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Effect of Aerobic Exercise on Mental Health among High School Students with Depression Symptoms

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Abstract

Background: *Psychological wellbeing impacts on daily living activities of every individual; as a result it can affect their Quality of life. Among the most important factors in mental health are developing happiness and reducing anxiety, depression, stress and increasing self-confidence in students. Therefore, the purpose of this study is to evaluate the effect of aerobic exercise on depressive symptoms, stress, anxiety, and self-esteem of high school students.*

Methods: *The present study was a quasi-experimental study and was performed as a pretest-posttest. Research subjects (N = 32) were assigned to the exercise group (16), received the aerobic exercises and non-exercise control group (16). The training have provided for over a period of 12 weeks with the intervention group performing the exercise for 3 days a week and each session takes 45-60 minutes. Mental health was measured by Depression, Anxiety, and Stress Scale (DASS21) and* Rosenberg Self-Esteem Scale).

Results: *The mean age of the experimental group 15.4 ± 0.63 and control group is 15.5 ± 0.52, respectively. After intervention, improvement was seen in the depressive symptoms, anxiety, stress and self-esteem when the experimental group compared to control group using independent t-test (p< .001). Additionally, regarding to pretest and posttest differences of study parameters from paired sample t-test have shown significant differences in depression, t(31)=7.60,P< .001,anxiety,t(31)=5.43,P< .001,stress, t(315.52, P<.001, self –esteem t(31)= -4.13, P<.001.*

Conclusion*: The study concludes that exercise had definitely helped in reducing the depressive symptoms, anxiety, and stress and improved the self-esteem of students. The study was found to be cost-effective and feasible to be made as a routine intervention for individuals to manage mental health.*

Key words*:* *Aerobic exercise, Psychological wellbeing, Depression, Anxiety, Stress, and self-esteem, mental health.*

1. Introduction

A sedentary lifestyle is considered one of the most important factors of morbidity and mortality worldwide (Alves et al., 2016; Qiu et al., 2017). It has been also demonstrated that regular exercise enhances not only physical, but also psychological well-being and quality of life. Participating in physical activity has been demonstrated to have a positive impact on mental health (Liang et al., 2023). Specifically, aerobic exercises

induce short and long-term effects on mood and emotional states by promoting positive effects, and decreasing the biological response to acute psychological stress. The implementation of physical activity also plays a role in reinforcing self-concept and self-esteem in children and adolescent (Calapai et al., 2024). Moreover, in younger age groups, physical fitness might stimulate academic achievement (Donnelly et al., 2016) and people who regularly perform aerobic exercise show greater scores on neuropsychological function (Calapai et al., 2024).

Recent studies indicate that regular aerobic exercise elicits benefits for individuals with anxiety and improve mood (Schuch et al., 2019; Stubbs et al., 2018). Regular physical activity showed positive impacts in cognitive, emotional and motor aspects with reduction in distress and promote psychological well-being in all age groups(Guerrera et al., 2020). Physical activity may play an important role in the management of mental health diseases, especially depression and anxiety(Ma et al., 2024).

Individuals who participate in regular aerobic activities have a higher level of mental stability; whereas those who do less aerobic exercise have a lower level of mental stability. Consequently, several recent studies have established that aerobic exercise and psychological variables have a significant relationship (Ma et al., 2024; Xu et al., 2021). Aerobic exercises including walking, cycling, and pushing a stroller seem to very important in easing depression symptoms (Stanton & Reaburn, 2014). One of the alternative approaches that are being used to control psychological factors is lifestyle medicine, specifically important of aerobic exercise to treat depression (Schuch et al., 2016; Stanton & Reaburn, 2014). Regular aerobic exercises was done 3 to 4 times a week, were used to reduce depression. Additionally, PA and the health benefits of exercise are linked to improved psychosocial adjustment(Firth et al., 2020).

The findings of certain studies show that lifestyle factor therapies and physical exercise practices were aimed at preventing anxiety, depression, and stress (Schuch et al., 2016). Exercises have also been recommended as a therapeutic treatment for psychological illnesses due to their multiple advantages for physical health(Marcos de Souza Moura et al., 2015). Aerobic exercise prescribed as alternative treatment for anxiety disorders due to its lower cost and fewer side effects in comparison to drug treatment, recommends that physical activities and exercise were effectively recovering anxiety (Wegner et al., 2014; Wu et al., 2020). According to several studies, aerobic exercise is effective in managing stress, anxiety and depression (C. P. Ramos-Sanchez et al., 2021; Wiese et al., 2018) and floor aerobic training program improved self-esteem and reduced anxiety among high school and college students (Maraz et al., 2015).

Adolescents with more physical activity have higher self-esteem. Low self-confidence is always correlated with a wide range of psychological (mental health) problems such as depressive symptoms, anxiety symptoms and eating problems. Low self-esteem can also correlate with social problems like violence and substance abuse (Moksnes & Reidunsdatter, 2019). Physical exercises, specifically aerobic exercise is more effective in treatment of adults to improve mental health (Park et al., 2014). A physical exercise can preventive and manage depression and anxiety disorder and promotes psychological well-being in all age groups (Archer et al., 2014). (Song et al., 2021) conducted a meta-analysis to demonstrate how increasing physical activity can both prevent clinical depression and anxiety from developing and lessen symptoms of these conditions in non-clinical populations. Despite the fact that numerous studies have shown the positive effects of physical activity on mental health,

they did not concentrate on high school pupils who had a high cognitive load (a situation where one is given too much information at once, or too many simultaneous tasks, resulting in not being able to perform or process the information as it would otherwise happen if the amount was instead sustainable). Furthermore, to the best of the researcher's knowledge, this study may offer the first description of the effect of aerobic exercise on mental health among high school students in Ethiopia. Hence this study aimed to determine the impact of aerobic exercise on mental health (depressive symptoms, anxiety, stress and self-esteem) of high school students.

2. Materials and Methods

Study Design

Following a quantitative research approach, this study used a "classic design for exploring cause-and-effect relationships," the pretest-post-test quasi-experimental design (Patten, 2017). The dependent variables were measured before and after the intervention.

Participants and Study Setting

This research was conducted on Sewoch Lesewoch general high school students, in Andead Woreda, East Gojjam Zone, Ethiopia, for three consecutive months, September to November, 2022. The total population was 416 (253 female and 163 male) students. Having and/or experiencing depression symptoms have been given to consideration as inclusion criteria. However, only thirty-two (male 18) and (female 14) students, aged 18-20 years, were selected according to the eligibility criteria.

Inclusion criteria: (1) 18 years and above, (2) with depression symptoms, (3) not smoking, (4), have no history of asthma, respiratory and heart diseases (5) no taking hypnotic drugs, (6) have no any musculoskeletal injuries that would prevent participation in physical exercises, (7) are currently physically inactive (exercising less than 150 min/week), (8) voluntary to participate. Participants were then randomly divided into two groups: experimental group (EG, N= 16) and control group (CG, N = 16). **Exclusion criteria**: (1) participants with health; (2) inability to perform training; (3) have no interest in continuing training.

Regarding to sample size, according to the study of Ramirez-Campillo et al. (Ramírez-Campillo et al., 2013), an a priori power analysis with an assumed Type I error of 0.05 and a Type II error rate of 0.20 (80% statistical power) was conducted on different exercise modalities for diabetic patient revealed that 12 participants for a group would be sufficient (Addis Alemayehu, 2023; Faul et al., 2007). Here, to increase the attendance/to decrease dropouts/ of participants, have added 30 percent, then the total sample size was 32.

Training protocol

Aerobic exercise interventions were conducted over 12-week period, with 3 training days per week. During the 8-week training period, the intervention group exercised for 60 minutes including warming up and cooling down exercises. This moderate aerobics training intervention was designed from different sources (Garber CE, 2014; Roxburgh, 2014). For the participants' health, all intervention days were supervised by health fitness experts.

Participants in the experimental group (EG) performed aerobic dance routines at lower range of heart rate of 64% HRMax, progressively increasing up to 76%HRMax as the intervention progressed. The experimental group was monitored in real-time by experienced aerobics instructors who gradually changed the intensity of the exercise based on the perceived abilities of the participants. Participants were informed to report if their heart rate dropped below 120 beats per minute or increased above 180

beats per minute. When 2 of 3 subjects who wore a chest belt and controlled the training load reported the similar discrepancy in heart rate (low or high from the required frequencies), the fitness instructor changed the training program by adding the exercise demands (i.e., changing the amplitude of performing the exercise, adding/removing jumps, adding/reducing the music tempo), which resulted in increased/decreased exercise load. However, the intensity of the aerobic dance cannot be said to be individualized, since the characteristics of the group fitness program generally do not allow for more precise interventions in exercise load (Sekulić et al., 2003).

Data Collection Instruments

Stress, Anxiety, and Depression (DASS21)

The standardized data collection tools of English version were translated to Amharic with the help of language experts and retranslation was done to ensure the language validity. Internal consistency of the tool was calculated using Cronbach's alpha. A 3-dimensional, self-administered questionnaire includes the Depression, Anxiety, and Stress Scale (DASS) (sometimes abbreviated as DASS 21) is applied to measure the presence and severity of depression, anxiety, and stress. The DASS-21 questionnaire includes three sections, each with seven questions, and all responses are given on a 4-point Likert scale ranging from 0 to 3 for each questionnaire (Sinclair et al., 2012).

Data collection tools for self-esteem

A popular self-report tool for assessing individual self-esteem and measuring positive and negative attitudes about oneself is the Rosenberg Self-Esteem Scale. The responses to each question are given on a 4-point Likert scale (Rosenberg, 1965).

Methods of Data Analysis

The data were collected on some selected mental health parameters (stress, anxiety, depression, and self-esteem) assessment tests after the data were coded and organized for analysis. To determine the change, the data were analyzed by using SPSS version 24.0, using paired sample t-test to compare the mean of study parametres before and after intervention, also by using independent t-test to compare the mean change between experimental and control group. Level of statistical significance was set at $p <$ or $= 0.05$. To keep the quality of data, have used test retest, intra-class correlation coefficient.

Ethical considerations

The present study was carried out in accordance with the principles of the Declaration of Helsinki and after the approval of the Research Ethics Committee (Ref. SPSC09/22). All subjects were informed of the study's purpose, assessed with physical activity readiness questionnaire, and signed a written consent form. They were also informed that they could leave the study if they want at any time, even after providing written consent.

3. Results

Demographics: the exercise intervention was completed by all participant subjects. Prior to the intervention, baseline demographic information on the subjects have no significant differences between exercise and non-exercise groups. The mean age intervention group was (33.4 years), and control group (33.8 years). Body mass index for the experimental group (23.45 %) and control group (23.34%). The mean body weight in experimental group was (59.7 kg) and control group (60.40 kg).

Depression symptoms: In the exercise group 81.3 % of the subjects and 75 % of non-exercise group reported to have mild depression symptoms. Anxiety symptoms: In

the exercise group 62.5 % reported to have mild anxiety where as in non-exercise group 56.3 % of them reported to have mild anxiety. Regarding to self-esteem; 56.3% of the participants in the experimental group and in the control group reported to have low self-esteem. Stress: In the experimental and control group; 62.5% and 56.3 % reported to have mild stress respectively. In this case, nearly all the study variables prior to intervention were proportionally distributed across the two groups.

The test retest reliability with Intra-class Correlation Coefficient for the study variables revealed that: stress (0.84), anxiety (0.93), depression (0.95), and self-esteem (0.91). Generally the tool that used to measure the study variables was more reliable.

The differences between post and pre-test showed that there was a significant difference in depression, anxiety, stress and low self-esteem for intervention group **(Table 1).** There was a statistically significant decrease in depression t(15)=-16.8, MD = -10.2,P < 0.001, the eta squared statistic (.65), anxiety t(15)=-9.8, MD=-9.6,P<0.001, the eta squared statistic (.48), stress t(15)= -11.4, MD=-11.7, P<0.001, the eta squared statistic (.50), and self-esteem t(15)= 12.2, MD=9.8,P<0.001, the eta squared statistic (.35). According to Cohen et al.,(Cohen et al., 2013), for eta squared, norm values are interpreted as small (.01), medium (.06), and large effects (.14). Those norm values are also used to describe how much of the variance in the dependent variable is explained by the independent variable. Ideally partial Eta Squared value of depression, anxiety, stress, and self-esteem revealed that large effect. Generally a paired sample t-test of the aerobic exercise group showed that there was a statically significant difference in depression, anxiety, stress and self-esteem between the pre-test and post-test scores. However, a paired sample t-test of the non- exercise group has not shown significant difference between pre-test and posttest of study variables.

Table 1. Paired sample t-test for mean change between pretest and posttest of study variables **(N=32)**

Variables	MD	SD	Std. Error	95% Confidence Interval		t	Df	P- value
				Lower	Upper			
Experimental Group								
Depression	-10.2	2.4	.61	-11.5	-8.9	-16.8	15	.000
Anxiety	-9.6	3.9	.9	-11.6	-7.5	-9.8	15	.000
Stress	-11.7	4.1	1.02	-13.9	-9.5	-11.4	15	.000
Self-esteem	9.8	3.2	.8	8.1	11.5	12.2	15	.000
Control Group								
Depression	-1.7	4.9	1.2	-4.4	.9	-1.4	15	.173
Anxiety	-.8	2.1	.5	-1.9	.3	-1.5	15	.149
Stress	-.9	2.5	.6	-2.2	.4	-1.4	15	.177
Self-esteem	-2.5	3.9	.9	-4.5	-.3	-2.5	15	.026

Key: MD= Mean difference **SD=** *standard deviation, DF=degree of freedom.*

To determine the effect of aerobic exercises comparing with control group on depressive symptoms, anxiety, and self-esteem among the high school students, independent t-test was applied (**Table 2).** There was statically significant change in the depressive symptoms score among subjects in the exercise group i.e., mean changes from 15.81 (2.23) in the pretest to 5.63 (2.5) after intervention when compared to non-exercise group who had 15.37(2.61) in pretest to 12.94 (2.05) in the posttest. The experimental group subjects showed a significant reduction in the depressive symptoms. The mean difference of depressive symptoms scores between the experimental and control group was -7.31 with a standard error mean difference of .81. The computed t-test between the experimental and control groups was statistically significant (t (31) = -9.05, p < 0.001). These results indicated that the aerobic exercises played a significant role in reducing the depressive symptoms.

Table 2. Independent t-test between exercise and non-exercise group

Variables	exercise group		Non-exercise group			SE	t	P-value
	Pre-test mean (SD)	Post-test mean (SD)	Pre-test mean (SD)	Post-test mean (SD)	Between Groups (MD)			
Depression	15.81(2.23)	5.63 (2.5)	15.37(2.61)	12.94 (2.05)	-7.31	.81	-9.05	.000
Anxiety	15.37(3.01)	5.81(4.25)	15.69(2.75)	13.94(3.021)	-8.13	1.3	-6.24	.000
Stress	18.31(1.4)	6.63(4.24)	16.94(1.44)	16.13(1.54)	-9.5	1.13	-8.42	.000
Self-esteem	13.44(1.63)	23.25 (2.86)	14.75(1.98)	13.87(1.15)	9.37	.77	12.16	.000

Mean difference: Posttest mean difference of experimental and control groups.

Key: MD= Mean difference **SD=** *standard deviation, DF=degree of freedom.*

The mean anxiety scores of subjects in the experimental group reduced mean scores from 15.37(3.01) to 5.81(4.25), whereas in control group there was only a slight decrease from 15.69 (2.75) to 13.94 (3.021). The mean change of anxiety results between exercise and non-exercise group (-8.13) was found to be statistically significant (t = -6.24, p < 0.001). The results revealed that a regular aerobic exercise was effective to improve anxiety symptoms among high school students.

There was improvement in the mean change self-esteem results of the intervention group subjects from 13.44(1.63) to 23.25 (2.86), whereas in non-exercise control group from 14.75 (1.98) to 13.87(1.15), with a mean difference of 9.37 between groups (p< .001). With regard to stress score, there was improvement in the mean stress scores of the experimental group from 18.31(1.4) to 6.63(4.24) with a mean difference of -9.5 (p<.001), where as in control group from 16.94 (1.44) to 16.13 (1.54) with a mean difference of 0.81 (p> .05). Generally, the improvement of depression symptoms, anxiety, stress and self-esteem scores were statistically significant in experimental group comparing with a non-exercise group; as a result the regular aerobic exercise training had a significant effect on the students' mental health.

4. Discussion

Regular exercise has a significant role on preventing and managing mental health parameters (depression, anxiety, stress, and self-esteem). This study was conducted to determine the effect of 12 weeks regular aerobic exercise training in improving depression symptoms, anxiety, stress and improving self-esteem.

The finding of the current study is similar with previous findings indicating that aerobic exercise is an effective therapy for depression. In one study conducted by Baily and colleagues (Bailey et al., 2018), regular physical exercise was found to effectively improve depressive symptoms in sub-clinical samples of people aged 12-25 years. results of this current research were also consistent with the study done by Carter and colleagues (Carter et al., 2016), who found in their meta-analysis that exercise was associated with a moderate effect size on individuals aged 13-17 years with depressive symptoms. Regular physical exercise programs in primary, and secondary school, Mendelson et al.,(Mendelson & Tandon, 2016), currently indicated that school based training have significant effects in terms of preventing the onset of depression in young people. Here, the impacts of regular aerobic exercise program on depressive symptoms can be as strong as those of psychotherapeutic management approach (Pereira-Payo et al., 2024). Regular medium- to high-load of aerobic exercise for adolescence with depression has been found to be effective (Harvey et al., 2018). According to a meta-meta-analytic findings (Rebar et al., 2015), aerobic exercise has reduced symptoms of depression among non-clinical participants.

The finding of this study is in line with previous results revealed that aerobic exercise is an effective treatment for stress symptoms. In addition, regular aerobic exercise program affects bodily and brain functions (Cornelia Herbert et al., 2020). As a result, one would expect a correlation between aerobic exercise and stress. Influential theoretical models such as the cross-stressor adaptation hypothesis (Molina-Hidalgo et al., 2023) suggest that regular aerobic exercise poses a physical stressor to the body and brain. In other hand, similar to mental health components (e.g., mood, depression, anxiety), it is neither clear nor certain whether exercise-induced physiological and psychological adaptation to stress are causally associated among healthy individuals (Cornelia Herbert et al., 2020). Here, the finding of the current study shows that, medium aerobic exercise program for 12 weeks improved stress symptoms of high school students. With regard to stress, regular aerobic exercise can improve subjective stress perception, irrespective of one's psychophysiological stress adaptation (Arvidson et al., 2018; Carlos Pelayo Ramos-Sanchez et al., 2021).

A number of pilot studies have shown that regular aerobic exercise interventions can reduce the stress, depression and anxiety levels of students while also supporting the healthy growth of their bodies and minds. Frequent aerobic exercise can lower physical and mental stress, anxiety, and depression, suggesting that it may benefit students' mental health (C. Herbert et al., 2020).

Current meta-analytic findings also suggest that acute bouts of exercise can reduce symptoms of anxiety (Ensari et al., 2015). In addition, meta analytic investigations support that regular aerobic exercise program is particularly effective in improving anxiety among non-clinical participants (Rebar et al., 2015). Regular aerobic exercise training has been found to be effective in managing anxiety (Stubbs et al., 2017). In line with those studies, the results of the current study

found that the aerobic exercise reduces anxiety symptoms of participant subjects.

Analysis of the current study reveals the mean score of the Self Esteem among students after intervention was improved. Our findings supported by Maraz et.al (Maraz et al., 2015), revealed that aerobics training program improved self-esteem and anxiety of high school and college students. In addition a study (Tao et al., 2022) suggested that, traditional dance program significantly improved the mental health parameters, namely, anxiety and self-esteem of high school students.

5. Conclusion

The following generalization can be derived from the present study that regular aerobic exercise training effectively improves depressive, stress and anxiety. This study concludes that regular aerobic exercise training had significantly helped in reducing the depressive symptoms, anxiety, stress, and improved the self-esteem of students. The study was found to be cost-effective and feasible to be made as a routine intervention for individuals to manage mental health.

6. Recommendations

To help students to have a good mood in school life and promote the importance of regular physical exercise, this paper puts forward the following recommendations:

- Promoting high school students' engaging in regular physical exercise is not only related to them and their schools, but also to the society at large. Government at all levels should promote the importance of regular physical exercise to improve the motivation of high school students to participate in physical exercise and make them realize the importance of physical exercise. Schools should help students to establish awareness of physical exercise, understand the value of physical exercise correctly, and develop a life time physical exercise habit.
- Establish a physical and mental health record as well as a platform for self-help exercise prescription for high school students, as well as regularly assess the mental health of those students. Let secondary school understudies have a superior comprehension of their mental health status and participate in actual regular physical exercise more effectively.
- To advance knowledge in this area, additional longitudinal study on the effect of different exercise modalities on mental health among high school students is required in large sample.

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