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Assessing adiposity indicators in short-term physical activity-based-programs: The impact of university resources on habit formation

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ABSTRACT

Background: Obesity is a significant public health concern associated with numerous adverse health outcomes. The development of exercise maintenance habits has yet to be thoroughly studied in Saudi Arabia. The aim of this study was to investigate the impact of promoting physical activity, with a particular focus on habit formation, on body mass index (BMI) and body fat (BF) percentage as well as healthy behavior parameters among the university community in the Eastern Province of Saudi Arabia.

Materials and methods: Volunteer participants (N = 139; age 34.78 ± 10.20 years; weight 85.14 ± 10.04 kg) university students and staff members aged 18-55 who were overweight (BMI 29.70 kg/m^2) were distributed into two groups; experimental (n = 74 habit formation with PA intervention 4-sessions-per-week) and control (n = 65 no habit formation 0-1-session-per week). The participants in the experimental group gave a pre-intervention instruction session and were then guided during the 12 weeks.

Results: The main outcomes of the investigation were objective measures, anthropometric parameters (weight, BMI, BF percentage) and healthy behavior parameters (moderate-to-vigorous physical activity [MVPA] minutes, step counts, and weekly leisure activity score) were executed at baseline and after 12 weeks. The experimental group achieved a notable enhancement ($p < 0.01$) in comparison to controls following 12-weeks period, shown in all anthropometric (weight, BMI, and BF percentage) and healthy behavior (MVPA minutes, step counts, and weekly leisure activity score) parameters.

Conclusion: This study represents the positive impact of regular physical activity interventions, combined with habit formation, on adiposity indicators and the promotion of healthy behaviors within a university setting. University should mandate 3 weekly physical activity hours as part of employment/student contracts and subsidize wearable activity trackers to reinforce habit cues. Future research should replicate this study with extended intervention periods to evaluate the long-term sustainability of the observed improvements in physical activity interventions.

Keywords: habits, physical activity, anthropometric, healthy behavior, university

INTRODUCTION

Obesity is a significant public health concern associated with numerous adverse health outcomes. It increases the risk of developing chronic conditions such as type 2 diabetes, cardiovascular diseases, hypertension, and certain types of cancer, including breast, colon, and endometrial cancer [1]. Beyond physical health, obesity negatively impacts mental health, contributing to depression, anxiety, and low self-esteem due to social stigma and discrimination [2]. Furthermore, obesity is associated with musculoskeletal disorders, such as osteoarthritis, due to excessive joint stress, and sleep apnea, which can lead to respiratory complications [3]. These health challenges not only reduce quality of life but also place a substantial economic burden on healthcare systems globally [4]. Addressing obesity through preventive measures and effective interventions is crucial to mitigating its widespread health impacts.

Recent epidemiological studies examining obesity trends among university-aged populations in Saudi Arabia reveal concerning prevalence rates with notable gender disparities [5]. A 2019 study reported that 35.3% of university students in Medina were classified as obese [6], indicating a substantial burden of adiposity among higher education students. This finding is further corroborated by a 2021 nationwide study that documented a similar overweight and obesity prevalence of 38.5% among participants aged 17-25 years across different Saudi regions [6]. When examining gender-specific patterns in adiposity metrics among Saudi adolescents, research conducted in Medina City in 2025 revealed that obesity was more prevalent in males (25.9%) than in females (13.5%) when using body mass index (BMI)-for-age z scores [6]. This gender distribution aligns with broader national data showing higher obesity rates in male adolescents [6].

The current gender disparity pattern presents an interesting contrast to historical data. Earlier findings from 2005 showed Saudi females having significantly higher obesity rates (44%) compared to males (26.4%) [7], suggesting a potential shift in gender-related adiposity patterns over the past two decades. This apparent reversal in gender-specific obesity prevalence warrants further investigation to understand the underlying sociocultural, behavioral, and environmental factors contributing to these changing patterns. The observed higher prevalence of overweight in males (42.4%) compared to females (31.8%) has remained relatively consistent3, though the overall magnitude of the problem continues to increase across both genders.

Reducing calorie intake and increasing energy expenditure are fundamental principles of lifestyle treatments, and engaging in physical activity is a crucial behavior for facilitating weight loss [8-10].

A significant association exists between participating in substantial amounts of moderate-to-vigorous physical activity (MVPA) and effectively sustaining weight loss over an extended duration [11]. According to current standards, to avoid gaining weight and maintain weight reduction, people should strive for 300 minutes per week of moderate-intensity exercise or 150 minutes per week of vigorous-intensity exercise [12]. However, the effect of physical activity with light-intensity and sedentary behavior on weight control needs to be treated [13].

Habit plays an essential role for some exercisers, implying a nonconscious, automated element to physical activity [14]. Experts believe that while physical activity might not be a habit (because it is very complex to be automated), the decision to exercise may become habitual [15]. The disagreement over the precise nature of habit within a workout demonstrates that any of these clearly defined definitions of habit have recently been used in studies on physical activity [16]. Knowing the process of habit structure during effective, frequent physical activities may help develop treatments for sedentary people; hence, studying habit formation mechanisms is crucial.

The vast majority of Saudi adolescents (≈84% of boys and ≈91.2% of females) spend over two hours every-day on electronic devices, and (≈50% of males and ≈75% of females) fail to reach the recommended daily physical activity standards [17]. Physical activity has been revealed to enhance longevity and decrease the possibility of diseases such as stroke and cancer [18]. Research has demonstrated that practicing 180 minutes of moderate physical activity weekly can potentially lower the occurrence of non-communicable chronic diseases [1, 19]. However, despite these findings, a significant proportion of adults in developed countries face challenges in attaining these advised standards [20].

Accordingly, studying how to effectively integrate regular physical activity into lifestyle is crucial. People do vary in their ability to start and maintain an exercise plan, which raises the question of why some can do so, while others are not able to do so. Physical activity maintenance has received little attention, and few theoretical models are available [21].

Despite the growing body of research on the benefits of physical activity and habit formation for improving health outcomes, there remains a significant gap in knowledge regarding their combined effect, particularly in the context of Saudi Arabia [22].

While studies have explored the impact of physical activity on reducing chronic diseases and promoting overall well-being, and others have examined the role of habit formation in sustaining healthy behaviors, there is a lack of research that specifically evaluates how these two factors interact to influence health outcomes in the Saudi population. This gap is particularly concerning given the high prevalence of sedentary lifestyles and obesity-related health issues in the region. Understanding the synergistic effect of habit formation and physical activity could provide valuable insights for designing targeted interventions to address public health challenges in Saudi Arabia. Further research is urgently needed to explore this underexamined area and inform evidence-based strategies for promoting healthier lifestyles in the Kingdom. Therefore, the aim of this study was to investigate the impact of promoting physical activity, with a particular focus on habit formation, on BMI and body fat (BF) percentage as well as healthy behavior parameters among the university community in the Eastern Province of Saudi Arabia.

MATERIALS AND METHODS

Participants and Procedures

A prospective cohort study was conducted at Imam Abdulrahman Bin Faisal University (IAU). The study population comprised university staff members and as well as students who were gym clients. Ethical approval was obtained from the Ethics Committee at IAU, Institutional Review Board (IRB number: IRB-2022-19-506), and all participants provided written informed consent.

The inclusion criteria were gym clients from IAU university staff and students aged 18-55 who participated in less than 150 minutes of moderate-intensity aerobic physical activity per week, less than 75 minutes of vigorous-intensity aerobic physical activity per week, and less than two days of muscle-strengthening activities per week. Participants were excluded if they declined to provide informed consent, were unable to attend all required measurement sessions or complete the entire duration of the physical activity program, had medical conditions contraindicating unsupervised exercise, were participating in another exercise or weight management study, had irregular schedules precluding consistent participation, had recent significant weight fluctuations or were currently enrolled in formal physical activity or weight management programs.

Participants were recruited for the study through various announcements, including flyers, brochures, email advertisements, and WhatsApp messages. Furthermore, they were selected to represent a demographic expected to engage in regular exercise.

The study focused on physical activities that utilized at the IAU Health Club, and regular training schedules, which include football, basketball, volleyball, and handball grounds, an athletics track, tennis courts, a gymnasium, squash courts, a bowling alley, table tennis and billiard tables, a fitness hall, and a swimming pool.

Initially, 139 Saudi participants completed all pre- and post-intervention measures. However, 33 participants did not meet the inclusion criteria and were subsequently excluded from the final analysis (**Figure 1**). Thus, a total of 106 participants were included in the final analysis.

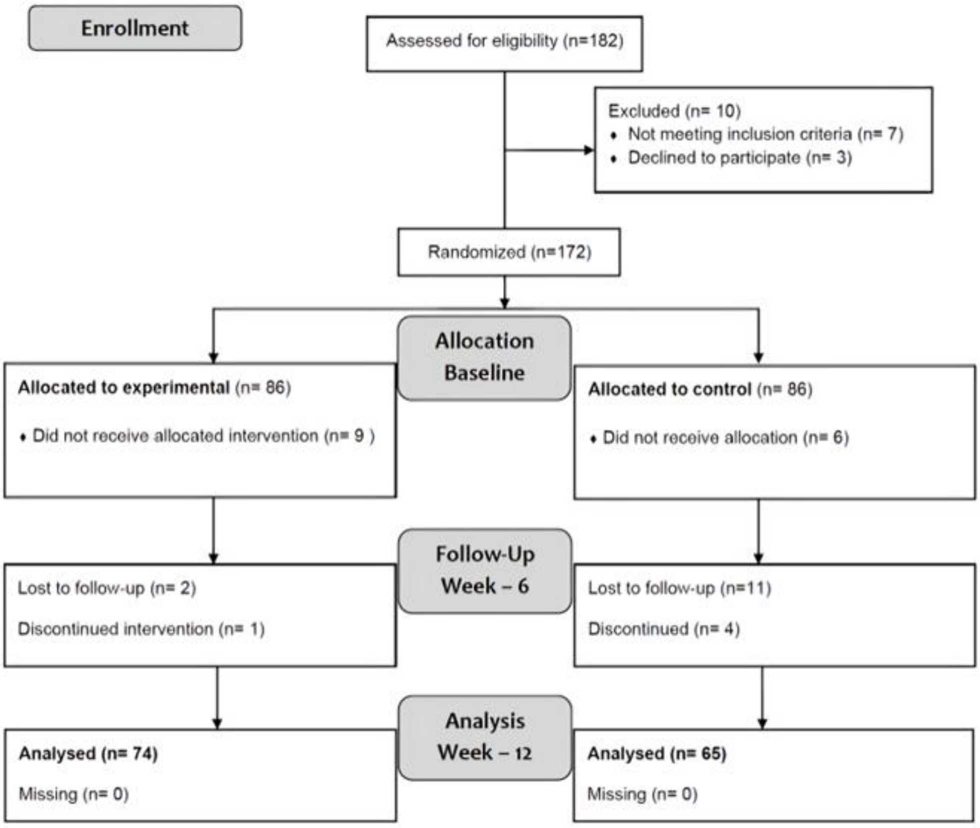

Figure 1. Flow diagram of enrolment, intervention allocation, follow-up, and analysis for the experimental and controls (Source: Authors' own elaboration)

Participants were recruited and divided into two groups: an experimental group (n = 74) that underwent a habit formation intervention with physical activity consisting of 4 sessions per week, and a control group (n = 65) that received no intervention and participated.

The experimental group participated in an initial pooled session during the first week and received personalized telephone follow-ups six weeks later. This group aimed to develop preparatory exercise routines among participants.

The preparatory stage involved activities preceding actual exercise performance, such as acquiring exercise equipment (e.g., training clothes, towels, resistance bands) and changing clothes before gym visits.

Participants were provided with an overview of the health benefits of regular physical activity [23] and received explanations about habit formation concepts. They were given specific behavioral guidelines to establish habits by completing at least four physical activity sessions per week for twelve weeks [24]. Additionally, participants were informed about critical psychological factors to consider during the preliminary stage, such as consistency and cues. The principal investigator emphasized the importance of maintaining a consistent preparation routine.

Behavioral consistency was highlighted as essential for establishing specific exercise times [25] and stabilizing events contributing to the preliminary stage. After this explanation, participants were guided to develop action plans to implement behavioral regulation techniques.

These action plans were designed to help participants schedule their workouts consistently, such as "after university at 5:30 p.m." or "before university at 7:00 a.m." Participants were instructed to select their preferred workout clothes from storage and place them on their beds before leaving for university. Upon returning home, they would keep the clothes on the bed until it was time to exercise.

After completing their workout, participants were advised to put the clothes back in the cupboard to deactivate the cue. This practice ensures that the cue is effective and not associated with unrelated activities. This routine can be applied to various items, such as athletic shoes or a sports drink bottle.

Physical Activity Intervention Combined With Habit Formation

The intervention for the experimental group was structured around established physical activity guidelines to achieve significant health benefits. Participants were involved in four weekly sessions, each lasting at least 60 minutes, over a 12-week period, ensuring a minimum of 180 minutes of activity per week. This regimen aligns with the guidelines recommending 150-300 minutes of moderate-intensity or 75-150 minutes of vigorous-intensity aerobic exercise weekly [26].

Exercise intensity: The intensity was regulated by maintaining participants' heart rates within 60-80% of their maximum, ensuring moderate exertion levels.

Attendance compliance: Participants were required to attend at least 90% of the sessions. Notably, all participants exceeded this attendance requirement, with their participation meticulously recorded for each session.

We enhanced the experimental group to attend physical activity intervention premised on the physical activity guidelines [27, 28] in order to get significant health advantages, the guidelines suggest that adults engage in 150-300 minutes of moderate-intensity aerobic exercise weekly, or 75-150 minutes per week of vigorous-intensity aerobic exercise, or a mix of both at an equivalent level.

The physical activity intervention consisted of four sessions of at least 60 minutes each per week for 12 weeks, totaling a minimum of 180 minutes of activity per week. Exercise intensity was controlled by keeping participants' heart rates within the moderate range, defined as 60-80% of their maximum heart rate.

It was required for the experimental group to keep up with the physical activity intervention (i.e., attendance ≥ 90% of workouts) [19].

The intervention consisted of both individual and group-mediated trials. Group-mediated trials aid in the creation of groups and the establishment of exercise adherent expectations [29]. Using worksheets and phone contact counselling have been demonstrated to be helpful components in behavior modification.

Targeted Consequences

To evaluate the research outcomes (i.e., weight, BMI, BF percentage, MVPA minutes, step counts, and weekly leisure activity score), measurements were taken at baseline, and after 12 weeks. The self-report surveys utilized to evaluate these constructs were distributed through online surveys at the mentioned time points (baseline and week twelve).

Anthropometric Assessment

BMI determined using the BMI formula = weight in kilograms (kg) divided by the square of the height in meter (m^2) (BMI [kg/m^2]). The BMI was classified according to the cut-off points established by the World Health Organization: underweight, healthy weight, overweight, or obese (< 18.5, 18.5-24.99, 25.0-29.99, or ≥ 30.0 kg/m^2, respectively) [30]. Formulas developed in 1991 were used to calculate BF percentage based on BMI as follows [31, 32]:

$$BF\ percentage = 1.20 \times BMI + 0.23\ \times age - 10.8\ \times sex - 5.4. \quad (1)$$

Healthy Behavior Assessment Accelerometry

Subjects were instructed to adopt an accelerometer for a continuous period of seven days, from the moment of awakening in the morning to the moment of retiring to bed. As well as wearing the accelerometer for at least 12 hours a day, participants were required to record any occurrences where the accelerometer was removed. The wear time parameters were established based on recommendations that stipulated a minimum of five consecutive days with ten legitimate hours [33].

Moderate-To-Vigorous Physical Activity

The calculation of MVPA time involved the use of frequency bouts, defined as periods of MVPA lasting at least 10 minutes (with an average acceleration count of 1,952 per minute) [34]. Therefore, the subjects' MVPA time was considered reasonable only if it lasted for a minimum of 10 minutes.

Weekly Leisure Activity Score

We used the Godin leisure-time exercise questionnaire to evaluate weekly leisure activity score [35]. It asked three open-ended questions about mild, moderate, and strenuous PA intensities. How frequently do you perform each of the following types of exercise for more than 15 minutes throughout a regular 7-day 'weekly', using Eq. (2):

$$Weekly\ leisure\ activity\ score = 9 \times strenuous + 5\ \times moderate + 3\ \times light. \quad (2)$$

Sample Size

According to prior recommendations [36], a power analysis using G Power 3.1.9.7 [37] revealed that 139 participants would be required to identify a medium-sized impact as significant for the primary outcome in a repeated measures test with an alpha error probability of 0.05 and a power adjustment of 0.90.

Statistical Analyses

Data were analyzed using SPSS for Windows (version 25, SPSS Inc., Chicago, IL, USA). The distribution of normality was evaluated with the Shapiro-Wilk test. Student t-test was utilized to examine general characteristics of participants' differences at baseline. To determine statistically significant differences between groups independent t-tests were used (between experimental and controls at baseline and after 12 weeks); and for within groups paired sample t-tests were used (between pre-post measurements for experimental groups; and between pre-post measurements for controls). Statistical analyses were undertaken using SPSS V 24.0 (SPSS Inc, Chicago, IL, USA). Central tendency (means) and dispersion (standard deviation) described the variables under investigation. Statistical significance was set at $p < 0.05$.

RESULTS

One hundred and thirty-nine participants ages ranged from 18-55 years (mean [M] ± standard deviation [SD]; age 34.78 ± 10.20 years, weight 85.14 ± 10.04 kg, body height 174.3 ± 4.2 cm, BMI 29.70 ± 2.89, BF percentage 27.37 ± 3.87) gym clients from IAU university staff members and students, volunteered to take part in the study.

According to BMI, a total of 133 (95.6%) of the entire sample were overweight or obese (n = 83 overweight 59.71% and n = 50 obese 35.97%) and didn't adhere to the suggested physical activities guidelines at the time of recruiting [23]. Additionally, 12% self-reported their first time engaging in an exercise routine, and over 90% desire to continue training in the IAU health club during the academic year and beyond 1-3 times per week, lasting 60 minutes at least. Participants underwent screening using the physical activity readiness questionnaire.

Comparison of Baseline Characteristics Between Experimental and Control Groups

Indeed, the two groups (experimental and control) exhibited similarities at the beginning of the study. **Table 1** displays the initial measurements of anthropometric and healthy behavior for both experimental and control groups. Both groups had similar characteristics at the start of the study. No statistically significant changes were seen between the experimental group and controls in any measured parameter (e.g., age, weight, BMI, BF percentage, MVPA minutes, step counts, and weekly leisure activity score).

Table 1. General characteristics (baseline) of participants, experimental, and controls

Parameter	Group	M ± SD	t	Mean difference[a]	95% confidence interval		p-value
					Lower	Upper	
Weight	Experimental	84.14 ± 8.72	-1.27	-2.16	-5.53	1.21	0.21
	Controls	86.29 ± 11.33					
BMI	Experimental	29.96 ± 2.96	1.15	0.56	-0.41	1.53	0.25
	Controls	29.40 ± 2.79					
BF percentage	Experimental	27.80 ± 4.51	1.42	0.93	-0.36	2.23	0.16
	Controls	26.87 ± 2.93					
MVPA	Experimental	180.68 ± 16.31	-0.69	-1.82	-7.03	3.4	0.49
	Controls	182.49 ± 14.55					
Step counts	Experimental	4,027.81 ± 597.40	-1.04	-98.84	-293.48	95.81	0.32
	Controls	4,126.65 ± 557.35					
Weekly leisure activity score	Experimental	35.35 ± 8.16	1.86	2.32	-0.15	4.79	0.07
	Controls	33.03 ± 6.29					

Note. $p < 0.05$ & [a]Experimental mean minus controls means

Table 2. Anthropometric and healthy behaviors parameters of the experimental group and controls after 12 weeks

Parameter	Group	M ± SD	t	Mean difference[a]	95% confidence interval		p-value
					Lower	Upper	
Weight	Experimental	78.83 ± 9.18	-4.55	-7.87	-11.29	-4.45	0.00
	Controls	86.70 ± 11.21					
BMI	Experimental	28.07 ± 3.14	-2.92	-1.48	-2.48	-0.48	0.00
	Controls	29.55 ± 2.80					
BF percentage	Experimental	25.53 ± 4.67	-3.10	-2.21	-3.61	-0.80	0.00
	Controls	27.74 ± 3.54					
MVPA	Experimental	253.86 ± 21.92	19.77	62.36	56.12	68.59	0.00
	Controls	191.51 ± 13.74					
Step counts	Experimental	6,132.42 ± 919.66	10.69	1,477.36	1,203.94	1,750.77	0.00
	Controls	4,655.06 ± 671.89					
Weekly leisure activity score	Experimental	74.77 ± 15.58	11.96	29.08	24.27	33.89	0.00
	Controls	45.69 ± 12.70					

Note. $p < 0.05$ & [a]Experimental mean minus controls means

Comparison of Experimental and Control Group Characteristics at 12-Week Follow-Up

Indeed, the two groups exhibited dissimilarities after a duration of 12 weeks. **Table 2** presents the anthropometric and healthy behavior measurements for both experimental and control groups after 12 weeks. Compared to the control group, the experimental group showed statistically significant reductions (improvements) in all anthropometric measurements and increases (improvements) in healthy behavior parameters.

Baseline and Post-Intervention Assessment of the Experimental Group

The experimental group exhibited improvements in all their anthropometric and healthy behavior indicators. These reductions were statistically significant for all parameters. All the parameters evaluated showed improvements, with the mean differences aligning in the anticipated direction. **Table 3** displays the anthropometric and healthy behavior parameters of the experimental group before and after 12 weeks.

Baseline and Post-Intervention Assessment of the Control Group

The control group showed a consistent rise (deterioration) in all the anthropometric measurements that were analyzed. All anthropometric parameters showed statistically significant increases. It is important to mention that for all anthropometric measurements, the differences observed in the control group were negative, indicating a significant decline in the individuals' condition. In contrast, healthy behaviors parameters showed statistically significant improvements. **Table 4** displays the initial measures of the control group, and their corresponding data acquired after a period of 12 weeks.

DISCUSSION

To the best of our knowledge, the current study is the first to examine the effects of university resources in short-term physical activity-based programs combined with habit formation intervention in relation to healthy behaviors and their related outcomes relied on self-reported activity.

Our findings demonstrate that leveraging university resources, combined with a focus on habit formation, led to significant improvements in health outcomes. These included reductions in BMI and BF percentage, alongside positive changes in health behaviors such as increased MVPA, higher step counts, and a decrease in weekly leisure activity scores

A previous report indicated that the percentage of university students engaging in physical activities was notably low (9.6%), attributed to factors such as a lack of guidance regarding the activities and their objectives, as well as the unattractive nature of most available activities [38].

With agreement of our finding, engaging in physical activity and habit formation intervention are linked to enhanced anthropometric [39] and health behaviors [40, 41].

Nevertheless, most of the evidence that confirms this correlation relies on self-reported data regarding physical exercise [42]. It is crucial to verify that the results obtained by

Table 3. Anthropometric and healthy behaviors parameters of the experimental group at baseline and after 12 weeks

Parameter	Group	M ± SD	t	Mean difference[a]	95% confidence interval		p-value
					Lower	Upper	
Weight	Pre	84.14 ± 8.72	13.92	-5.30	4.54	6.06	0.00
	Post	78.83 ± 9.18					
BMI	Pre	29.96 ± 2.96	11.28	-1.89	1.56	2.23	0.00
	Post	28.07 ± 3.14					
BF percentage	Pre	27.80 ± 4.51	11.28	-2.27	1.87	2.68	0.00
	Post	25.53 ± 4.67					
MVPA	Pre	180.68 ± 16.31	-42.46	73.19	-76.62	-69.75	0.00
	Post	253.86 ± 21.92					
Step counts	Pre	4,027.81 ± 597.40	-26.50	2,104.61	-2,262.89	-1,946.33	0.00
	Post	6,132.42 ± 919.66					
Weekly leisure activity score	Pre	35.35 ± 8.16	-33.82	39.42	-41.74	-37.10	0.00
	Post	74.77 ± 15.58					

Note. $p < 0.05$ & [a]Experimental mean minus controls means

Table 4. Anthropometric and healthy behaviors parameters of the control group at baseline and after 12 weeks

Parameter	Group	M ± SD	t	Mean difference[a]	95% confidence interval		p-value
					Lower	Upper	
Weight	Pre	86.29 ± 11.33	-3.24	0.41	-0.66	-0.16	0.00
	Post	86.70 ± 11.21					
BMI	Pre	29.40 ± 2.79	-3.36	0.15	-0.23	-0.06	0.00
	Post	29.55 ± 2.80					
BF percentage	Pre	26.87 ± 2.93	-3.05	0.87	-1.43	-0.30	0.00
	Post	27.74 ± 3.54					
MVPA	Pre	182.49 ± 14.55	-9.76	9.02	-10.86	-7.17	0.00
	Post	191.51 ± 13.74					
Step counts	Pre	4,126.65 ± 557.35	-19.72	528.42	-581.96	-474.87	0.00
	Post	4,655.06 ± 671.89					
Weekly leisure activity score	Pre	33.03 ± 6.29	-10.74	12.66	-15.02	-10.31	0.00
	Post	45.69 ± 12.70					

Note. $p < 0.05$ & [a]Experimental mean minus controls means

self-report accurately reflect that physical activity linked to anthropometric and health behaviors. Meanwhile, the results of this study are based on reliable measurements, providing valuable insights into the effects of physical activity intervention combined with habit formation on sustained anthropometric and healthy behavior parameters.

While habit formation was proposed as a method for changing behavior within the broader framework of behavior modification [43], this intervention initially focuses on promoting exercise through habit development.

Unconscious processes may contribute significantly to exercise behavior prediction, and future interventions should focus more on this.

Habit is best characterized as a cognitive-motivational process conceptually different from behavior. Although the distinction between habit and behavior is not new [44], its ramifications have not been adequately explored. Habits are cue-dependent, meaning the habit-generated impulse will not be engaged if the signal is not present [45]. The evaluation of habit development in health activities is a new research topic [14]. According to social psychology studies, habit development defines many of our everyday activities [46], including some exercise behaviors, allowing us to focus on other tasks and think about other things.

Training weekly days revealed a statistical significance trend with the location. Generally, we suppose that the more habitually individuals exercise, the more expected they are to develop regular patterns and, consequently, the greater their likelihood of being influenced by the environment. The knowledge gained about the strength of habits validates the notion that consistently doing a selected behavior within a specific context can result in automaticity [45]. An advantage of the present study was the incorporation of habit theory [47] in creating the intervention.

Particularly for those who belong to a health club center that they use almost exclusively for exercise. However, the frequency was strongly linked with automaticity-driven psychological habits. Consequently, multiplied frequency can lead to automated performance (e.g., the automated decision to execute) of the habit, such as regular exercise [25].

The participants who got the intervention showed more significant average gains in MVPA, which is consistent with the main hypothesis. More precisely, the experimental group that followed the healthy habit instructions achieved the recommended MVPA criteria more than the control group by week 12. The minimal cognitive demand of regular activities may be advantageous for developing healthy behavior [48]. If a behavior can be established as automatic and cued by consistent external cues, it is more likely to be done regularly [16]. On the other hand, reducing harmful habits characterized by such automaticity is a problem for the exact cause.

Participants who received physical activity intervention combined with habit formation accumulated the most steps per day, demonstrating that taking a lot of steps could be a significant factor in weight loss, BMI, BF percentage, and in preventing weight gain. Our results are consistent with earlier research showing that a 6-month intervention, people in the top quartile of weight loss significantly increased their daily step count (by 2,607 steps) in comparison to those in the lowest quartile [49]. Incorporating more standing and walking into daily routines, in place of prolonged sitting, could be a valuable recommendation for individuals aiming to manage their weight. Even small changes such as standing instead of sitting can lead to significant increases in total daily energy expenditure [34].

The results of the current study clearly indicate the significance of the habit formation combined with physical activity intervention in improving the weekly leisure activity score, highlighting its importance in enhancing health indicators. This align with the American College of Sports Medicine's guidelines on weight loss and weight control which recommend the following:

(a) at least 150 minutes per week of moderate-intensity physical activity to prevent weight gain;

(b) 150-250 minutes per week (roughly 1,200-2,000 kcal) of moderate physical activity avoid gaining weight greater than 3% and to support modest weight loss; and

(c) approximately 250-300 minutes per week (about 2,000 kcal) of moderate-intensity physical activity for more significant weight-loss and to prevent weight-gain [9].

This study enhances the existing literature by demonstrating that strategies to establish experience associations relevant to the context seem to have a comparable effect. The present study not only includes a sample of the general population and fresh findings that are backed by objective measurement, but it also has significant translational value for trainers and new gym members between the ages of 18 and 55. There are some limitations that have to be acknowledged. Females were not involved in our study. The study was executed in only one health club. Additionally, certain crucial factors, including participants' income, lifestyle, and other activities were not gathered.

CONCLUSIONS

This study represents the positive impact of regular physical activity interventions, combined with habit formation, on adiposity indicators and the promotion of healthy behaviors within a university setting. For university health clubs and gyms, it is essential to establish habits alongside physical activities, particularly for new practitioners, to ensure consistent engagement in training. University policymakers should prioritize the effective implementation of physical activity guidance both during and outside university hours to encourage participation among students and staff. Institutions should mandate 3 weekly physical activity hours as part of employment/student contracts and subsidize wearable activity trackers to reinforce habit cues. Future research should replicate this study with extended intervention periods to evaluate the long-term sustainability of the observed improvements in physical activity interventions.

Limitation of the Study

One notable limitation of this study is that it did not include female students in the physical exercise intervention The decision to exclude female students from the physical exercise component of this study was based on several practical and methodological considerations. First, the study aimed to control potential confounding variables, such as physiological differences between genders, which could influence the outcomes of the exercise intervention. By focusing exclusively on male students, the study sought to establish a more homogeneous sample, reducing variability and increasing the internal validity of the findings. Additionally, logistical constraints, such as limited resources and the availability of gender-segregated facilities, played a role in this decision. While this approach allowed for a more controlled investigation, it also introduced a limitation in terms of generalizability to female populations. Future studies are encouraged to include both male and female participants to explore potential gender differences and ensure broader applicability of the results.

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Ethical statement: The authors stated that the study was approved by the Ethics Committee at the IAU on 1 December 2022 with approval number IRB-2022-19-506. Written informed consents were obtained from the participants.

Declaration of interest: No conflict of interest is declared by the authors.

Data sharing statement: Data supporting the findings and conclusions are available upon request from the corresponding author.

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