on-demand classes	Immersive classes, high user engagement	High-quality equipment, interactive classes, comprehensive metrics tracking	High cost, requires subscription
Tonal	Wall-mounted strength training system, digital weights, AI workouts	Space-saving design, personalized training	Space-saving, personalized workouts, progress tracking	High price
Nordic Track	Treadmills, ellipticals, rowing machines, iFit coach support	Durable equipment, multifunctional	Durable equipment, reasonable price, multifunctional adjustment	Requires substantial space
Mirror	Smart fitness mirror, real-time guidance, on-demand classes	Modern design, diverse class selection	Space-saving, interactive classes, multiple training modes	High cost, requires subscription
REP Fitness	Power racks, weight plates, adjustable dumbbells, durable materials	High quality and durability	High-quality materials, durable, excellent customer service	Lack of pre-programmed workouts, bulky equipment

Life Fitness	Strength and cardio equipment, supports various programming	High quality and durability	High-quality equipment, programmable, app compatibility	High price

2.2. Comparative Analysis

The comparative analysis in this study primarily relies on the results of the literature review, comparing changes in health indicators among participants engaging in different types of home fitness methods (such as aerobic exercise, strength training, and yoga)9. The goal is to analyze the specific mechanisms and effects of these fitness methods. The core of the comparative analysis is to systematically collect and analyze existing research data, revealing the impacts of different fitness methods on cardiopulmonary function, muscle strength, flexibility, and balance. The specific methods include establishing literature selection criteria, data extraction and organization, and applying statistical analysis methods to ensure the comprehensiveness and scientific validity of the comparative analysis.

After selecting literature that meets the criteria, a detailed review is conducted. By systematically organizing this data, the study describes the basic characteristics and changes in health indicators for each fitness method, exploring the effects and data distribution of different fitness methods, and evaluating their advantages and disadvantages.

Based on the comparative analysis, we delve into the specific mechanisms of different fitness methods in conjunction with relevant literature10. Aerobic exercise improves cardiopulmonary function significantly by increasing cardiopulmonary load and enhancing oxygen utilization efficiency. Strength training promotes muscle fiber growth and enhancement through repeated load training, significantly boosting muscle strength. Yoga, through stretching and posture exercises, increases the flexibility of muscles and joints, improving balance capabilities.

2.3. Brand Analysis

This study selected representative home fitness equipment brands in the market for analysis, including Peloton, Mirror, and Tonal. These brands have high recognition and user bases in the market, representing the main types and development trends of current home fitness equipment. To fully understand the functionalities and user experiences of these devices, we collected information on each brand's equipment features, technical characteristics, and user evaluations through online searches. Specific data sources include official brand websites, product review sites, user review platforms, and related market research reports. By systematically organizing and analyzing this information, we can accurately understand the primary functionalities and technical advantages of each device, as well as the actual experiences and feedback from users during use.

In the analysis process, we focused on comparing the functionalities and technical characteristics of each brand's equipment. We also categorized user evaluations to analyze satisfaction with device performance, user experience, and after-sales service. By comparing the advantages and disadvantages of each brand's equipment, we provide important references for the future design and improvement of home fitness equipment systems.

RESULTS AND DISCUSSION

3.1. Home Fitness Based on Computer Systems

3.1.1 Design Concept and Function Implementation

The home fitness system based on computer technology aims to enhance users' fitness experiences and outcomes through modern technological means. The design concept primarily revolves around user experience, personalization, and interactivity. This system utilizes advanced sensing technology11, artificial intelligence, and big data analysis to provide real-time feedback and personalized recommendations, enabling users to conduct scientific and effective fitness training at home. The system includes multiple functional modules, such as exercise data monitoring, personalized training plan formulation, real-time guidance, and social interaction. The realization of these functions relies on high-precision sensor devices, powerful computing capabilities, and intelligent algorithms. By monitoring and analyzing users' exercise data in real time, the system can provide detailed exercise feedback and improvement suggestions, helping users continuously optimize their training outcomes.

The implementation of the system's functions involves several steps12: real-time collection of users' exercise data (such as heart rate, steps, and exercise posture) through sensor devices (e.g., smart wristbands, motion-sensing cameras); analyzing these data using artificial intelligence algorithms to assess users' exercise status and health conditions; based on the analysis results, automatically adjusting and optimizing users' training plans, and providing personalized training suggestions and guidance through virtual coaches or real-time instructions. Moreover, the system supports various exercise modes, including aerobic exercise, strength training, and yoga, allowing users to freely choose and switch between different training modes according to their needs.

Table 2 Functional steps of home fitness system

Steps	Keywords
Data Collection	Sensor devices, smart wristbands, motion capture cameras, heart rate, steps, exercise posture
Data Analysis	Artificial intelligence algorithms, data analysis, exercise status, health condition
Plan Adjustment Optimization	Automatic adjustment, optimization of training plans, virtual coach, real-time guidance, personalized training suggestions
Support for Various Exercise Modes	Aerobic exercise, strength training, yoga, user needs, flexible choice, switching exercise modes

3.1.2 Application of Gamification Elements in Home Fitness Systems

To enhance user engagement and long-term motivation, the computer-based home fitness system extensively applies gamification elements. Gamification involves incorporating game design principles and elements into non-game contexts to increase fun and interactivity, thereby boosting user engagement and loyalty13. In the home fitness system, the application of gamification elements is primarily reflected in the following aspects: tasks and challenges, points and rewards, leaderboards, and social interaction.

Tasks and challenges are core elements of gamification. The system designs a series of progressively challenging tasks based on the user's fitness level and goals. As users complete these tasks, they can gradually improve their fitness levels and health status. The points and rewards mechanism provides immediate positive feedback by setting various fitness achievements and goals, motivating users to persist in their training. Each time a user completes a task or reaches a goal, the system rewards them with points or virtual rewards. These points and rewards can be used to unlock more training content or redeem physical rewards.

Leaderboards and social interactions further enhance user engagement by increasing interaction and competition among users14. The system generates a real-time updated leaderboard based on users' fitness performance and points, allowing users to compete with friends or other users worldwide to see who performs better. Additionally, the system supports social interaction features, enabling users to share their training results and experiences on the platform, interact with other users, and form a positive and healthy fitness community.

3.3 Analysis of the Principles and Mechanisms of Home Fitness

3.3.1 Impact of Home Fitness on Physical Health

Home fitness significantly improves physical health through various means, primarily involving the enhancement of cardiovascular function, muscle strength, flexibility, and balance. Aerobic exercise is one of the core components of home fitness. By increasing cardiovascular load, heart rate, and breathing rate, it enhances the function of the cardiovascular system. Regular aerobic exercise can effectively lower blood pressure, improve blood lipid levels, and enhance vascular elasticity, thereby preventing cardiovascular diseases. It also promotes metabolism, improves oxygen utilization efficiency, and helps the body burn fat more effectively, aiding in weight control and the prevention of obesity-related diseases.

Strength training also holds an important position in home fitness. Through repeated muscle contractions and load training, it can increase the thickness and number of muscle fibers, thereby enhancing muscle strength and endurance. Improved muscle strength not only aids in daily physical activities but also effectively prevents muscle atrophy and osteoporosis, particularly important for the elderly. By increasing bone density and strengthening

skeletal structure, strength training reduces the risk of fractures. Additionally, it can raise the basal metabolic rate, helping to burn calories more efficiently and support weight management and metabolic health.

Flexibility and balance are important indicators of physical health, with yoga and other home fitness practices excelling in this aspect. Yoga, through a series of stretching and postural exercises, increases the flexibility of muscles and joints, making the body more agile and coordinated. Improved flexibility not only reduces the risk of sports injuries but also enhances balance and coordination, preventing falls and related injuries. Through deep breathing and meditation, yoga can also reduce stress, promote mental health, and improve overall quality of life.

3.4 Comparison of the Effects of Different Fitness Methods

Different types of home fitness methods have varying focuses on health effects. Aerobic exercise is particularly effective in improving cardiovascular function and metabolic health15. Studies have shown that individuals participating in aerobic exercise significantly enhance their cardiovascular endurance, increase maximum oxygen uptake (VO2max), and significantly reduce resting heart rate and blood pressure levels, effectively improving blood glucose and lipid levels, and helping to prevent and manage diabetes and cardiovascular diseases. Compared to other forms of exercise, aerobic exercise is more effective in weight management and fat burning, making it suitable for those needing to control weight and improve cardiovascular health.

Strength training has unique advantages in enhancing muscle strength and skeletal health. By imposing repeated loads on muscles, strength training can significantly increase muscle strength and endurance, improving muscle mass and function. Particularly for the elderly, strength training can prevent muscle atrophy, increase bone density, and reduce the risk of osteoporosis and fractures. Additionally, strength training can raise metabolic rate, helping to burn calories more efficiently and support weight management. Compared to aerobic exercise, strength training is more effective in enhancing muscle strength and skeletal health.

Flexibility training, such as yoga, excels in improving flexibility and balance. Through a series of stretching and postural exercises, yoga can significantly increase the flexibility of muscles and joints, making the body more agile and coordinated. Improved flexibility not only reduces the risk of sports injuries but also enhances balance and coordination, preventing falls and related injuries. Yoga, through deep breathing and meditation, can also effectively reduce stress, promote mental health, and improve overall quality of life. Compared to aerobic and strength training, yoga focuses more on the coordination and balance of body and mind, with unique effects on stress relief and mental health improvement.

In the design and implementation of the home fitness system, the advantages of these different fitness methods should be fully considered to provide personalized training programs and guidance according to users' specific needs16. With technological advancement and increased health awareness, home fitness systems will continue to develop and improve. By continuously optimizing sensor accuracy and stability, enriching training content and modes, and enhancing social interaction functions, home fitness systems will provide users with a more scientific, effective, and enjoyable fitness experience. Further research should focus on the long-term effects of different fitness methods and their applicability to different populations, providing more comprehensive theoretical support and data for the promotion and application of home fitness.

3.5. Analysis of the Characteristics of Common Brands of Home Fitness Equipment

The functions and technical features, user experience, advantages, and disadvantages of common brands of home fitness equipment were analyzed. These brands include Peloton, Tonal, NordicTrack, Mirror, REP Fitness, and Life Fitness, offering various equipment and features to meet different fitness needs and preferences (Table 3).

Peloton is renowned for its high-quality stationary bikes and treadmills, equipped with large screens for immersive live and on-demand classes. Comprehensive metric tracking enhances user engagement, making it a top choice for those seeking a studio-like experience at home. However, high costs and subscription requirements may be a barrier for some users. Tonal offers a space-saving solution with its wall-mounted strength training system. Utilizing digital weights and AI, it provides personalized training and effectively tracks progress. The main drawback is the high price, which may not be suitable for everyone.

NordicTrack offers a range of equipment, including treadmills, ellipticals, and rowing machines, all supporting the iFit coaching app17. Users appreciate the durability and versatility of the equipment, making it reasonably priced. However, some devices require significant space, making them unsuitable for small homes. Mirror provides a modern design with its smart fitness mirror, offering real-time guidance and on-demand classes. Space-saving and diverse training modes are its main advantages, but high costs and subscription requirements may limit its market appeal. REP Fitness focuses on strength training, offering high-quality power racks, weight plates, and adjustable dumbbells, known for their material durability and customer service. While durable, the equipment lacks pre-programmed training and tracking software and some pieces are cumbersome. Life Fitness is praised for its strength and cardio equipment, supporting various programming options and compatibility with apps like iFit and Peloton. The high quality and durability of the equipment are significant advantages, but high prices may deter some potential buyers.

Table 3 Analysis of advantages and disadvantages of different brands of home fitness equipment

Brand	Functionality and Technical Features	User Experience	Advantages	Disadvantages
Peloton	Spin bikes, treadmills, large screen, live and on-demand classes	Immersive classes, high user engagement	High-quality equipment, interactive classes, comprehensive metrics tracking	High cost, requires subscription
Tonal	Wall-mounted strength training system, digital weights, AI workouts	Space-saving design, personalized training	Space-saving, personalized workouts, progress tracking	High price
NordicTrack	Treadmills, ellipticals, rowing machines, iFit coach support	Durable equipment, multifunctional	Durable equipment, reasonable price, multifunctional adjustment	Requires substantial space
Mirror	Smart fitness mirror, real-time guidance, on-demand classes	Modern design, diverse class selection	Space-saving, interactive classes, multiple training modes	High cost, requires subscription
REP Fitness	Power racks, weight plates, adjustable dumbbells, durable materials	High quality and durability	High-quality materials, durable, excellent customer service	Lack of pre-programmed workouts, bulky equipment
Life Fitness	Strength and cardio equipment, supports various programming	High quality and durability	High-quality equipment, programmable, app compatibility	High price

3.6. Integration of Sports Games and Home Fitness Systems

The application of sports games in home fitness is becoming increasingly popular, providing users with a more enjoyable and interactive fitness experience11. By incorporating gamified elements into home fitness systems, users can achieve fitness goals while having fun, maintaining long-term motivation for exercise. Many home fitness systems have introduced sports game elements to enhance user engagement and experience. For example, Peloton's cycling courses include competitive and challenge modes, allowing users to compete in real-time with others globally and motivating them to continually surpass themselves through leaderboards and reward systems. Similarly, Mirror's fitness mirror offers gamified workouts through virtual coaches and interactive games, enabling users to complete exercise tasks while being entertained.

The application of gamification in home fitness not only adds fun but also significantly enhances the effectiveness of workouts. Research indicates that gamified elements can stimulate users' intrinsic motivation, making them more willing to continue exercising. Real-time feedback, reward mechanisms, and social interaction allow users to better track their progress and gain a sense of accomplishment. This positive feedback loop helps establish long-term fitness habits, thereby improving overall health. Tonal's strength training system utilizes AI technology to provide personalized training plans and motivates users through gamified progress bars and achievement badges to continually challenge themselves and improve their training outcomes.

In addition to boosting motivation and effectiveness, the integration of sports games in home fitness systems also promotes interaction and participation among family members. Home fitness is no longer a solitary activity but can become a group activity where family members support and motivate each other. Nintendo's Ring Fit Adventure, for example, combines gaming and fitness, bringing the entire family into a virtual world to complete tasks and challenges together. This family-oriented fitness activity not only enhances relationships among family members but also fosters a shared interest and habit in fitness. The integration of sports games and home fitness systems not only increases user engagement and fitness outcomes but also brings more interaction and fun to families, with broad application prospects and development potential.

3.7. Current Issues and Solutions

Existing home fitness systems face several issues in terms of technology and usability. The high cost of equipment is a significant barrier. Many high-end home fitness devices are expensive and often require additional subscription fees, which may be unaffordable for ordinary families. The space required for equipment and the complexity of installation are also concerns, especially for small households where the size of the equipment might take up valuable living space. There are also user experience issues, such as insufficient technical support and after-sales service, making it difficult for users to get timely help during use. For highly intelligent devices, technical failures and software updates can also affect the fitness experience. To address these issues, various improvement measures can be taken:

1). Manufacturers can reduce production costs by optimizing production processes and material selection, making the equipment more affordable. Additionally, improving the portability and foldability of devices to meet the needs of small households is essential. Designing foldable and storable equipment can reduce its footprint and make it easier for users to store after use. For technical support and after-sales service, fitness equipment manufacturers should establish a more comprehensive customer service system, providing round-the-clock technical support and quick-response after-sales service to ensure users can get timely help when encountering problems. Enhancing the intelligence functions of devices and improving system stability and user experience is also crucial. Regular software updates and maintenance ensure the smoothness and reliability of device operation.

2). Future research should focus on further improving the user experience and effectiveness of home fitness systems. By incorporating more virtual reality and augmented reality technologies, more immersive and interactive fitness experiences can be provided. Developing personalized fitness plans and real-time feedback systems based on users' health data and exercise performance, providing customized training suggestions and adjustment plans. Moreover, home fitness systems should pay more attention to developing social functions, allowing users to exercise with friends and family, enhancing the fun and motivation of fitness. Researching how to integrate more health monitoring features, such as heart rate, blood pressure, and sleep quality, to provide comprehensive health management solutions is also an important direction. These improvements and innovations will help enhance the overall efficiency of home fitness systems, better serving the fitness needs of a broad user base.

CONCLUSION AND RECOMMENDATIONS

This study delved into the gamified solutions for computer-based home fitness systems, analyzing the current status and development trends of home fitness systems and the application effects of sports games in home fitness. The study found that home fitness systems hold significant importance in modern life, with gamified elements playing a notable role. By incorporating gamified elements into home fitness systems, users can enjoy a more interesting fitness experience and be motivated to persist in exercising through real-time feedback and reward mechanisms. Existing home fitness systems still have some technical and usability shortcomings, such as high equipment costs, large footprint, and insufficient technical support. To address these issues, various improvement measures have been proposed, including optimizing production processes to reduce costs, designing portable and easy-to-store equipment, and providing more comprehensive technical support and after-sales services.

ACKNOWLEDGEMENTS

The authors would like to thank all participants and institutions involved in this research. Special thanks to the technical team for their support in system development and data analysis.

FUNDING STATEMENT

The author received no specific funding for this study.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest to report regarding the present study.

REFERENCES

[1] Filgueira TO, Castoldi A, Santos LER, et al. The relevance of a physical active lifestyle and physical fitness on immune defense: mitigating disease burden, with focus on COVID-19 consequences. Frontiers in immunology 2021; 12: 587146.
[2] Yusof MM, Kuljis J, Papazafeiropoulou A, Stergioulas LK. An evaluation framework for Health Information Systems: human, organization and technology-fit factors (HOT-fit). International journal of medical informatics 2008; 77(6): 386-98.
[3] Cotton V, Patel MS. Gamification use and design in popular health and fitness mobile applications. American Journal of Health Promotion 2019; 33(3): 448-51.
[4] Chen J, Liang M. Play hard, study hard? The influence of gamification on students' study engagement. Front Psychol 2022; 13: 994700.
[5] Kramer JN, Kowatsch T. Using Feedback to Promote Physical Activity: The Role of the Feedback Sign. J Med Internet Res 2017; 19(6): e192.
[6] Abbasi R, Martinez P, Ahmad R. The digitization of agricultural industry–a systematic literature review on agriculture 4.0. Smart Agricultural Technology 2022; 2: 100042.
[7] Yazici İ, Shayea I, Din J. A survey of applications of artificial intelligence and machine learning in future mobile networks-enabled systems. Engineering Science and Technology, an International Journal 2023; 44: 101455.
[8] Zhang Z, Wen F, Sun Z, Guo X, He T, Lee C. Artificial intelligence-enabled sensing technologies in the 5G/internet of things era: from virtual reality/augmented reality to the digital twin. Advanced Intelligent Systems 2022; 4(7): 2100228.
[9] Leong MQ, Lim CW, Lai YF. Comparison of Hospital-at-Home models: a systematic review of reviews. BMJ open 2021; 11(1): e043285.
[10] Haesebrouck T, Thomann E. Introduction: Causation, inferences, and solution types in configurational comparative methods. Quality & Quantity 2021: 1-22.
[11] Pizzo AD, Baker BJ, Jones GJ, Funk DC. Sport experience design: Wearable fitness technology in the health and fitness industry. Journal of Sport Management 2020; 35(2): 130-43.
[12] Carayon P, Wooldridge A, Hoonakker P, Hundt AS, Kelly MM. SEIPS 3.0: Human-centered design of the patient journey for patient safety. Applied ergonomics 2020; 84: 103033.
[13] Lu H-P, Ho H-C. Exploring the impact of gamification on users' engagement for sustainable development: A case study in brand applications. Sustainability 2020; 12(10): 4169.
[14] Bitrián P, Buil I, Catalán S. Enhancing user engagement: The role of gamification in mobile apps. Journal of Business Research 2021; 132: 170-85.
[15] Franklin BA, Eijsvogels TM, Pandey A, Quindry J, Toth PP. Physical activity, cardiorespiratory fitness, and cardiovascular health: A clinical practice statement of the American Society for Preventive Cardiology Part II: Physical activity, cardiorespiratory fitness, minimum and goal intensities for exercise training, prescriptive methods, and special patient populations. American Journal of Preventive Cardiology 2022; 12: 100425.
[16] Martinho D, Carneiro J, Corchado JM, Marreiros G. A systematic review of gamification techniques applied to elderly care. Artificial Intelligence Review 2020; 53(7): 4863-901.
[17] Verma N. Strategic Analysis of Mirror: The Gym. 2021.