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Physical and Psychological Outcomes of an Online vs. In-Person Training Program in Adults: The Role of Exercise Adherence

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KEYWORDS: PHYSICAL ACTIVITY, ADHERENCE, SUPERVISED TRAINING, DIGITAL INTERVENTION, VO_2MAX, BLOOD PRESSURE, CRAVE, PANAS

“A real loser is somebody that’s so afraid of not winning, they don’t even try”

-Little miss sunshine

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Resumo

Introdução. A inatividade física e os estilos de vida sedentários continuam a ser preocupações urgentes de saúde pública. Abordagens inovadoras, incluindo formatos de treino digitais, podem oferecer alternativas viáveis ao exercício supervisionado, mas as evidências que comparam a sua eficácia e o papel da adesão ainda são limitadas.

Objetivo. Este estudo teve como objetivo avaliar os efeitos de um programa de treino combinado de dez semanas, ministrado em dois formatos – presencial supervisionado e online autónomo –, nos resultados físicos e psicológicos. Os objetivos secundários foram examinar a influência da adesão e da interação dos formatos.

Métodos. Vinte e cinco adultos (15 mulheres, 10 homens; idade média 50.92 ± 10.47 anos) completaram a intervenção. Os participantes auto-selecionaram-se para o grupo supervisionado (n = 15) ou para o grupo autónomo (n = 10). Os resultados principais incluíram os testes de resistência muscular (supino, agachamento) e capacidade cardiorrespiratória (VO_2max). Os participantes mais velhos realizaram testes adequados à idade (levantar da cadeira, flexão de braço, 6MWT). A adesão foi analisada de forma contínua (%) e categórica (≥75% vs. <75%). Os resultados psicológicos incluíam, o estado de motivação momentânea (CRAVE) e o estado afetivo (PANAS)

Resultados. Foram observadas melhorias significativas antes e depois no supino, no agachamento e no VO2max ($p < 0.05$). Os adultos melhoraram em todos os testes de desempenho; os participantes mais velhos apresentaram ganhos descritivos, apenas na variável sentar e levantar ($p = 0.04$). Os participantes que cumpriram o programa (≥75%) alcançaram melhorias significativamente maiores no VO2max. Não foram encontradas diferenças significativas entre os formatos de entrega, bem como nos resultados psicológicos que permaneceram inalterados.

Conclusões. Um programa de treino combinado de dez semanas melhorou a aptidão física em adultos, independentemente do formato de entrega. A adesão surgiu como um determinante crítico dos ganhos cardiorrespiratórios. Os resultados psicológicos permaneceram estáveis, sugerindo que intervenções mais longas podem ser necessárias para detetar mudanças motivacionais e afetivas. Essas descobertas fornecem evidências preliminares que apoiam a viabilidade dos formatos de treino supervisionado e digital.

Palavras-chave: atividade física, adesão, treino supervisionado, intervenção digital, VO_2máx, pressão arterial, CRAVE, PANAS

Abstract

Introduction. Physical inactivity and sedentary lifestyles remain pressing public health concerns. Innovative approaches, including digital training formats, may provide feasible alternatives to supervised exercise, but evidence comparing their effectiveness, and the role of adherence is still limited.

Objective. This study aimed to evaluate the effects of a ten-week combined training program delivered in two formats – supervised in-person and autonomous online – on physical and psychological outcomes. Secondary aims were to examine the influence of adherence and the interaction of formats.

Methods. Twenty-five adults (15 female, 10 males; mean age 50.92 ± 10.47 years) completed the intervention. Participants self-selected into either the in-person group (n = 15) or the online group (n = 10). Core outcomes included muscular endurance (bench press, squats), and estimated VO_2max. Older participants performed age-appropriate tests (chair stand, arm curl, 6MWT). Adherence was analyzed both continuously (%) and categorically (≥75% vs. <75%). Psychological outcomes were the state of momentary motivation (CRAVE) and the affective state (PANAS).

Results. Significant improvements were observed before and after in bench press, squat, and VO2max ($p < 0.05$). Adults improved in all performance tests; older participants showed descriptive gains only in the chair stand variable ($p < 0.04$). Participants who completed the program (≥75%) achieved significantly greater improvements in VO2max. No significant differences were found between delivery formats, and psychological outcomes remained unchanged.

Conclusions. A ten-week combined training program improved physical fitness in adults regardless of delivery format or baseline activity status. Adherence emerged as a critical determinant of cardiorespiratory gains. Psychological outcomes remained stable, suggesting longer interventions may be required to detect motivational and affective changes. These findings provide preliminary evidence supporting the feasibility of both supervised and digital training formats and highlight the need for larger, longer-term studies.

Keywords: physical activity, adherence, supervised training, digital intervention, VO_2max, blood pressure, CRAVE, PANAS

List of abbreviations

6MWT – Six Minute Walk Test

ACSM – American College of Sports Medicine

BMI – Body Mass Index

bpm – beats per minute

CI – Confidence Intervals

CRAVE – Cravings for Rest and Volitional Energy Expenditure

d – Cohen's d

DBP – diastolic blood pressure

DXA – Dual-energy X-ray absorptiometry

HR – Heart Rate

HRV – Heart Rate Variability

kg – kilograms

MC – Mean Change

min – Minutes

mL – milliliters

mmHg – millimeters of mercury

PANAS – Positive and Negative Affect Schedule

SD – Standard deviation

SBP – systolic blood pressure

VO_2max – Maximal oxygen consumption

Introduction

Sedentary behavior is increasingly recognized as a major public health concern and an independent risk factor for type 2 diabetes, cardiovascular disease, certain cancers, and premature mortality (Wilmot et al., 2012; Henson et al., 2023). Projections indicate that the global target of reducing physical inactivity by 15% by 2030 will not be met, with Portugal remaining among the countries with the highest prevalence of sedentary lifestyles (Special Eurobarometer 472, 2017; Strain et al., 2024). These trends underscore the urgency of developing effective interventions to increase physical activity across diverse populations.

Regular participation in physical activity, including both aerobic and resistance training, has been consistently associated with improvements in cardiorespiratory capacity, muscular strength, body composition, blood pressure, and health-related quality of life (Warburton & Bredin, 2019; González-Gross & Meléndez, 2014). These benefits are particularly relevant in middle-aged adults and older individuals, who often experience larger health gains and improvements in functional autonomy following structured training programs (Rejeski et al., 1996; De Backer et al., 2007).

Traditionally, exercise programs have been delivered in face-to-face, supervised settings. However, advances in technology and the time constraints of modern life have led to the development of online digital training formats, which offer greater flexibility and accessibility (Steele et al., 2009; Valenzuela et al., 2018). Evidence suggests that both supervised, and technology-based interventions can yield comparable physical outcomes, although engagement and adherence may differ between delivery modes (Terashima et al., 2023; Peña et al., 2024).

Adherence is a key determinant of intervention success. Participants with higher attendance typically achieve greater improvements in cardiorespiratory fitness and strength compared to those with lower adherence (Gjestvang et al., 2019; Little et al., 2022). Similarly, individuals with a history of regular physical activity are more likely to complete training programs successfully (Saida et al., 2017). Thus, evaluating not only mean effects but also the moderating role of adherence and prior activity status is crucial to understand exercise outcomes.

Psychological factors also influence the adoption and maintenance of active lifestyles. Positive affect is associated with higher levels of physical activity, whereas sedentary behavior has been linked to more negative affect (Pasco et al., 2011; Hogan et al., 2015). Momentary motivational states, such as the desire to move or rest, provide insight into automatic processes that may influence behavior. The CRAVE scale (Stults-Kolehmainen et al., 2021) offers a validated measure of such states, while the PANAS (Watson et al., 1988; Galinha et al., 2014) captures fluctuations in affective experience. Together, these instruments allow for the assessment of emotional and motivational dimensions that may interact with adherence and physical outcomes.

Despite growing interest in digital exercise interventions, few studies have simultaneously compared delivery format (in-person vs online), and adherence (compliers vs. non-compliers) on both physical and psychological outcomes. Addressing this gap requires semi-experimental, pilot interventions that can test feasibility, identify preliminary trends, and generate evidence for larger, controlled trials.

The primary aim of this study was to evaluate the effects of a ten-week combined training program (aerobic plus resistance) delivered in two formats: autonomous/online via a mobile application and supervised/in-person on physical and psychological results. Secondary aims were to examine: (i) whether outcomes differed between delivery format; (ii) the influence of adherence (≥75% vs. <75% session attendance) on physical and psychological results.

Literature review

The existence of a dose–response relationship between physical activity levels and reduced mortality highlights the importance of implementing physical activity interventions regardless of intensity or delivery format. Regular engagement in physical activity plays a critical role in counteracting the onset or progression of various comorbidities (Warburton & Bredin, 2017).

Despite these advances, in terms of adherence, physical activity remains a central challenge. Engaging in moderate-to-vigorous activity often declines as part of daily routines (Maillane-Vanegas et al., 2017), underscoring the importance of reinforcing sustained active lifestyles. Promoting long-term adherence to exercise, sport, and healthy lifestyles is considered one of the most significant achievements in human development, as it contributes not only to physical health but also to life skills acquisition. Nevertheless, maintaining regular participation is influenced by a range of individual, social, and contextual factors (Pühse & Gerber, 2005). Continually, adherence to exercise programs remains a critical challenge, with the high dropout rates limiting their effectiveness (Collins et al., 2022).

Promoting sustained adherence to physical activity, sport, and healthy lifestyles is one of the greatest achievements of human development and plays a central role in the acquisition of life skills; however, maintaining regular physical activity over the years faces several challenges, since it's influenced by diverse variables (Pühse & Gerber, 2005). Life's transitions are closely associated with changes in an individual's engagement in sport and physical activity (Tammelin et al., 2014). Continually, moderate-to-vigorous physical activity has gradually declined in prominence within daily routines, underscoring the need to reinforce the importance of sustaining an active lifestyle, particularly during the transition into adulthood (Maillane-Vanegas et al.,2017). Furthermore, in terms of moderate-to-vigorous physical activity (MVPA), individuals who participated in sports during earlier life stages were, as adults, on average 48 minutes more active per week compared to those who had never engaged in such activities (Kongsvold et al.,2025).

This raises the question of whether training format (in-person vs. online) influences adherence and, consequently, the evolution of physical and psychological indicators in adults. Understanding these differences is decisive to guide health professionals and exercise practitioners in tailoring interventions that maximize adherence and both physical and psychological outcomes.

Beyond increasing time spent in moderate-to-vigorous physical activity, the World Health Organization also emphasizes the importance of engaging in muscle-strengthening activities. For adults, performing strength-based exercises involving all major muscle groups on two or more days per week is considered an additional factor contributing to improved health outcomes (WHO, 2020).

Therefore, strength training should be applied alongside aerobic exercise to promote not only muscle gains but also cardiorespiratory endurance, which is an asset in everyday life, reducing and mitigating the risk of recurrence (Beniamini et al. 1999). Regardless of cardiorespiratory fitness levels, the association between muscle strength and mortality remains significant, even after controlling other variables, emphasizing that greater muscle strength is inversely associated with all-cause mortality across both sexes (Ruíz et al.,2008; Phillips,1986; Blair et al.,1995).

Muscle strength is understood as the ability to provide momentum against a load, which can be characterized by the maximum torque that can arise from a given movement (Signal, 2014). The term strength involves morphological and neuronal components, including the recruitment and synchronization of motor units, as well as muscle stiffness and suppression (Suchomel et al. 2018). Adaptable attributes include muscular strength, power, hypertrophy, and local muscular endurance, integrated into a well-rounded fitness program, aerobic exercise enhances cardiovascular function and decreases physical vulnerability (Fleck, 1988 & Evans, 1999), while being monitored and prescribed by a qualified and capable professional who follows training principles of progression, overload, specificity, and individualization, helping on adapting the training based on each person's objectives (Williams et al. 2007).

The profound influence of technology on daily life has extended into the field of sport, where it is increasingly utilized to promote physical activity and support a wide range of sport-based interventions (Fucarino et al., 2024).

E-health is an emerging term that can designate interventions in the context of health services, which can also emphasize the promotion of physical activity (Eysenbach, 2001; Matthews et al.,2016). In this way, these types of interventions can be at the root of an increased number of dedicated hours and energy spent on active behaviors, highlighting the importance of grounding any initiative in the guidelines outlined above. Interventions regarding this method may encompass application methods, including tele-counselling, online resources, online support, video games/gamification, and video demonstrations

(Kwan et al., 2020). To reach a broader audience, public policies should incorporate digital applications into their implementation, as these tools have proven to be effective not only in promoting physical activity but also in positively influencing individuals' mental health. Therefore, digital health applications should be integrated into national health plans (Sousa Basto & Ferreira, 2025).

Traditionally, training programs have been predominantly delivered in face-to-face settings, however, advancements in technology and evolving time constraints have led to the emergence of new training modalities. These alternative approaches accommodate a broader population and help mitigate scheduling conflicts, ensuring that time constraints do not serve as a barrier to physical activity adherence (Valenzuela et al.,2018). While previous studies have shown meaningful and positive results in face-to-face settings (Van Der Biji et al., 2002), a more recent study expanded the vision beyond the limitations of face-to-face intervention with new methodologies (Marcus et al., 1998). When comparing the effectiveness of a training program assigned participants to three different modalities: face-to-face, online, and a hybrid approach combining both methods. The findings indicated that all three modalities yielded comparable results, with no single approach demonstrating clear superiority, suggesting that the success of a training program depends on effectively managing constraints and potential barriers to participation (Steele et al., 2009). In terms of a fully remote approach, incorporating video-based training sessions alongside outdoor exercises such as walking triggered a positive consequence for both physical fitness and strength (Terashima et al. 2023).

These constant technological advancements and ongoing changes have intensified workplace demands, leading to increased physical and mental strain among workers. In response, the implementation of 'Gymnastics at Work' aims to mitigate this imbalance. To ensure its effectiveness, physical education professionals must carefully align participants' schedules and optimize time management to accommodate all required activities (Aguiar et al., 2015).

When implementing a physical exercise intervention program, attention should be paid to the context of participants' behaviors, taking this point into account so as not to exacerbate, reduce, or mitigate behaviors related to physical activity and daily well-being. Thus, individuals who perform physical interventions, the social context in which they find themselves is a moderator between inactivity behaviors and negative affect, contrary to the physical context that links sedentary behavior to positive affect (Hevel et al., 2021), revealing that sedentary behavior has an impact and consequences in terms of negative affect (Elavsky et al., 2016). The association between increased physical activity and decreased time spent in sedentary behavior reveals gains in health and psychological well-being (Ryu et al.,2023).

A study investigating the effects of a training program aimed at increasing muscle strength in participants with a mean age of 22 years demonstrated that a frequency of three sessions per week resulted in significant gains in muscular strength (Pamart et al., 2023). Beyond enhancing strength, resistance training also contributes to injury prevention across various age groups and genders (Chaabene et al., 2020). Consequently, as people age, increasing physical activity engagement and regular exercise participation must prevail to prevent the aggravation of falls (Fletcher et al.1996; Gillespie et al. 1996). This approach aims to enhance lower limbs' power by improving autonomy in daily living activities, such as chair-rising, stair climbing, pace, and walking speed, while improving overall quality of life (Bassey et al. 1992).

In terms of cardiorespiratory adaptations, a meta-analysis examining high-intensity interval training (HIIT) in university students aged 18 to 25 reported significant improvements in maximal oxygen uptake (VO_2max), alongside increases in muscular strength and reductions in various anthropometric indicators (Yin et al.,2025). Regarding the benefits of high-intensity training in an older population, the gains also underline an improvement in VO2max, as well as other cardiac and muscular parameters (Wu et al., 2021).

In conclusion, combining resistance training with aerobic exercise has been shown to optimize physical function, enhance overall well-being, and mitigate age-related declines in health and mobility (González-Gross & Meléndez, 2014).

Musculoskeletal disorders remain among the most common workplace injuries, often caused by repetitive motions that affect muscles, tendons, nerves, bones, and even the circulatory system (APSEI, 2022). Consequently, preventive measures should be prioritized in these settings, including encouraging sports participation and promoting regular work breaks. Evidence suggests that supervised active breaks can significantly reduce musculoskeletal discomfort, particularly in administrative workers, and may be equally beneficial in other professional contexts (Cáceres-Muñoz et al., 2017). A structured physical activity program at work, conducted over four months, consisting of 15-minute sessions, three times per week, led to improvements in flexibility, reductions in body fat, and increases in lean body mass. The work environment itself often influences the success of such programs; for instance, social strategies like inviting colleagues to participate can foster mutual motivation and encourage more frequent active breaks, such as standing or stretching (Martins & Silva, 2000). Additionally, leveraging technology can further support these efforts; for example, using computer reminders to prompt movement has proven to be an effective tool in promoting a more active and healthier lifestyle (Warren et al., 2018)

Finally, the growing recognition of the strong connection between physical activity and psychological well-being, both of which contribute positively to organizational functioning, workplace physical activity programs not only enhance productivity but also improve employees' quality of life, strengthen interpersonal relationships, and promote a healthier, more supportive work environment (Oliveira et al., 2007).

A fundamental challenge in the study of physical activity is gaining insight into what drives motivation. Although physical activity encompasses a wide range of behaviors, most of the research targeted promoting motivation and long-term engagement but frequently neglecting involvement in sports (Kilpatrick et al.,2005). When examining the differences between motivation for exercise and for physical activity, it becomes evident that participation in sports is often driven by intrinsic factors, such as enjoyment and the desire for challenge (Kilpatrick et al., 2005). However, previous studies indicate that a predictor for physical activity is activation, making it an important tool for regulating health behaviors. Personal factors or emotional states that tend to change significantly over time can benefit from strategies that help manage and control one's own behavior (Maher et al., 2019).

Methods

Study Design

This was a semi-experimental, pre-post intervention study with two delivery formats: supervised in-person training and autonomous online training via a mobile application. Given the convenience-based allocation and small sample size, the study is best interpreted as a pilot feasibility trial.

Participants

A total of 27 adults aged 18-65 years from the Faculty of Sport, University of Porto, were recruited through presentations and information sessions. Two participants withdrew (one early dropout, one incomplete assessments), leaving 25 participants (15 female, 10 male) who completed all phases of the study.

Inclusion criteria: adults aged 18-65 years, healthy adults, willing to participate in the program, and individuals with clinical restrictions but with medical authorization.

Exclusion criteria: age outside the defined range and individuals with clinical restrictions, but without medical authorization.

Participants provided written informed consent. The protocol was approved by the institutional Ethics Committee (CID.DPC.01.19) and conducted in accordance with the Declaration of Helsinki.

Group Allocation

Participants self-selected, based on preference and scheduling availability, into one of two intervention formats:

- In-person group: face-to-face sessions guided by a certified trainer.
- Online group: independent training via the Self-Training mobile application.

Additionally, participants were categorized in a post hoc analysis according to adherence (compliers ≥75% attendance vs. non-compliers <75%).

Intervention

This study is part of a broader research project, 'Self-Training,' which aimed to evaluate the validity and reliability of heart rate variability measurements using a newly developed application (Casanova-Lizón, et al. 2023).

The pre-and post-intervention assessments took place at the Faculty of Sport of the University of Porto, mainly within two physiological laboratories, a psychological laboratory, and a fully equipped and accessible space for all participants. For organizational purposes, a proper schedule was made available for the participants to select according to their availability, based on the timetables of the college locations. Participants were previously instructed to avoid any strenuous physical activity for at least 24 hours prior to testing and to remain still and at rest during procedures that required it, preventing potential interferences with the results. On the day of the initial and final measurements, the participants were dressed in their usual sportswear, which was suitable and comfortable.

At first, the participants were brought to the Dual-Energy X-ray Absorptiometry (DXA) (GE-Lunar Prodigy, Madison, WI, USA) conducted by a certified professional, to not only evaluate the changes in muscle mass (lower body, abdominal region, upper body, and total mass) but manly to verify any contradiction to the physical activity participation.

To ensure baseline measurements did not interfere with subsequent exercise interventions, arterial pressure and heart rate were prioritized. Participants were escorted into a quiet environment where they remained seated for a five-minute rest period. Resting heart rate (RHR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) were recorded using a digital sphygmomanometer (Omron).

Anthropometric data was then collected: (i) body mass, in kg, using a scale (Tanita Bc-730); (ii) height, in cm, using a stadiometer SECA 213; (iii) BMI, in kg/m2. Next, hip and waist circumference were measured using a tape measure. Finally, subcutaneous adiposity folds (abdominal and triceps) were measured using an adipometer Holtain (cescorf ins.) where the fold is made ± 2cm above the reference site and the adipometer penetrates about 1cm into the fold, forming a 90-degree angle.

Handgrip strength was measured using the Handgrip device (dynamometer). Participants started standing with their feet shoulder-width apart, starting with the right hand, followed by the left hand. The subjects repeated the test twice on each hand, and if there was a difference between the first two attempts, they had to perform a third test (Chen et al. 2024).

The physical testing protocol comprised assessments of maximal aerobic capacity and muscular strength, stratified by age group. Therefore, participants below the age of 60 were evaluated on peak oxygen uptake (VO_2 peak) measured by using the Bruce protocol on an incremental treadmill (Bruce, 1971). This protocol is characterized by standardized 3-minute stages; at the commencement of each stage, both treadmill speed and inclination were increased until the participant reached exhaustion (Shah et al., 2016).

In terms of Muscular strength for participants below 60 years old were evaluated in both upper and lower body strength. For upper body assessment, the one-minute Bench Press Test was performed using a Smith machine and standardized equipment, with fixed loads of 35 kg for males and 15 kg for females (Bayles., 2023). Proper execution required full elbow extension and bringing the load close to the chest, while maintaining attention to key safety aspects, such as controlled breathing throughout the movement. Lastly, to assess lower-body strength, a squat test was employed to measure the maximum number of repetitions performed within one minute. The test emphasized correct technique and compliance with safety standards, particularly in relation to squat depth (Bayles., 2023). Feedback was given to ensure a 90-degree flexion of the knee, as well as to guarantee the correct depth, since the participants differed in height, a support was used to perform the exercise. (Lorenzetti et al.,2018).

In contrast, not all participants were able to complete the full battery of tests, not solely due to the high energy demands-since even less physically fit individuals attempted them-but also due to the wide age range within the sample. As a result, participants aged 60 and over were assigned alternative exercises more suited to their functional capacity. Thus, regarding aerobic capacity, the 6-minute walk test (6MWT), which is part of the senior fitness test battery (Rikly & Jones., 2013), was carried out to evaluate upper-body strength, the 30-Second Arm Curl Test. In this test, participants performed as many full arm curls as possible within 30 seconds using a standardized weight of 2.3 kg for women and 3.6 kg for men. For lower-body strength, the 30-Second Chair Stand Test was implemented, in which participants completed as many full stands as possible from a seated position within 30 seconds, with arms crossed over the chest or held in a comfortable position.

To evaluate psychological performance at the beginning and end of the program, two separate questionnaires were administered, CRAVE and PANAS, respectively, with the aim of assessing the momentary state of motivation (CRAVE), followed by the questionnaire that assesses the affective state of a given experience (PANAS).

The program lasted 10 weeks, with three sessions per week (45-60 minutes each). Each group was provided with 4 levels of intensity, starting from level 1 (low-intensity) to progressively upgrade to the following levels until reaching the final 4th level (high- intensity).

The training program progressed through four levels of increasing intensity. Level 1 emphasized exercise familiarization and correct technique, with basic strength and core exercises performed for 15 repetitions and one-minute rests. Level 2 introduced an endurance component by adding dynamic movements, such as jumping jacks and burpees, in 30-second work/rest intervals. In Level 3, training volume increased to ten exercises with progressive variations, while rest and execution times remained constant. Finally, Level 4 maximized the physiological challenge by adjusting the intervals to 40 seconds of effort and 20 seconds of rest.

During the first two weeks, training began with low-intensity sessions before progressing to a structure of two high-intensity and one low-intensity session per week. The Self-Training application supported continuous monitoring of physical and psychological parameters, including body mass, and used daily heart rate variability (HRV) assessments to automatically adjust exercise intensity, optimizing training while reducing the risk of overtraining. Regarding session selection, participants in the in-person format followed a session prescribed by the supervising instructor; however, some participants performed the session at different intensities based on their heart rate variability (HRV) assessed on the morning of the session. In contrast, participants who completed the intervention online were able to autonomously select among the available session options according to their HRV measurements. Exercise prescriptions were individualized based on a seven-day rolling average of the natural logarithm of the rMSSD (Ln-rMSSD7day−roll−avg) (Plews et al.,2012). Training intensity was adjusted relative to the smallest worthwhile change (SWC), which was calculated as the mean ± 0.5 × standard deviation (SD). Specifically, high-intensity sessions were performed when the HRV values remained within or exceeded the SWC thresholds. Conversely, if the HRV fell below the lower limit of the SWC, low-intensity exercise was prescribed to account for potential fatigue or reduced recovery (Javaloyes et al., 2019 & Kiviniemi et al., 2007).

The design and functionalities of the application ensures an easy and intuitive user-friendly for beginners, allowing their participants to not only choose where they want to execute the program session but also guaranteeing a low budget and accessible equipment. To enhance motivation and engagement, the training program was gamified within the app. Participants earned stars upon completing sessions, which allowed them to progress to higher intensity levels, introducing a dynamic and rewarding challenge structure throughout the intervention.

Outcome Measures

Baseline Outcomes (measured in all participants)

- Age (years), Body mass (kg), Height (cm) and BMI (kg/m^2)
- Systolic and diastolic blood pressure (mmHg)
- HRrest (bpm)
- HRmax (bpm)

Age-Specific Performance Outcomes

To preserve the full sample while respecting age-appropriate testing:

- Adults: bench press, squats, VO_2max (Bruce protocol; Bruce, 1971).
- Older participants: chair stand (30 s), arm curl (30 s), and 6-minute walk test (6MWT).
  These were analyzed within subgroups only; no cross-test conversions were attempted.

Exploratory Outcomes

- Psychological variables, including the CRAVE (desire to move/rest; Portuguese validation) and PANAS (positive/negative affect; Portuguese validation) questionnaires.

Adherence

Adherence was tracked via the app in the online format and through a registration sheet in the in-person format. Compliers were defined as attending ≥75% of all sessions, following established thresholds (Taylor et al., 2011). At the end of the intervention, participants were allocated to their respective adherence groups: those who met the ≥75% threshold were classified as compliers, while those who did not were categorized as non-compliers. Both categorical adherence (complier vs. non-complier) and continuous adherence (% of sessions attended) were analyzed.

Statistical Analysis

Data were analyzed in SPSS (v.27, IBM, SPSS Inc., Chicago, IL, USA). Descriptive statistics (mean ± SD) and normality tests (Kolmogorov–Smirnov) were computed. For core outcomes, pre-post comparisons used paired t-tests; subgroup differences (format, baseline activity, adherence) used independent t-tests. Given the small sample, analyses were treated as exploratory, with emphasis on effect sizes (Cohen's d, 95% CI) rather than strict significance. Cohen's d was selected as an effect size (d) interpreted as: trivial if $|d| < 0.2$, medium if $0.2 > |d| < 0.5$, and large if $|d| \geq 0.5$ (Cohen, 1988). The alpha level was set at $p < .05$.

Results

Participants

Of the 27 individuals initially recruited, two withdrew (one early dropout and one incomplete post-testing), leaving 25 participants (15 female, 10 males) for analysis. Participants were on average middle-aged (50.92 ± 10.47 years) and overweight (BMI = 28.9 ± 5.5 $kg.m^{-2}$). Ten participants joined the online group and 15 were trained in-person format. Fourteen participants achieved complier status (≥75% adherence). Table 1 provides an insight of the baseline descriptive statistics, based on participants allocated groups, and their respective gender and showing its interaction between those groups.

Table 1. Baseline descriptive statistics of the participants (mean ± SD) for online vs in- person training formats and female vs male participants.

Characteristics	**Online (n= 10)**	**In-Person (n= 15)**	**Woman (n=15)**	**Men (n=10)**	**Sig, training format**	**Sig, sex**
Age (years)	50.6±15.0	51.1±6.5	52.3±10.5	48.9±10.6	ns	0.02
Height (cm)	163.1±7.7	165.7±10.4	158.6±5.1	174.7±4.3	ns	ns
Weight (kg)	73.1±18.1	82.9±21.0	69.9±10.5	94.9±22.7	ns	ns
BMI ($kg.m^{-2}$)	27.2±5.3	29.7±5.6	27.7±4.5	30.8±6.6	ns	ns
SBP (mmHg)	126.5±12.0	120.0±14.4	118.5±12.5	132.1±14.3	ns	ns
DBP (mmHg)	75.5±7.9	74.2±9.6	72.9±6.0	79.8±12.9	0.02	ns
HRrest (bpm)	65.4±9.7	63.7±6.8	64.3±8.9	64.6±167.7	ns	ns
HRmax(bpm)	169.1±19.0	167.4±12.3	168.3±14.2	167.7±17.4	ns	0.05

BMI, body mass index; bpm, beats per minute; DBP, diastolic blood pressure; HRrest, resting heart rate; HRmax, maximum heart rate; mmHg, millimeters of mercury; SBP, systolic blood pressure.

Performance Outcomes by age

Table 2 presents pre- and post-program performance outcomes for adults (n=20) and older (n=5) participants. In adults, significant improvements were observed across all variables, indicating gains in both muscular endurance and cardiorespiratory fitness. Among older participants (n = 5), descriptive improvements were evident in the chair stand, arm curl, and 6MWT, reflecting enhanced functional performance. However, these changes did not reach statistical significance, likely due to the small sample size, though they suggest positive trends toward improved functional capacity. Furthermore, all conducted comparisons proved to present large effects.

Table 2. Pre- and post-program mean ± SD values for the assessed performance outcomes for adults and older participants, and intragroup p-values (p) and Cohen's d (d).

Performance outcomes	**< 60 years (n=20)**			
	Pre	**Post**	**p**	**d**
Bench press (reps, 1 min)	17.20 ± 10.77	22.05 ± 11.08	<0.001	1.15
Squats (reps, 1 min)	46.9 ± 9.25	52.65 ± 9.58	<0.001	0.92
VO_2max (ml/kg/min, estimated)	32.74 ± 8.93	34.36 ± 8.89	<0.001	1.02
Performance outcomes	**≥ 60 years (n=5)**			
	Pre	**Post**	**p**	**d**
Arm curl (30s, reps)	22.2 ± 2.39	25.00 ± 4.30	0.22	1.29
Chair stand (30s, reps)	19.00 ± 3.00	22.60 ± 3.36	0.04	1.07
6MWT (m)	675.35 ± 30.54	706.50 ± 48.33	0.25	1.24

Performance Outcomes by groups

An analysis comparing participants in the online and in-person intervention formats revealed no statistically significant differences in any performance variables (Table 3). Revealing that program modality (online vs. in-person) did not significantly influence performance in Bench Press, Squat, or VO_2max. Nonetheless, when the pre- and post-intervention evaluations were analyzed separately, statistically significant improvements were observed among participants who completed the program online. Similar findings were identified in the group that completed the intervention in person; however, in this group, the squat test did not reach statistical significance. When comparing the variance of the means between both formats, participants who completed the intervention in person demonstrated greater overall improvements than those who completed the program autonomously. This difference may be attributed to the larger group size and the higher proportion of participants with prior physical activity experience in the in-person intervention.

Table 3. Pre- and post-program mean ± SD values for the assessed fitness variables for both online and in-person format training groups, and intergroup p-values (p).

Variável	Grupo	Pré	p, d intergroup	Pós	p, d intergroup	Δ	%Δ	p, d intragroup
Bench Press	Online (n=7)	14.8 ± 8.9	0.72, 0.48	17.8 ± 8.9	0.57, 0.70	+3.00	+20.3%	0.02, 0.34
	Presencial (n=13)	19.6 ± 10.9		24.8 ± 10.9		+5.22	+26.7%	<0.01, 0.48
Squats	Online (n=7)	45.9 ± 14.5	0.89, 0.32	50.5 ± 16.7	0.77, 0.20	+4.62	+10.1%	0.06, 0.30
	Presencial (n=13)	41.5 ± 13.4		47.4 ± 13.7		+5.86	+14.1%	<0.01, 0.43
VO_2max	Online (n=7)	32.5 ± 8.6	0.98, 0.12	33.2 ± 9.1	0.93, 0.03	+0.79	+2.4%	0.03, 0.09
	Presencial (n=12)	31.4 ± 9.5		32.9 ± 9.5		+1.54	+4.9%	<0.01, 0.16

Psychological Outcomes

Exploratory outcomes, including psychological measures (CRAVE, PANAS) positive and negative affect), did not demonstrate statistical differences, nonetheless when analyzing the pre and post results by means and standard deviation, it is possible to see improvements, however no statistically significant differences emerged, which can be explained by the fact that the sample was smaller, and the intervention period was considerably reduced.

Table 4. Mean ± SD values for Cravings for Rest and Volitional Energy expenditure (CRAVE) questionnaire parameters (Move Score and Rest Score) for both online and in- person training format groups, and intragroup p-value (p), mean change (MC), 95% Confidence Intervals (CI) and Cohen's d (d).

Variable	Group	Pre	Post	p	MC (95% CI)	d
MoveScore	Online	6.22 ± 3.31	7.78 ± 1.35	0.35	-1.56 (-7.12, 4.00)	0.70
	In-person	7.64 ± 1.83	7.85 ± 2.23	0.83	-0.21 (-2.25, 1.84)	0.06
RestScore	Online	3.81 ± 3.45	2.67 ± 2.08	0.41	1.14 (-3.63, 5.91)	0.59
	In-person	2.05 ± 1.90	1.96 ± 3.20	0.92	0.08 (-1.74, 1.91)	0.03

Table 5. Mean ± SD values for Cravings for Rest and Volitional Energy expenditure (CRAVE) questionnaire parameters (MoveScore and RestScore) for both online and in- person training format groups, and intragroup p-value (p), mean change (MC), 95% Confidence Interval (CI) and Cohen's d (d).

Variable	Group	Pre	Post	p	MC (95% CI)	d
Positive Affective	Online	16 ± 2.83	18 ± 1.41	0.3	-2.00 (-14.71,10.71)	1.41
	In-person	20.50 ± 4.42	18.25 ± 6.59	0.36	2.25 (-2.91,7.41)	0.28
Negative Affective	Online	13 ± 7.07	11 ± 8.49	0.3	2.00 (-10.71, 14.71)	1.41
	In-person	8.08 ± 2.75	7.67 ± 3.52	0.66	0.42 (-1.62, 2.45)	0.13

Adherence

Mean adherence was 72% ± 25% of scheduled sessions, with variability across individuals. Compliers (≥75%) showed significantly greater VO_2max improvements compared to non-compliers, while differences for other outcomes were small and non-significant (Table 6).

Table 6. Variation of maximal oxygen consumption (VO_2max Δ) for the adherence compliers vs non-compliers grouping (i.e., above and under 75%, respectively), and intergroup p-value (p).

Group	**Adherence (%)**	**VO_2max Δ (ml/kg/min)**	**p**
Compliers (≥75%)	86.4 ± 6.2	+2.1 ± 1.8	0.02
Non-compliers (<75%)	54.7 ± 9.5	+0.5 ± 1.4	---

Discussion

The present pilot study evaluated the effects of an eight-week combined exercise program delivered in autonomous online and supervised in-person training formats. The main findings were: (i) consistent improvements in physical fitness indicators (upper and lower limbs strength and VO_2max), (ii) largely stable psychological outcomes, and (iii) adherence as a determinant of cardiorespiratory fitness gains. These results should be interpreted within the limitations of a semi-experimental design with a small sample size, but they provide valuable insights into the feasibility of delivering short-term exercise interventions in different formats.

Physical Outcomes

Across the total sample, participants showed significant improvements in muscular strength (bench press and squats) and cardiorespiratory fitness (VO_2max) were also observed. These results are consistent with evidence that relatively short interventions combining aerobic and resistance training can produce clinically meaningful changes in cardiovascular and musculoskeletal health (Warburton & Bredin, 2019; González-Gross & Meléndez, 2014; Schlegel et al., 2022).

For older participants, descriptive gains in functional tests (chair stand, arm curl, 6MWT) indicated potential improvements, especially on chair stand variable ($p<0.05$), although the small subgroup size limited statistical significance. These patterns align with findings from multicomponent exercise programs in older adults (Giné-Garriga et al., 2014). Importantly, no major differences emerged between in-person and online training formats, echoing previous reports of comparable physical outcomes across delivery modes (Valenzuela et al., 2018; Peña et al., 2024). In older adults, evidence supports that both formats provide improvements without dominance of any format (Neda et al., 2025).

This suggests that digital approaches can serve as feasible alternatives for individuals who cannot regularly attend face-to-face sessions, and that tailored online exercise programs for older adults could be integrated into corporate wellness initiatives to enhance accessibility and participation (Peterlin et al., 2024).

Psychological Outcomes

Contrary to expectations, psychological measures remained largely unchanged. CRAVE scores showed no significant pre-post variation, although active participants tended to report a higher desire to move than sedentary peers. PANAS scores also remained stable, showing no meaningful changes during the intervention.

These null findings may be explained by the short duration of the program, the limited sample size, and the possibility that the selected instruments are less sensitive to short-term fluctuations in a non-clinical adult population. Previous studies suggest that psychological and motivational shifts often require longer exposure, stronger social components, or targeted behavioral strategies (Rhodes & Kates, 2015).

Adherence and Compliance

Adherence averaged 72% of sessions, with notable variability. Participants classified as compliers (≥75%) achieved significantly greater VO_2max improvements, while differences for other outcomes were small. This reinforces adherence as a critical factor influencing cardiorespiratory adaptations, consistent with prior research (Gjestvang et al., 2019; Little et al., 2022). Evidence from recent feasibility studies highlights that the amount of time participants spends exercising at the prescribed intensity is a decisive factor for cardiorespiratory improvements (Wei et al., 2022)

The absence of format-related differences in adherence suggests that self-directed digital formats can achieve engagement levels comparable to in-person training, though strategies to support consistency remain crucial. This indicates that, when properly designed and monitored, digital interventions can effectively promote exercise adherence and elicit meaningful outcomes similar to those observed in traditional face-to-face programs (Haglo et al., 2021). Evidence showing that older adults can benefit from well-structured self-directed programs supported by technology, providing both high engagement and functional improvements comparable to supervised sessions (Mathur et al., 2025)

Limitations

This study has several limitations, namely the reduced sample size and the subdivision into multiple subgroups (format and adherence) further reduced statistical power. Group allocation was based on participant preference, introducing potential bias. The intervention duration (8 weeks) was relatively short, which may explain the absence of significant psychological changes. VO_2max was estimated using the Bruce protocol rather than directly measured. Finally, the study was conducted in a single institution, limiting generalizability.

Practical Implications

Despite these limitations, the study demonstrates the feasibility of implementing both online and in-person training formats over 8 weeks, with tangible improvements in strength and aerobic capacity. The findings highlight the importance of adherence as a determinant of outcomes, particularly cardiorespiratory fitness. For practice, this suggests that digital interventions may serve as viable and flexible alternatives, as long as effective mechanisms are in place to promote ongoing engagement.

Conclusion of the Discussion

This semi-experimental pilot study provides preliminary evidence that an eight-week combined training program can improve cardiovascular and musculoskeletal fitness in adults, regardless of delivery format. Psychological outcomes remained stable, and adherence emerged as a key determinant of VO_2max improvement. While exploratory in nature, these findings support the feasibility of short-term digital and in-person supervised programs and inform the design of larger, more controlled trials with longer follow-up.

Conclusions

This semi-experimental pilot study examined the effects of an eight-week combined training program delivered in autonomous online and supervised in-person formats. The intervention led to significant improvements in physical outcomes, including increases in muscular endurance and cardiorespiratory fitness. These effects were observed regardless of delivery format or baseline activity status, highlighting the feasibility of both approaches.

Adherence emerged as a key determinant, with compliers achieving greater gains in VO_2max compared to non-compliers. By contrast, psychological outcomes remained stable, suggesting that longer interventions or targeted behavioral strategies may be needed to capture motivational and affective changes.

Overall, the findings support the feasibility of both in-person and online formats and emphasize the importance of promoting adherence as a driver of physiological improvement. Future research with larger, randomized samples and longer follow-up is needed to validate these preliminary results and to further explore psychological dimensions of exercise engagement.

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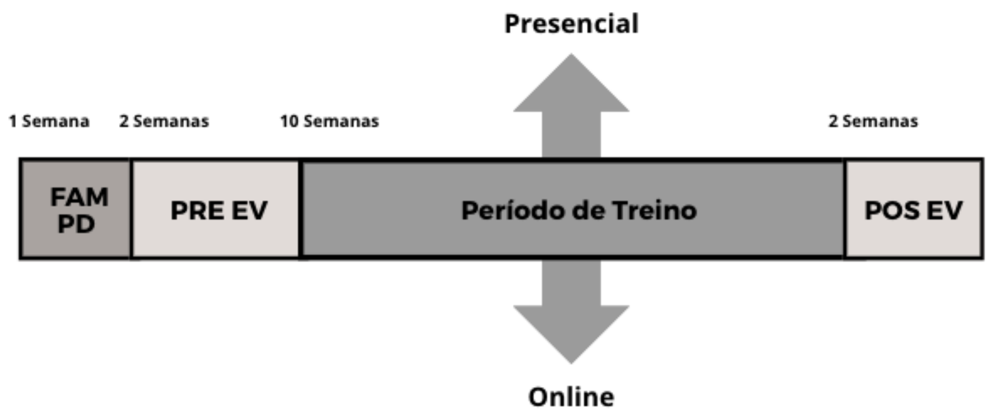
Appendices

Appendix A – Psychological Outcomes

- Table A1. Mean ± SD values for Cravings for Rest and Volitional Energy expenditure (CRAVE) questionnaire parameters (MoveScore and RestScore) for both online and in-person training format groups, and intragroup p-value (p), mean change (MC), 95% Confidence Intervals (CI) and Cohen's d (d).
- Table A2. Mean ± SD values for Cravings for Rest and Volitional Energy expenditure (CRAVE) questionnaire parameters (MoveScore and RestScore) for both online and in-person training format groups, and intragroup p-value (p), mean change (MC), 95% Confidence Interval (CI) and Cohen's d (d).

Appendix B – Supplementary Material

- Figure B1. Structure of the semi-experimental study design, including duration for familiarization (FAM), pre-evaluation (PRE EV), training and post-evaluation (POST EV) periods.



- Figure B2. Screenshots of the Self-Training mobile application (online format).