



HAL
open science

Effectiveness of an Adapted Physical Activity Program on anxiety, depression, and self-esteem on a heterogenous sample: A randomized controlled trial

Mathilde Plard, Claire El-Jor, Rebecca Shankland, Quentin Hallez

► **To cite this version:**

Mathilde Plard, Claire El-Jor, Rebecca Shankland, Quentin Hallez. Effectiveness of an Adapted Physical Activity Program on anxiety, depression, and self-esteem on a heterogenous sample: A randomized controlled trial. *Baltic Journal of Health and Physical Activity*, 2025, 17 (3), pp.Article5. <10.29359/BJHPA.17.3.05>. <hal-05304313>

HAL Id: hal-05304313

<https://hal.science/hal-05304313v1>

Submitted on 8 Oct 2025

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons CC BY-NC-ND 4.0 - Attribution - Non-commercial use - No Derivative Works - International License

2025

Effectiveness of an Adapted Physical Activity Program on anxiety, depression, and self-esteem on a heterogenous sample: A randomized controlled trial

Mathilde Plard

Université d'Angers, CNRS, ESO, ESTHUA, Angers, France, plard.mathilde@gmail.com

Claire El Jor

Université Lumière Lyon 2, Institut de Psychologie, Laboratoire DIPHE, France, claire.el-jor@univ-lyon2.fr

Rebecca Shankland

1. Université Lumière Lyon 2, Institut de Psychologie, Laboratoire DIPHE; 2. Institut Universitaire de France, Paris, France, rebecca.shankland@univ-lyon2.fr

Quentin Hallez

Université Lumière Lyon 2, Institut de Psychologie, Laboratoire DIPHE, France, quentin.hallez@gmail.com

Follow this and additional works at: <https://www.balticsportscience.com/journal>



Part of the [Disability Studies Commons](#), [Health Psychology Commons](#), [Other Social and Behavioral Sciences Commons](#), [Sports Sciences Commons](#), and the [Sports Studies Commons](#)

Recommended Citation

Plard M, El-Jor C, Shankland R, Hallez Q. Effectiveness of an Adapted Physical Activity Program on anxiety, depression, and self-esteem on a heterogenous sample: A randomized controlled trial. *Balt J Health Phys Act.* 2025;17(3):Article5. DOI: 10.29359/BJHPA.17.3.05

This Article is brought to you for free and open access by Baltic Journal of Health and Physical Activity. It has been accepted for inclusion in Baltic Journal of Health and Physical Activity by an authorized editor of Baltic Journal of Health and Physical Activity.

Effectiveness of an Adapted Physical Activity Program on anxiety, depression, and self-esteem on a heterogenous sample: A randomized controlled trial

Abstract

In recent decades, numerous studies have demonstrated the effectiveness of Adapted Physical Activity (APA) interventions in improving the mental health of individuals. However, a limitation of these studies is their predominant focus on homogeneous groups, characterized by similar diseases or disorders and characteristics. Thus, effects associated with these groups may largely account for the observed benefits, rather than the physical activity itself. This study aimed to investigate the impact of an eight-week APA intervention on anxiety, depression, and self-esteem in a heterogeneous group of participants with diverse health conditions and ages. Participants were randomly assigned to either an experimental group (n = 38) that engaged in the eight-week APA intervention or a control group (n = 31) that delayed participation. The findings of this study provide compelling evidence that an APA intervention significantly improves self-esteem while reducing symptoms of anxiety and depression, even in a heterogeneous group. These results contribute to the understanding of the effects of APA on mental health outcomes and support its implementation for diverse populations. Further research comparing homogeneous and heterogeneous groups and exploring the underlying mechanisms is warranted.

Keywords

Adapted Physical Activity, Mental Health, Self-esteem, Anxiety, Depression

Creative Commons License



This work is licensed under a [Creative Commons Attribution-Noncommercial-No Derivative Works 4.0 License](https://creativecommons.org/licenses/by-nc-nd/4.0/).

Article

Effectiveness of an Adapted Physical Activity Program on anxiety, depression, and self-esteem on a heterogenous sample: A randomized controlled trial

Mathilde PLARD¹, Claire EL-JOR², Rebecca SHANKLAND³, Quentin HALLEZ^{4*}

¹ Université d'Angers, CNRS, ESO, ESTHUA, Angers, France; ORCID 0000-0001-8498-1763

² Université Lumière Lyon 2, Institut de Psychologie, Laboratoire DIPHE, France; ORCID 0000-0002-1979-378X

³ 1. Université Lumière Lyon 2, Institut de Psychologie, Laboratoire DIPHE; 2. Institut Universitaire de France, Paris, France; ORCID 0000-0002-9182-5483

⁴ Université Lumière Lyon 2, Institut de Psychologie, Laboratoire DIPHE, France; ORCID 0000-0003-2035-8694

* Correspondence: Dr Quentin Hallez; e-mail: quentin.hallez@gmail.com

Abstract. In recent decades, numerous studies have demonstrated the effectiveness of Adapted Physical Activity (APA) interventions in improving the mental health of individuals. However, a limitation of these studies is their predominant focus on homogeneous groups, characterized by similar diseases or disorders and characteristics. Thus, effects associated with these groups may largely account for the observed benefits, rather than the physical activity itself. This study aimed to investigate the impact of an eight-week APA intervention on anxiety, depression, and self-esteem in a heterogeneous group of participants with diverse health conditions and ages. Participants were randomly assigned to either an experimental group (n = 38) that engaged in the eight-week APA intervention or a control group (n = 31) that delayed participation. The findings of this study provide compelling evidence that an APA intervention significantly improves self-esteem while reducing symptoms of anxiety and depression, even in a heterogeneous group. These results contribute to the understanding of the effects of APA on mental health outcomes and support its implementation for diverse populations. Further research comparing homogeneous and heterogeneous groups and exploring the underlying mechanisms is warranted.

Keywords: adapted physical activity, mental health, self-esteem, anxiety, depression.

Citation: Plard M, El-Jor C, Shankland R, Hallez Q. Effectiveness of an Adapted Physical Activity Program on anxiety, depression, and self-esteem on a heterogenous sample: A randomized controlled trial. *Balt J Health Phys Act.* 2025;17(3):Article5. DOI: 10.29359/BJHPA.17.3.05

Academic Editor:

Dominika Wilczyńska

Received: November 2024

Accepted: August 2025

Published: September 2025

Publisher's Note: BJHPA stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2025 by Gdansk University of Physical Education and Sport.

Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC-BY-NC-ND) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Mental health is a complex and multifaceted concept that encompasses various dimensions of overall well-being, including negative indicators such as depression and anxiety, as well as positive indicators such as self-esteem [1]. In recent decades, physical activity has gained attention as a potential intervention for reducing symptoms of depression and anxiety [2, 3] and promoting positive self-perceptions and self-esteem [4]. In light of the importance of anxiety, depression, and self-esteem for mental health, sport has been proposed as an adjunct therapy for individuals with mental illness [5], and treatment programs have been suggested as complementary interventions in psychiatry [6]. Furthermore, prospective studies have suggested that physical activity may have a preventive role in reducing the incidence of depression and anxiety [7, 8].

Despite their potential benefits, physical activity programs are not always suitable for all individuals. One reason for this is that physical activity involving high levels of bodily stress has been associated with adverse effects in individuals with certain physio-

logical conditions, such as those who are overweight, have somatic disorders, or have reduced fitness [9]. Additionally, specific disabilities, including rheumatic, coronary, metabolic, cardiovascular, and respiratory conditions, can pose significant challenges to participating in regular physical activities. This is particularly concerning since these populations are especially susceptible to poor mental health [10, 11] and health risk behaviors [12]. In response, adapted physical activity (APA) programs have been developed to provide tailored physical activity opportunities that cater to individual needs and abilities [13, 14].

In recent decades, APA programs have been extensively researched, with evidence demonstrating positive effects on the psychophysical health of various populations. For example, it has been reported that APA had positive psychophysical outcomes on patients with chronic kidney disease [15], chronic venous disease [16], chronic hemiparesis [17], cardiovascular disease [18], Parkinson's disease [19], multiple sclerosis [20] or cancer [21, 22], and has also been demonstrated as beneficial on older adults with no particular disease [23, 24]. That being said, the existing research on the effects of APA on mental health has mainly focused on specific groups of individuals with particular characteristics or traits. This is problematic since studies have shown increased effectiveness of many kinds of interventions associated with homogeneous groups compared to heterogeneous groups [25, 26, 27]. Therefore, it could be that the reasons for the efficacy of APA on mental health are related to group cohesion, group identification, and other social and psychological factors, rather than the specific intervention and activity performed by the participant [28]. Although some studies have transcended disability categories [29], to our knowledge, no study has directly investigated the effects of APA on mental health outcomes such as anxiety, depression, and self-esteem of a heterogeneous population, sharing diverse diseases, issues, or traits, specifically regarding the outcomes on anxiety, depression, and self-esteem. To add to this, previous research has shown a strong correlation between self-esteem and anxiety and depression in cross-sectional studies [30, 31]. Additionally, longitudinal studies have indicated that low self-esteem predicts increased anxiety and depression over time, while anxiety and depression do not lead to declining levels of self-esteem [32, 33]. Thus, the available literature provides evidence to support that low self-esteem causes anxiety and depression, rather than the other way around.

Building on previous findings and addressing the identified limitations, the present study aimed to evaluate the impact of an eight-week APA intervention on these outcomes in a diverse sample characterized by a wide range of health challenges and personal circumstances. Additionally, this study aimed to analyze the relations between anxiety, depression, and self-esteem. We thus hypothesized that an adapted physical activity intervention in a heterogeneous population would lead to 1- an increase in self-esteem, 2- a decrease in depression, and 3- a decrease in anxiety compared to the control group. Additionally, we expected that the changes in self-esteem would predict changes in anxiety and depression over time.

2. Material and methods

2.1 Participants

Seventy-six adults expressed interest in an adapted physical activity program, out of which 38 were randomly assigned to the experimental group, and 38 to the waiting-list control group. However, seven participants from the waiting-list group only completed the pre-test questionnaire. Thus, the final sample comprised 69 participants, including 38 in the experimental group (Mean_{age} = 56.21; SD = 16.23, 28 females), and 31 in the control group (Mean_{age} = 58.58; SD = 13.74, 20 females). All participants provided written informed consent to participate in this study, which adhered to the principles of the Helsinki Declaration. Participants were recruited from individuals seeking membership at Participants were recruited from individuals seeking membership at LABSPORT – Sports and

Health Center – Sports Complex in Saint Nazaire (France). Membership in the program required payment, with fees based on a sliding scale according to household income and composition. Participants joined voluntarily, upon recommendation from their healthcare professionals.

The distribution of diseases among the participants within the control and experimental groups can be accessed through an online supplemental table file on the following OSF link. Note that all research data are also accessible on the following anonymous link: https://osf.io/mkts6/?view_only=7341149b88964dce9aa5dce3ff189f8d

2.2. Materials and procedures

Measurements associated with this study were collected twice: first at baseline, denoted as T0, when participants enrolled in the LABSPORT program and before the intervention commenced; and second, 8 weeks later at T1, corresponding to 8 weeks after the beginning of the training for the experimental group, and 8 weeks after enrollment for the control group (delayed participation). Questionnaires were completed individually by participants using the Qualtrics® software. The questionnaires presented below were randomized in their order of presentation.

The Hospital Anxiety and Depression (HAD) scale. Participants were asked to complete the French version of the Hospital Anxiety and Depression (HAD) scale, which is a screening tool for anxiety and depressive disorders. The original version was developed by Zigmond and Snaith [34], while the French version was translated by Lépine and colleagues [35]. The questionnaire consists of 14 items, with seven items dedicated to each construct (i.e., anxiety and depression). Participants rated the items on a scale ranging from 0 to 3. Internal consistency was good for the anxiety subscale, as indicated by both Mac Donald's omega ($T1\Omega = .79$; $T2\Omega = .78$) and Cronbach's alpha ($T1\alpha = .78$; $T2\alpha = .78$). The internal consistency of the depression scale was slightly lower, but stable over time, and other validity tests supported the validity of the measure ($T1\Omega = .65$; $T1\alpha = .69$; $T2\Omega = .63$; $T2\alpha = .62$).

The Rosenberg Self-Esteem scale. Participants were requested to complete the Rosenberg Self-Esteem Scale, which is a widely used questionnaire developed by Rosenberg in 1965 [36] to assess an individual's general self-esteem. The French version of the scale was developed by Vallieres and Vallerand [37]. The scale comprises 10 items (e.g., I feel that I have a number of good qualities), half of which are positively-worded and the other half negatively-worded, rated on a four-point Likert scale ranging from strongly agree to strongly disagree. It is designed to measure self-worth, self-acceptance, and self-respect. Higher scores on the scale indicate higher levels of self-esteem. The internal consistency of these measures was satisfactory ($T1\Omega = .86$; $T1\alpha = .84$; $T2\Omega = .78$; $T2\alpha = .73$).

The Adapted Physical Activity Program. The APA program, which lasted for eight weeks, was designed collaboratively with the participants to cater to their individual needs, abilities, and preferences. LABSPORT provided seven different activities, including cardio training, muscle strengthening, balance gym, chair gym, stretching, and gentle or dynamic walking, and these activities were conducted in groups of six people without any distinction based on their medical conditions. Each session lasted for 45 minutes, with an additional 15 minutes allocated for athletes to prepare themselves (such as changing into sports clothes) and to help with equipment storage and changing. The sessions were inclusive and open to people of all ages.

2.3. Analysis

JASP 0.17.20 (released on February 13th, 2023) was used to analyze the data. The first step involved computing descriptive statistics such as means, standard deviations, skewness, kurtosis, and Pearson correlations for each assessment interval. This was done to describe the data, examine the relationships between the factors, and test the assumptions

underlying the use of Repeated-measures analyses of variance (Repeated measures ANOVAs). The analysis showed that the absolute values of skewness and kurtosis were within the acceptable range of -2 to +2 (see Table 1), indicating that multivariate normality was satisfied (38). These preliminary findings confirmed the suitability of using RM ANOVAs for our variables. For each of the ANOVAs that will follow, the within-subject factor was time, which had two levels (Time 0: Pre-Test and Time 1: Post-Test), while the between-subject factor was the intervention group (Control vs. Experimental Group). For each ANOVA model, Eta squared (η^2) and partial Eta square (η^2p) were calculated to estimate the effect size of changes over evaluation contexts. Mauchly's test indicated that the assumption of sphericity was met for each of the ANOVAs. To analyze the effects of self-esteem changes from T1 to T2 on the changes in depression and anxiety scores, linear regressions will be performed. Table 1 shows the descriptive statistics for each variable associated with experimental and control groups. Finally, clinically significant improvements were assessed by calculating the percentage of participants showing a reduction of ≥ 1.5 points [39], the Minimal Clinically Important Difference (MCID), in anxiety and depression scores from T1 to T2. The results indicated meaningful changes in both the experimental and control groups. Assessment of clinical significance using the RSES is not feasible due to the lack of robust literature support and the fact that not all participants presented with clinically low self-esteem at baseline.

Table 1. Descriptive statistics for experimental and control groups

	Control group					Experimental group				
	M	SD	[Min;Max]	Skewn.	Kurt.	M	SD	[Min;Max]	Skewn.	Kurt.
T0 (pre-test)										
HAD	11.10	6.61	[2; 25]	0.72	-0.31	15.53	6.14	1; 31	0.42	0.73
Anxiety	6.32	3.82	[1; 15]	0.53	-0.68	9.05	4.16	[0;18]	0.20	-0.32
Depression	4.77	3.50	0;15	1.17	1.32	6.47	3.13	1;14	0.75	0.21
Self-Esteem	15.00	1.51	[12, 18]	0.39	-0.04	18.43	5.15	7;29	0.43	-0.04
T1 (post-test)										
HAD	12.93	6.97	[3;27]	0.31	-0.93	11.97	5.28	[2;23]	0.12	-0.67
Anxiety	7.74	4.19	[2;17]	0.53	-0.69	7.32	3.59	[1;14]	0.05	-0.94
Depression	5.19	3.30	[1;13]	0.46	-0.64	4.66	2.71	[0;9]	0.13	-1.03
Self-Esteem	15.90	2.09	[10;20]	-0.47	0.85	21.00	4.76	[13;30]	0.19	-0.91

3. Results

3.1. Anxiety

Figure 1 shows the anxiety scores for both the control and experimental groups through the two measurement times of the experiment.

The first Repeated Measures ANOVA on this measure did not reveal any main effect of Time, $F(1, 67) = 0.21, p = 0.65$, but showed a significant time * condition interaction, $F(1, 67) = 20.76, p < 0.001, \eta^2 = 0.24, \eta^2p = 0.24$. Additional independent t-tests revealed that the magnitude of the difference from T1 to T2 was significant, as anxiety scores increased within the control group (Mean_{difference} = -1.42, SD = 2.22), while they decreased in the experimental condition (Mean_{difference} = 1.74, SE = 3.29), $t(67) = -4.56, p < 0.001$. Finally, the ANOVA did not reveal any main effect of the condition, $F(1, 67) = 1.68, p = 0.20$, which suggests that participants did not significantly differ in their estimates.

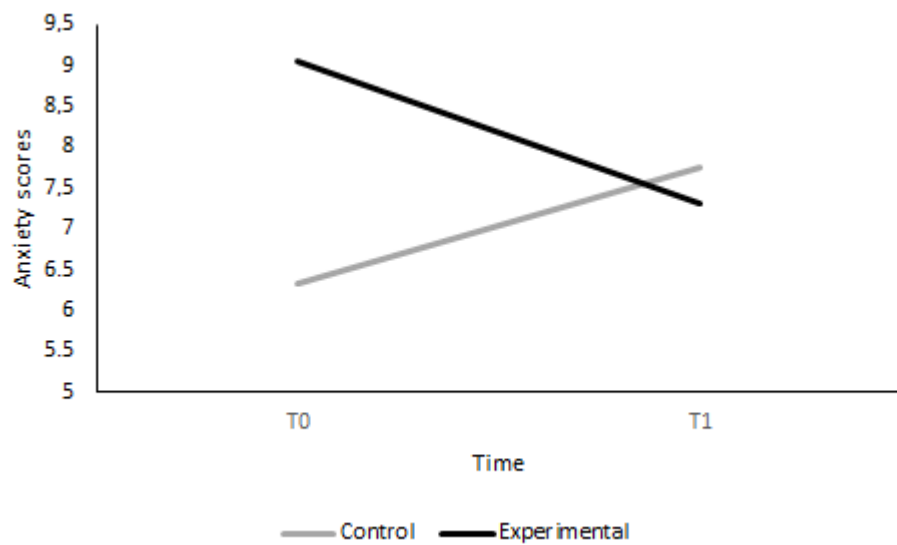


Figure 1. Anxiety Scores of Control and Experimental Groups associated with the pre (T0) and post-test (T1).

3.2. Depression

The main effect of time just failed to reach significance, $F(1, 67) = 3.95, p = 0.051$, suggesting that overall, participants tended to show a reduction in their depression scores over time ($\text{Mean}_{T0} = 5.71, SD = 3.38; \text{Mean}_{T1} = 4.90, SD = 2.98$). Once again, the ANOVA revealed a significant time * condition interaction, $F(1, 67) = 10.11, p = 0.002; \eta^2 = 0.03; \eta^2p = 0.13$. As shown in Figure 2, participants in the experimental condition showed a higher reduction of depression scores from T0 to T1 ($\text{Mean}_{\text{difference}} = 1.82, SD = 3.03$) compared to participants in the control condition ($\text{Mean}_{\text{difference}} = -0.42, SD = 2.74$). Finally, the ANOVA did not reveal any main effect of the condition, $F(1, 67) = 7.74, p = 0.39$.

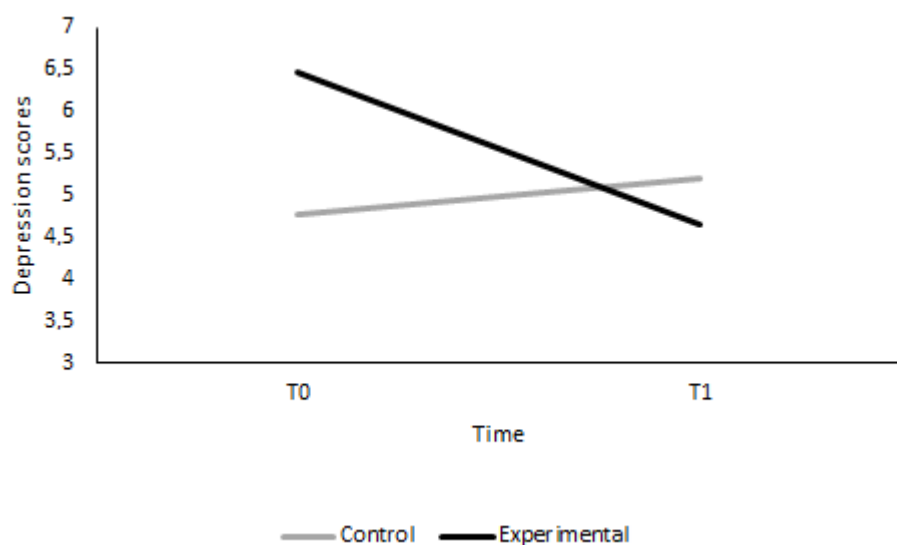


Figure 2. Depression Scores of Control and Experimental Groups associated with the pre (T0) and post-test (T1).

3.3. Self-esteem

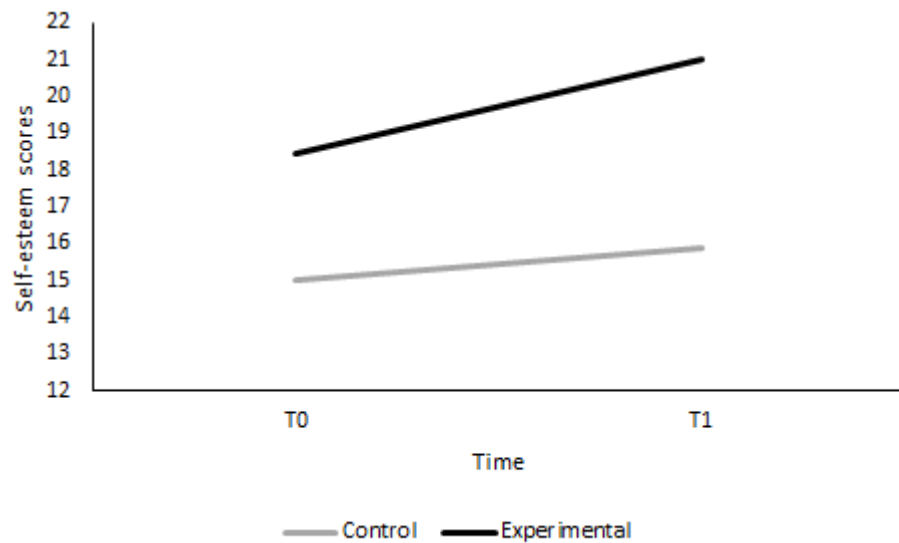


Figure 3. Self-Esteem scores of Control and Experimental Groups associated with the pre (T0) and post-test (T1).

The ANOVA launched on the scores of Self-Esteem revealed a main effect of the condition $F(1, 66) = 25.35, p < 0.001; \eta^2 = 0.23; \eta^2p = 0.28$. Indeed, participants within the experimental group showed a higher level of self-esteem throughout the entire experiment (Mean = 19.82; $SD = 4.56$) compared to control participants (Mean = 15.45; $SD = 1.50$). In addition, the ANOVA showed a main effect of time $F(1, 67) = 24.15, p < 0.001; \eta^2 = 0.04; \eta^2p = 0.27$. As shown in Figure 3, this indicated higher levels of self-esteem at T1 compared to T0. Finally, the ANOVA also revealed a significant Time * condition interaction $F(1, 67) = 6.32, p = 0.01; \eta^2 = 0.01; \eta^2p = 0.09$. An additional independent t-test showed that participants within the experimental condition showed greater self-esteem score increases (Mdiff = -2.78; $SD = 3.63$) compared to control participants (M = -0.90, $SD = 2.12$) $t(65)=2.51, p = 0.014$.

3.4. The relation between self-esteem, depression, and anxiety changes

A first regression analysis was performed with the difference score of self-esteem (T0-T1) as a predictor of the change in anxiety from T0 to T1. The linear regression model was significant $F(1, 67) = 6.52, p = 0.013, \eta^2 = 0.09, \eta^2p = 0.08$. The regression coefficients showed that the more self-esteem increased from T0 to T1, the greater the reduction in anxiety from T0 to T1 ($t = -2.55, \beta = -0.302, SE = 0.12, p = 0.013$). Similar results were found for the effect of self-esteem on depression, although the effect was only trending $F(1, 67) = 3.25, p = 0.076$. In other words, higher increases in self-esteem tended to be associated with greater reductions in depression.

3.5. Post-hoc mediation analysis

We performed a post-hoc mediation analysis to investigate whether the significant decrease in anxiety caused by the APA was in fact a consequence of the increase in self-esteem caused by the program. In other words, we tested whether self-esteem mediated the relationship between APA and anxiety. The mediation analysis was conducted using the bootstrap method (with 1,000 replications). However, the mediation was not confirmed due to the non-significant indirect effect ($\beta = 0.36, t = -1.35, p = 0.18, 95\% \text{ CIs } [-0.03, 0.96]$). Therefore, we did not proceed with further analysis.

Assessment of Clinical Significance

Clinically meaningful improvements (defined as a ≥ 1.5 -point reduction; 39) were observed in 62.3% of participants for anxiety and 55.1% for depression. When examined by group, 73.7% of participants in the experimental condition showed clinically significant improvement in anxiety symptoms, compared to 48.4% in the control group. For depression, 68.4% of participants in the experimental group improved, compared to 38.7% in the control group.

4. Discussion

The purpose of this study was to explore the impact of an Adapted Physical Activity (APA) intervention on the mental health of a population with various diseases and physical disorders, focusing on the effects of anxiety, depression, and self-esteem. To achieve this goal, individuals seeking membership in an adapted physical activity intervention were randomly assigned to either an experimental group that engaged directly in the APA intervention for eight weeks or a control group that waited for eight weeks before beginning the intervention.

The results of this study revealed that the APA program had a positive effect on anxiety, depression, and self-esteem. More specifically, the anxiety scores of the experimental group decreased, while those of the control group increased. Regarding depression, participants in the experimental group showed a greater reduction in depression scores compared to the control group. Finally, although participants in the experimental group showed higher levels of self-esteem throughout the experiment compared to the control group, they also showed a higher increase in self-esteem from the pre to the post-test. Taken together, these results corroborate previous studies which demonstrated that APA has beneficial effects on mental health [15–24]. Beyond statistical significance, the findings also demonstrated meaningful clinical improvements. Using a threshold of a ≥ 1.5 -point reduction as a marker of clinical relevance [39], a majority of participants in the experimental group showed significant decreases in both anxiety and depression scores. Specifically, 73.7% of participants in the experimental condition experienced clinically meaningful reductions in anxiety symptoms, compared to 48.4% in the control group. Similarly, 68.4% of participants in the experimental group improved in depression, compared to 38.7% in the control group. These proportions suggest that the intervention not only produced statistically significant effects but also led to changes that are likely to be meaningful in real-world, clinical contexts.

Our study goes beyond previous results since it demonstrates, for the first time, that the positive effects of the APA on mental health are applicable to a heterogeneous group. Although the potential impact of social and group effects cannot be entirely discounted (i.e., group identification, social and psychological factors, or phenomena of cohesion), the results of this study demonstrate the effectiveness of APA intervention for a diverse range of individuals, encompassing varying ages (ranging from 18 to 83 years old), and various health conditions (ranging from no reported diseases to metabolic, cardiovascular, neurological, respiratory, rheumatological issues, or even cancer). This finding holds significance for certain rural areas where it may be challenging to gather individuals afflicted by a common ailment. Our study results thus support the implementation of APA for groups comprising individuals who do not share similar health issues or conditions. Yet, in future studies, it may be worthwhile to compare the effects of APA for similar versus heterogeneous groups in order to 1- be able to generalize on the effects previously obtained by researchers on a heterogeneous group and 2- to calculate the weights associated with the social factors of homogeneous groups.

In addition, our study is innovative in that it focused specifically on the mental health outcomes of anxiety, depression, and self-esteem. Although previous research has demonstrated the positive effects of APA on self-esteem in breast cancer patients, we are not aware of any studies that have examined these specific outcomes in relation to each other.

Prior research has suggested that self-esteem can predict anxiety and depression [32, 33]. Specifically, it has been reported that an increase in self-esteem can lead to a decrease in anxiety and depression, and vice versa. Our study supports these findings, as we found a significant negative linear relationship between self-esteem and anxiety. However, self-esteem does not appear to be the only predictor at play here. First, because the negative relationship between self-esteem and depression was only a trend. Second, because the post-hoc mediation analysis did not support the hypothesis that the effectiveness of APA on anxiety reduction was mediated by self-esteem. It thus remains to be determined what mechanisms can account for the observed changes in well-being. According to Self-Determination Theory [40], well-being is enhanced by the experience of autonomy, competence, and social connectedness [41]. Autonomy involves experiencing a sense of choice and ownership in one's actions; competence involves feeling effective and capable in one's activities; and social connectedness involves the sense of being meaningfully connected to others [40]. In the context of APA, each of these needs may be naturally fostered. Participants often have opportunities to make choices and set personal goals (autonomy), engage in skill-building and experience mastery (competence), and interact with peers in a supportive group setting (relatedness). Previous research supports the idea that basic psychological need satisfaction is related to higher self-esteem and lower depression and anxiety. Specifically, in exercise participants, higher self-esteem has been shown to be related to higher basic psychological need satisfaction [42]. Additionally, research on physical education among adolescents suggests that global self-worth may be enhanced by way of basic psychological need satisfaction [43]. Lower levels of depression and anxiety have also been related to higher basic psychological need satisfaction [44]. Although our findings suggest that APA is beneficial to mental health, the underlying psychological mechanisms remain underexplored. Given SDT's strong empirical foundation, future research would benefit from directly measuring the extent to which APA environments satisfy these basic psychological needs. Such work could clarify the pathways through which APA contributes to enhanced well-being and guide the development of more targeted and effective interventions.

Finally, our study also revealed an interesting and unexpected result. Specifically, participants showed an increase in self-esteem and tended to exhibit a reduction in their depression scores throughout the course of the experiment. These effects may be linked to the fact that simply engaging in an Adapted Physical Activity intervention is beneficial to mental health, even outside of practice (albeit to a lesser extent than when the participant is actively practicing). One possibility is that engaging in the APA intervention increased participants' sense of control over their lives, which in turn led to an increase in self-esteem and a decrease in depression. This refers to a phenomenon used in behavioral therapies, called behavioral activation, in which the patient is expected to engage in an activity in order to generate a virtuous circle for their mental health [45]. However, this does not appear to be a viable long-term strategy, as an increase in anxiety is still observed in the control participants over time. While the current paper focuses on psychological pathways, it is important to acknowledge that APA may also exert benefits through physiological mechanisms, such as stress hormone regulation and neurochemical changes. These processes, while beyond the scope of our current discussion, represent a valuable direction for future research.

5. Conclusions

This study contributes to the growing body of evidence on the psychological benefits of APA by using a randomized controlled design and including a heterogeneous sample reflective of real-world diversity. However, several considerations should be taken into account when interpreting the findings. Although participants were randomly assigned to groups, we did not control for certain potential confounding variables such as prior physical activity levels, dietary habits, medication use, or socioeconomic status. These factors may have influenced the psychological outcomes studied (i.e., anxiety, depression,

and self-esteem). Also, while the use of a control group helps mitigate placebo effects, the possibility of expectancy or engagement-related biases cannot be entirely ruled out. Furthermore, as outcomes were assessed only immediately following the intervention, the long-term sustainability of the observed effects remains uncertain. Future studies should incorporate extended follow-up periods and, when possible, collect detailed demographic and medical history data to provide a fuller understanding of the mechanisms and moderators of APA's impact on mental health. To add to this, due to our limited sample size, we were not able to identify whether certain subgroups (e.g., by age, pathology, or baseline mental health status) may benefit more than others. Future studies with larger, stratified samples are warranted to explore potential differential effects and to better tailor APA interventions to individual needs.

Overall, the results of the study suggest, for the first time, that an APA intervention significantly increases self-esteem while reducing anxiety and depressive symptoms in a heterogeneous group of participants of different ages and illnesses/disorders. Although our study suggests that the effect of APA on anxiety and depression reduction is not mediated by self-esteem, the nature of the changes in these well-being outcomes remains to be explained. In the future, it would be interesting to analyze the influence of APA on depression, anxiety, and self-esteem by comparing homogeneous and heterogeneous groups while examining the weight of the three fundamental needs of autonomy, competence, and social connectedness. Finally, it is essential for policymakers and healthcare professionals to prioritize the development and implementation of adapted physical activity interventions that are evidence-based, accessible across diverse settings, and flexible enough to accommodate the varying characteristics of different populations to ensure maximum reach and effectiveness.

References

1. Dale LP, Vanderloo L, Moore S, Faulkner G. Physical activity and depression, anxiety, and self-esteem in children and youth: An umbrella systematic review. *Ment Health Phys Act.* 2019;16:66–79. DOI: 10.1016/j.mhpa.2018.12.001
2. Rebar AL, Stanton R, Geard D, Short C, Duncan MJ, Vandelanotte C. A meta-meta-analysis of the effect of physical activity on depression and anxiety in non-clinical adult populations. *Health Psychol Rev.* 2015;9(3):366–78. DOI: 10.1080/17437199.2015.1022901
3. Wanjau MN, Möller H, Haigh F, Milat A, Hayek R, Lucas P, Veerman JL. Physical activity and depression and anxiety disorders: a systematic review of reviews and assessment of causality. *Am J Prev Med Focus.* 2023;100074. DOI: 10.1016/j.focus.2023.100074
4. Fox KR, Magnus L. Self-esteem and self-perceptions in sport and exercise. In: Tenenbaum G, Eklund RC, editors. *Routledge Companion to Sport and Exercise Psychology*. 1st ed. London: Routledge; 2014, 34–48.
5. Rosenbaum S, Tiedemann A, Sherrington C, Curtis J, Ward PB. Physical activity interventions for people with mental illness: a systematic review and meta-analysis. *J Clin Psychiatry.* 2014;75(9):964–74. DOI: 10.4088/JCP.13r08765
6. Ströhle A. Sports psychiatry: mental health and mental disorders in athletes and exercise treatment of mental disorders. *Eur Arch Psychiatry Clin Neurosci.* 2019;269(5):485–98. DOI: h10.1007/s00406-018-0891-5
7. Ku PW, Fox KR, Chen LJ. Physical activity and depressive symptoms in Taiwanese older adults: a seven-year follow-up study. *Prev Med.* 2009;48(3):250–5. DOI: 10.1016/j.ympmed.2009.01.006
8. McDowell CP, Dishman RK, Vancampfort D, Hallgren M, Stubbs B, MacDonncha C, Herring MP. Physical activity and generalized anxiety disorder: results from The Irish Longitudinal Study on Ageing (TILDA). *Int J Epidemiol.* 2018;47(5):1443–53. DOI: 10.1093/ije/dyy141
9. Voderholzer U, Dersch R, Dickhut HH, Herter A, Freyer T, Berger M. Physical fitness in depressive patients and impact of illness course and disability. *J Affect Disord.* 2011;128(1–2):160–4. DOI: 10.1016/j.jad.2010.06.028
10. Hopman WM, Harrison MB, Coo H, Friedberg E, Buchanan M, VanDenKerkhof EG. Associations between chronic disease, age and physical and mental health status. *Chronic Dis Can.* 2009;29(3):108–16. DOI: 10.24095/hpcdp.29.3.03
11. Talen MR, Mann MM. Obesity and mental health. *Prim Care.* 2009;36(2):287–305. DOI: 10.1016/j.pop.2009.01.012

12. Bartlem KM, Bowman JA, Bailey JM, et al. Chronic disease health risk behaviours amongst people with a mental illness. *Aust N Z J Psychiatry*. 2015;49(8):731–41. DOI: 10.1177/0004867415569798
13. Hutzler Y, Sherrill C. Defining adapted physical activity: International perspectives. *Adapt Phys Act Q*. 2007;24(1):1–20. DOI: 10.1123/apaq.24.1.1
14. Sherrill C. *Adapted physical activity, recreation and sport: Crossdisciplinary and lifespan*. WCB/McGraw Hill; 1998.
15. Grazioli E, Tranchita E, Marrone G, et al. The impact of functional bars and adapted physical activity on quality of life in chronic kidney disease: A pilot study. *Int J Environ Res Public Health*. 2022;19(6):3281. DOI: 10.3390/ijerph19063281
16. Thibert A, Briche N, Vernizeau BD, Mouglin-Guillaume F, Béliard S. Systematic review of adapted physical activity and therapeutic education of patients with chronic venous disease. *J Vasc Surg Venous Lymphat Disord*. 2022. DOI: 10.1016/j.jvsv.2022.05.004
17. Macko RF, Benvenuti F, Stanhope S, et al. Adaptive physical activity improves mobility function and quality of life in chronic hemiparesis. *J Rehabil Res Dev*. 2008;45(2). DOI: 10.1682/JRRD.2007.02.0025
18. Ahmed HM, Blaha MJ, Nasir K, Rivera JJ, Blumenthal RS. Effects of physical activity on cardiovascular disease. *Am J Cardiol*. 2012;109(2):288–95. DOI: 10.1016/j.amjcard.2011.08.042
19. Cugusi L, Solla P, Zedda F, et al. Effects of an adapted physical activity program on motor and non-motor functions and quality of life in patients with Parkinson's disease. *NeuroRehabilitation*. 2014;35(4):789–94. DOI: 10.3233/NRE-141162
20. Pau M, Corona F, Coghe G, et al. Quantitative assessment of the effects of 6 months of adapted physical activity on gait in people with multiple sclerosis: a randomized controlled trial. *Disabil Rehabil*. 2018;40(2):144–51. DOI: 10.1080/09638288.2016.1244291
21. Speyer E, Herbinet A, Vuillemin A, Briançon S, Chastagner P. Effect of adapted physical activity sessions in the hospital on health-related quality of life for children with cancer: A cross-over randomized trial. *Pediatr Blood Cancer*. 2010;55(6):1160–6. DOI: 10.1002/pbc.22698
22. Landry S, Chasles G, Pointreau Y, Bourgeois H, Boyas S. Influence of an adapted physical activity program on self-esteem and quality of life of breast cancer patients after mastectomy. *Oncology*. 2018;95(3):188–91. DOI: 10.1159/000489265
23. Battaglia G, Bellafiore M, Alesi M, et al. Effects of an adapted physical activity program on psychophysical health in elderly women. *Clin Interv Aging*. 2016;11:1009–15. DOI: 10.2147/CIA.S109591
24. Delle Fave A, Bassi M, Boccaletti ES, et al. Promoting well-being in old age: The psychological benefits of two training programs of adapted physical activity. *Front Psychol*. 2018;9:828. DOI: 10.3389/fpsyg.2018.00828
25. Cruwys T, Haslam SA, Dingle GA, Haslam C, Jetten J. Depression and social identity: An integrative review. *Pers Soc Psychol Rev*. 2014;18(3):215–38. DOI: 10.1177/1088868314523839
26. Postmes T, Haslam SA, Swaab RI. Social influence in small groups: An interactive model of social identity formation. *Eur Rev Soc Psychol*. 2005;16(1):1–42. DOI: 10.1080/10463280440000062
27. Rees T, Alexander Haslam S, Coffee P, Lavallee D. A social identity approach to sport psychology: Principles, practice, and prospects. *Sports Med*. 2015;45:1083–96. DOI: 10.1007/s40279-015-0345-4
28. Sani F, Herrera M, Wakefield JR, Boroch O, Gulyas C. Comparing social contact and group identification as predictors of mental health. *Br J Soc Psychol*. 2012;51(4):781–90. DOI: 10.1111/j.2044-8309.2012.02101.x
29. Haegele JA, Lee J, Porretta DL. Research trends in adapted physical activity quarterly from 2004 to 2013. *Adapt Phys Act Q*. 2015;32(3):187–2016. DOI: 10.1123/APAQ.2014-0232
30. Liu Y, Wang Z, Zhou C, Li T. Affect and self-esteem as mediators between trait resilience and psychological adjustment. *Pers Individ Dif*. 2014;66:92–97. DOI: 10.1016/j.paid.2014.03.023
31. Michalak J, Teismann T, Heidenreich T, Ströhle G, Vocks S. Buffering low self-esteem: The effect of mindful acceptance on the relationship between self-esteem and depression. *Pers Individ Dif*. 2011;50(5):751–4. DOI: 10.1016/j.paid.2010.11.029
32. Orth U, Robins RW, Widaman KF, Conger RD. Is low self-esteem a risk factor for depression? Findings from a longitudinal study of Mexican-origin youth. *Dev Psychol*. 2014;50(2):622. DOI: 10.1037/a0033817
33. Sowislo JF, Orth U. Does low self-esteem predict depression and anxiety? A meta-analysis of longitudinal studies. *Psychol Bull*. 2013;139(1):213. DOI: 10.1037/a0028931

34. Zigmund AS, Snaith RP. The hospital anxiety and depression scale. *Acta Psychiatr Scand.* 1983;67(6):361–70. DOI: 10.1111/j.1600-0447.1983.tb09716.x
35. Lépine JP, Godchau M, Brun P, Lempérière TH. Évaluation de l'anxiété et de la dépression chez des patients hospitalisés dans un service de médecine interne. *Ann Méd Psychol.* 1985;143(2):175–89.
36. Rosenberg M. Rosenberg self-esteem scale (RSE). *Acceptance and Commitment Therapy. Measures Package.* 1965;61(52):18. 10.1037/t01038-000
37. Vallieres EF, Vallerand RJ. Traduction et validation canadienne-française de l'échelle de l'estime de soi de Rosenberg. *Int J Psychol.* 1990;25(2):305–16. DOI: 10.1080/00207599008247865
38. Van Zyl LE, Arijs D, Cole M, et al. The strengths use scale: Psychometric properties, longitudinal invariance and criterion validity. *Front Psychol.* 2021;12:2135. DOI: 10.3389/fpsyg.2021.676153
39. Puhan MA, Frey M, Büchi S, et al. The minimal important difference of the hospital anxiety and depression scale in patients with chronic obstructive pulmonary disease. *Health Qual Life Outcomes.* 2008;6(1):46. DOI: /10.1186/1477-7525-6-46
40. Deci EL, Ryan RM. Self-determination theory: When mind mediates behavior. *J Mind Behav.* 1980;33–43. <https://www.jstor.org/stable/43852807>
41. Ryan R. Self determination theory and well being. *Soc Psychol.* 2009;84(822):848. Available from: https://www.welldev.org.uk/wed-new/network/research-review/Review_1_Ryan.pdf
42. Lee GC. The effect of basic psychological needs satisfaction on self-esteem of the exercise participants. *J Korea Academia-Industrial Cooperation Soc.* 2016;17(10):490–8. DOI: 10.5762/KAIS.2016.17.10.490
43. Erdvik IB, Standal ØF, Hagen KA. Global self-worth among adolescents: The role of basic psychological need satisfaction in Physical Education. *Scand J Educ Res.* 2019;64(5):768–81. DOI: 10.1080/00313831.2019.1600578
44. Schutte NS, Malouff JM. Basic psychological need satisfaction, affect, and mental health. *Curr Psychol.* 2021;40(4):1228–33. DOI: 10.1007/s12144-018-0055-9
45. Huguet A, Rao S, McGrath PJ, et al. A systematic review of cognitive behavioral therapy and behavioral activation apps for depression. *PLoS One.* 2016;11(5):e0154248. DOI: 10.1371/journal.pone.0154248

Author Contributions: Study Design, MP; Data collection: QH; Statistical analysis: QH; Data interpretation: QH, RS, MP, CEJ; Manuscript preparation: QH, CEJ. All authors have read and agreed to the published version of the manuscript. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki.

Informed Consent Statement: Written informed consent was obtained from all subjects involved in the study.

Data Availability Statement: N/A.

Conflicts of Interest: The authors declare no conflict of interest.