Research Paper

The Effectiveness of Pilates Training on Cognitive Function, Mental Wellbeing, and Students' Hope for Education

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ABSTRACT

Purpose: Students have important talents whose flourishing is a necessary and basic condition for the success and development of today's societies. The purpose of this study is to investigate the effectiveness of Pilates training on cognitive function, mental wellbeing, and students' hope for education.

Methods: This study is a randomized clinical trial. A total of 30 male students in the sixth grade of elementary school, aged ≥11 years, were initially allocated to either a pilates group (n=15, who underwent a 16 week Pilates exercise program) or to a control group (n=15, who did not receive any intervention). The data collection tools were the mini-mental state examination (MMSE), the questionnaire of academic hope by Campbell and Cowen (2001), and the short form of mental wellbeing questionnaire by Ryff and Singer (2006). We performed the analysis of covariance for data analysis using SPSS software, version 21 at a significant level of 0.05.

Results: Results of the analysis of covariance showed between-group differences for cognitive function ($F_{1, 27}$=3.8, P=0.01), mental wellbeing ($F_{1, 27}$=232.46, P=0.001), and hope for education ($F_{1, 27}$=29.26, P=0.001). Therefore, Pilates training increased cognitive function, mental wellbeing, and hope for education in students.

Conclusion: Pilates training significantly increases cognitive function, mental wellbeing, and hope for students' education. Therefore, it is suggested to use Pilates training for school students.

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Highlights

- The research was quasi-experimental with a pre-test and post-test design and a control group using the available sampling method.

- The results showed that Pilates exercises training plays a significant role in increasing the cognitive function, mental wellbeing, and hope of students to study.

Plain Language Summary

The purpose of this research was to investigate the effectiveness of Pilates training on cognitive function, mental wellbeing, and students' hope for education. The study was quasi-experimental with a pre-test and post-test design with a control group using the available sampling method. The result showed that Pilates training increased cognitive function, mental wellbeing, and hope for education in students.

1. Introduction

Education is the foundation of the cultural, social, economic, and political development of any society. Today, in most countries, education is regarded as one of the important pillars of growth and development, and after defense affairs, it occupies the largest government budget [1]. Students, as the basic pillar of the country's education system, have a special role and place in achieving the goals of the country's education system; paying attention to this group in terms of education and training will make the society's education and training system more fertile and flourishing [2]. One of the variables related to student's academic performance is cognitive function. Cognitive function is a set of thought processes that lead to understanding and awareness of thoughts and ideas. This function includes all aspects of perception, thinking, reasoning, and recalling [3].

By creating a gap between a person's thinking and emotions, cognitive and emotional variables can make students' academic progress face important obstacles. Students with problems in cognitive processes, attention, and encoding of materials show more problems in tasks related to working memory and perform poorly in remembering verbal items [4, 5]. Studies have shown that physical activity and sports can effectively improve memory, learning, and cognitive function [6]. Regular physical activity leads to the adjustment of hippocampal adaptations, which play a significant role in learning and memory [7, 8]. Researchers believe that even a very small amount of exercise and physical activity can help improve memory, and this effect increases when it is done regularly and at least three times a week [9].

In recent years, wellbeing as one of the basic components of quality of life has been the focus of positive psychology [10]. Psychological studies in wellbeing originate from two convergent and relatively distinct perspectives (pleasure and happiness), which have different philosophical roots [11]. From the hedonic perspective, wellbeing consists of happiness or pleasure and is focused on balancing positive and negative emotions. However, happiness's perspective is characterized by trying to realize human potential and understanding one's inspiring force or true nature [12]. Research conducted by proponents of the hedonic tradition of wellbeing has led to the emergence of subjective wellbeing. Mental wellbeing refers to how people evaluate their lives [13], which can be achieved through life satisfaction and evaluations based on feelings, mood, and excitement [14]. Sports training has beneficial psychological effects, which include high levels of overall wellbeing, positive mood, and low levels of depression and anxiety [15]. Mental wellbeing is one of the necessary indicators of a good life. Factors related to mental wellbeing (such as age, culture, life experiences, sports function, economy, society, personality, cognitive factors, etc.) have already been described [16]. Sohrabi et al. [17] concluded that there was a positive and significant relationship between most subscales of mental wellbeing and mental wellbeing. It was also found that physical activity could mediate between mental strength and wellbeing.

Hope is another variable whose relationship with students' success has been established in research so that hope can bring a person's success and mental wellbeing to the peak [13]. Hope is the ability to believe a feeling is better than the future. With its penetrating power, hope stimulates the activity system to acquire new experiences and create new forces in the organism. As a result, hope

makes a person strive and achieve a high level of psychological and behavioral functions. Hope is one of the signs of mental health [18]. Hope is a cognitive capacity based on a mutual feeling arising from the purposeful determination of goals and the path to achieving them [19]. With a positive psychology approach, hope is not just wishful thinking, nor is it just about best efforts. This cognitive state is the belief in determining achievable goals, the paths to achieve these goals, and developing specific plans to reach the final goals [20]. The importance of hope for academic activities is so much that researchers such as Snyder [21] and Pekrun [22] proposed a concept called educational hope. In Schneider's theory, educational hope is considered a kind of hope specific to education [23]. Academic hope is learners' belief in their abilities to develop strategies to achieve goals, having the necessary motivation to use strategies, the ability to maintain a high level of positive affect, as well as the commitment to persevere longer and spend more effort to challenge and doing coursework [24].

Hopeful students have better academic adaptation [25], more satisfaction with education and the educational environment [26], and a higher level of academic involvement [27]. The findings of Yang et al. [28] indicate the effect of sports on the level of hope among elite sports students. Sports and physical activity are the factors that can affect people's life satisfaction. Many studies [1, 26] have indicated a significant relationship between physical activity and quality of life, life satisfaction, and life expectancy. Since examining and providing practical solutions to increase academic achievement among students can help improve their education, conducting research that can consistently and accurately determine the effect of a suitable physical activity such as Pilates, which is one of the most common and popular types of sports today, seems practical and useful. So far, no study has been done to investigate the effect of Pilates exercises in the high school age range on increasing students' performance. In this regard, the present research was conducted to answer whether Pilates exercises affect cognitive function, mental wellbeing, and education hope in students.

2. Materials and Methods

This quasi-experimental research has a pre-test and post-test design with a control group using an available sampling method. The statistical population of this research included all the male students in the sixth grade of elementary school, studying in Tabriz City, East Azerbaijan Province, Iran, in the academic year 2021-2022. The participants were preliminarily studied in terms of their interest in participating in the study, no history of mental or physical illness, and the possibility of participating in training sessions. A total of 30 students who scored lower than the cut-off point were selected as participants in the research project. Then they were randomly assigned into the experimental and control groups. In this method, the experimental group was subjected to implementing the Pilates exercise program, but no intervention was done for the control group. Both groups answered the pre-test and post-test. The independent variable of the experiment in this research included the intervention of Pilates exercises, and the dependent variables included cognitive function, mental wellbeing, and students' hope for education. The inclusion criteria were as follows: studying in school, getting a score lower than average in research questionnaires (lower than average), and having the desire to participate in research. The exclusion criteria included suffering from psychiatric disorders or other chronic physical diseases during the treatment process and withdrawing from the study.

Study tools

Mini-mental state examination (MMSE)

The mini-mental state examination (MMSE) questionnaire was developed by Folstein et al. [29]. It is the most common screening tool for cognitive disorders worldwide, which has been translated into different languages and standardized in different cultures. The test is concise and can be performed in 10 minutes or less. For this reason, the intended test is a common tool for screening cognitive disorders that shows changes in intelligence over time and the potential effect of therapeutic factors on cognitive functions [30]. The cognitive domains that are evaluated in this questionnaire are orientation (10 questions), immediate memory (3 questions), attention and calculation (5 questions), word registration (3 questions), language functions (3 questions), and visual-spatial thinking (8 questions). In this questionnaire, the maximum score obtained is 30 points, and the score lower than 23 points to the possibility of cognitive impairment. Each correct answer has one score, and the range of scores of each subject is between 0 and 30 variables. In the research of Rezaei et al. [31], the internal consistency of the items of the MMSE was obtained at 0.85 using the Cronbach alpha coefficient.

Academic hope questionnaire

Campbell et al. [32] used the academic hope questionnaire to measure students' academic hope. This questionnaire contains 9 questions that are scored on a 5-point

Likert scale: I completely agree=5, I agree=4, I have no opinion=3, I disagree=2, I completely disagree=1. This scale measures the two components of agency and passages. Campbell et al. [32] have reported medium to high reliability for this questionnaire at 0.89 by using the Cronbach α method. Also, Sohrabi and Samani [17] reported the reliability of the academic hope scale with Cronbach α values of 0.73 and 0.75. The reliability level in the research of Kadampour et al. [33] was calculated at 0.76 using the Cronbach α coefficient. In the study of Dehghani et al. [34], the reliability of the educational hope questionnaire was obtained at 0.78 through the Cronbach α method. The validity of the educational hope questionnaire was assessed through the correlation of each question with the total score of the question. The results indicated the correlation of all questions with the total score of the questionnaire.

Mental wellbeing short form questionnaire

The mental wellbeing short-form questionnaire was designed by Ryff [35]. The 18-item short form was derived from the 120-item form, which has 6 factors: independence (questions 9, 12, 18), control over the environment (questions 1, 4, 6), personal growth (questions 7, 15, 17), positive communication with others, purposefulness in life (questions 3, 11, 13) and self-acceptance (questions 2, 8, 10). The questions are scored on a 6-point Likert scale from completely disagree=1 to completely agree=6. Questions 1, 4, 5, 8, 15, 16, 17, and 18 are reverse-scored. Ryff et al. [12] have reported the correlation of this test with the 84-question scale of this questionnaire from 0.70 to 0.89. Using the Cronbach α calculation, Khanjani et al. [36] found its internal consistency for the components of self-acceptance, positive relationship with others, having a purpose in life, personal growth, and independence as 0.51, 0.60, 0.53, 0.73, and 0.71 respectively in Iran.

Pilates training intervention

The experimental group performed Pilates-modified exercises (Figure 1), based on the Pilates exercise protocol for four months (16 weeks) (Table 1), three sessions per week, each lasting 60 minutes (under the supervision of a physical education instructor).

Data analysis and tools

In this research, two methods of descriptive and inferential statistics were used to analyze the data. First, the obtained data were described using descriptive statistics such as calculating the frequency, Mean±SD. Then, to comply with the assumption of normality of the distribution of scores, the Shapiro-Wilk test was used. Levene's test was also used to determine the homogeneity or equality of variances, as well as the homogeneity of the regression slope. Also, covariance analysis was used to test the hypotheses at a 5% significance level. The Cronbach α method was used to calculate and measure the reliability coefficients of the questionnaire. The data obtained from this project were analyzed using SPSS software, version 25 at a 5% significance level.

3. Results

In Table 2, the Mean±SD of the research variables in the pre-test and post-test stages can be seen in the experimental and control groups. The Mean±SD of the dependent variables of the research are different in the pre-test and post-test phases and indicate the effect of the intervention (independent) variable. The values of the cognitive function, mental wellbeing, and educational hope variables in the post-test and the ratio of the pre-test have increased in the experimental group.

The results show the normality of the studied variables for the experimental and control groups (P>0.05) and the homogeneity of variances for all three studied variables (P>0.05). It also shows the non-significant factor between auxiliary and dependent variables (P>0.05).

Table 3 shows the values obtained from multivariate analysis of covariance (MANCOVA). The findings f indicate that Pilates training leads to a significant difference between the groups in cognitive function (P=0.01, $F_{(1, 27)}$=3.8, mental wellbeing (P=0.001, $F_{(1, 27)}$=232.46), and educational hope ($F_{(1, 27)}$=29.26, P=0.001). Therefore, Pilates training has increased cognitive function, mental wellbeing, and hope compared to the control group.

4. Discussion

The present study aimed to investigate the effect of Pilates training on the variables of cognitive function, mental wellbeing, and educational hope in students. The results showed that Pilates training caused a significant increase in the cognitive function scores of students in the experimental group compared to the control group. The findings of this research are consistent with the findings of Zahedi et al. [37] and Niedermeier et al. [38]. Pilates creates structural and functional changes in the brain, which improves the functions and cognitive function of students [39]. As Shabir et al. [40] stated, among the other effects of exercise, we could mention the in-

Table 1. Pilates exercises protocol

Movements	The Intensity of the Exercise	Activity Area	The Most Important Muscles Involved
A tray with hands and an ignorant cat waiter standing	3-10 repetitions	Upper	Trapezius-dorsal-dolly muscles
Simple raising of one leg - the small circle of one leg - rotation of the leg from the pelvis (mobilization hip joint (movement in all directions)	3-10 repetitions	Trunk	Flexor and extensor muscles of the trunk of the leg muscles (flexion-adduction-adduction-abduction of the thigh)
Balance one leg in front with bent and straight leg	3-10 repetitions	Lower body	Thigh flexor muscles
Shoulder movement in all directions	3-10 repetitions	Upper	Shoulder, shoulder, and hand muscles
Four hands and feet, fixed function and Four hands and feet, steady execution, and hand and foot kicks - the movement of the opposite hand and foot diagonally and folding the legs into the chest and opening them (knee stretch)	3-10 repetitions	Trunk	Flexor and extensor muscles of the trunk
Threading the needle (side tension)	3-10 repetitions	Trunk	Shoulder and hand muscles
Mermaid	3-10 repetitions	Upper	Side muscles
Going down from the back to the ground	3-10 repetitions	Center of the trunk	Stomach muscle
Can balance with a closed leg and a straight leg, and two straight legs (inhale and exhale deeply)	3 to 6 breaths	Trunk	Leg muscles
Ankle flex and point in standing and lying position	to 12 repetitions5	Leg	Ankle flexor and extensor muscles
Lying on the side, lifting the leg from the side, front and back	3-10 repetitions	Lower body	Leg abduction muscles
Side bridge	3-6 breaths	Trunk	Trunk muscles
Ruler from back and front	3-6 breaths	Trunk	Central trunk muscles
Cobra and cobra with neck rotation	3-10 repetitions	Trunk	Trunk extensor muscles
Rhombus pressure	3-10 repetitions	Trunk	Trunk extensor muscles
Superman	3-6 breaths	Trunk	Trunk extensor muscles
Swim	3-10 repetitions	Trunk	Flexor muscles of the trunk and shoulder
Swedish swimming	3-10 repetitions	Upper	Chest and back muscles
Stage 1 star and full star	3-6 breaths	Trunk	Trunk extensor muscles
Pulling the belt	3-10 repetitions	Trunk	Trunk extensor muscles
Cradle	3-10 repetitions	Trunk	Relaxation of back muscles
Lying on your back, bend your knees and bring your fingertips to your knees	3-10 repetitions	Trunk	Central abdominal muscles
Lumbar rotation while lying on the back	3-10 repetitions	Lower body	Leg abduction muscles
Leg movements in all directions while lying down	3-10 repetitions	Trunk	Leg muscles and abdominal area
Two-legged stretch with flex and frog claws	3-10 repetitions	Lower body	Quadriceps and lower abdominal muscles
Hundred	Repetition (1 to 10 breaths)	Center of the trunk	Muscles of the center of the abdomen
Single leg stretch in the lying position	3-10 repetitions	Trunk	Muscles of the center of the trunk and legs
Stretching two legs in a lying position	3-10 repetitions	Trunk	Muscles of the center of the trunk and legs
Single leg pull with an upper body twist	3-10 repetitions	Trunk	Muscles of the center of the trunk and legs
Single-leg stretch with straight legs	3-10 repetitions	Trunk	Muscles of the center of the trunk and legs
Vertebral screw	3-10 repetitions	Trunk	Trunk muscles
Laser movement (with abdominal massage and upper torso twist)	3 to 6 breaths	Center of the trunk	Muscles of the center of the abdomen
Raising the pelvis (shoulder bridge) and shoulder bridge by moving one leg	3-10 repetitions	Center Of The Trunk	Back and gluteal muscles
Cradle tension	3-6 breaths	Trunk	Trunk extensor muscles
Dart foot sting with rotation from the waist to the sides	3-10 repetitions	Trunk	Trunk extensor muscles
Lotus (hand up movement)	3-10 repetitions	Upper	Daly-chest-back muscles
Tendon stretch	3 to 6 breaths	Trunk	Arm and central trunk muscles
Stretching the legs in a sitting position	3-10 repetitions	Trunk	Leg muscles and the center of the trunk
Side by side and hugging	3-10 repetitions	Trunk	Side, chest, and back muscles

Figure 1. Pilates exercises

PHYSICAL TREATMENTS

Table 2. Mean±SD variables of cognitive function, mental wellbeing, and educational hope in the experimental and control groups

Variables	Mean±SD			
	Experimental Group		Control Group	
	Pre-test	Post-test	Pre-test	Post-test
Educational hope	10.53±2.38	17.60±2.61	10.60±3.22	19.93±2.68
Mental wellbeing	55.63±2.13	64.00±1.83	54.53±2.79	55.54±2.15
Cognitive function	19.65±2.65	21.63±2.85	18.92±2.16	19.05±3.51

PHYSICAL TREATMENTS

Table 3. The results of covariance analysis (ANCOVA), the effectiveness of pilates exercises on the investigated variables

Variables	Source of Changes	Sum of Squares	F	P	Eta Squared
Cognitive function	Pre-test	377028	7.74	0.001	0.44
	Group	156.41	3.80	0.001	0.31
	Error	428.58			
Mental wellbeing	Pre-test	62.03	32.47	0.001	0.54
	Group	445.12	232.46	0.001	0.82
	Error	51.70			
Hope for education	Pre-test	164.21	91	0.05	0.77
	Group	52.80	29.26	0.001	0.52
	Error	47.82			

PHYSICAL TREATMENTS

crease in hippocampal activity and the size of the internal hippocampus, increase in the volume of white and gray areas of the brain, increase in neurotransmitters, increase in blood flow, and increase in synaptic flexibility. The sport requires the use of attention, memory, logical processing, and physical mobility [41], and improving these skills and mental processes improves the cognitive status of people. By affecting the white and gray matter areas of the brain and increasing them, Pilates will cause faster nerve transmission and increase cognitive skills [42]. Hartman et al. [43] showed that sport causes short- and long-term changes in the brain, which in learning and memorization are very important. In this regard, several different theoretical areas can be mentioned in explaining this finding.

According to brain biochemistry theories, physical activity in people can improve the body's biological mechanism, such as improving the state of fueling and increasing the level of glucose in the brain, which can facilitate the memory process. In addition to biological theories, from a cognitive-behavioral point of view, it can also be said that Pilates exercise is considered a potentially superior activity for maintaining or improving cognitive ability. From a cognitive perspective, rhythmic movements require learning complex movement sequences, procedural memory, attention, coordination of space and time (rhythmic movements), and emotional expression [44]. In this explanation, it should be said that doing Pilates exercises is a balance of dynamics and expansion of the movement, which are connected and repeated like inhaling and exhaling. These connected movements are performed many times and form a rhythmic movement, and students must observe and implement a set of predetermined patterns. In this case, the student is encouraged to predict the next move with the help of his memory, and as a result of following these hierarchical and regular principles, his memory will be strengthened and improved. In other words, maintaining the rhythmic movements in students strengthens active memory. Also, the results showed that Pilates exercises caused a significant increase in mental wellbeing scores in the experimental group students compared to the control group. The results of this research are consistent with the results of Mahtab et al. [45], Keshtidar et al. [46]. Pilates improves the quality of life regarding physical and mental health [47].

The basic principles of Pilates are concentration, control, diaphragmatic breathing, lightness, precision, strength, and relaxation [48]. Wellbeing includes the feeling of coherence and continuity in life, emotional balance, and overall life satisfaction. It means the ability to find all one's talents [49]. Positive body perception plays a key role in the cognitive health and mental wellbeing of a person [50]. Baek and Jeong [51] reported that the way people perceive their respective bodies has a positive effect on their subjective wellbeing. In particular, physical activities such as Pilates help people to perceive their bodies positively and make them healthy, which leads to improved mental wellbeing [52]. In other words, the state of cognitive health and mental wellbeing is closely related to physical self-concept and has been reported as a result of physical activity. Recently, a strong correlation between these variables in exercise, such as Pilates, is especially important for physical and mental development [53]. Ferreira et al. [54] reported that by increasing people's physical perception and self-esteem, their psychological wellbeing increases because people's subjective evaluation of their body is affected by their physical and mental wellbeing management. Positive physical self-perception is important in improving mental wellbeing [55].

Therefore, improving the physical self-perception of students participating in Pilates classes should be considered in teaching such classes, as it can encourage students to actively recognize their mental wellbeing. Jovic-Vranes et al. [56] stated that by increasing a person's understanding of health status, perception of interpersonal relationships, personal growth, life purpose, and autonomy would become more positive. These favorable changes may be attributed to the mechanism by which Pilates exercises activate multiple interstitial channels (i.e. proprioception from the motor and vestibular systems, as well as visceral sensation through controlled breathing) that significantly promote growth and or retaining first-person helps. Also, the results of the present study showed that Pilates exercises increased the hope of students in the experimental group compared to the control group. This finding was in line with the results of Mohammadi et al. [57] and Liu et al. [58]. In this regard, the results of the study by Zemestani and Fazeli Nikoo [59] showed that Pilates exercises are effective in reducing the symptoms of depression and rumination and improving the hope of the subjects. Mohammadi et al. [60] also concluded research that Pilates exercises have a significant effect on increasing the life expectancy of subjects. To explain this finding, it can be stated that through the effectiveness of mediators such as information processing and directing selective attention to the structure of hope and its level as an emotion, increasing controlled motivation and reducing automatic motivation, create and stopping self-regulation and counter-regulation and reducing and increasing problem-solving, memory and strategic thinking affects people's function [61]. So, when training in Pilates exercises, the amount and level of athletes' hope changes. By reducing mental pressure,

their hope improves, and they become aware that they can be in a favorable physical condition by creating a better environment, situation, and conditions. Increasing the student's hope by teaching Pilates exercises leads to the ability to motivate oneself, to feel efficient enough to achieve the goal, to give oneself strength when in trouble, to have the necessary flexibility to find different ways to achieve one's goals or, in case of failure, changing one of them and having this logic that divides any difficult task into smaller pieces that can be solved [62].

Study limitations and suggestions

Several limitations caused the problem in making the decision for the present study. They affected the presentation of the results, including the statistical population of the present study being limited to male students in the sixth grade of elementary school. Also, there are limited domestic studies for comparison.

Thus, we suggest that future research should be carried out on a wide range of people and in other societies to increase the generalizability of the findings. According to the obtained results, psychologists, counselors, and school administrators are suggested to use sports interventions, including Pilates training, to improve and increase the academic performance of students of different grades.

5. Conclusion

The present study showed that Pilates exercises positively affect cognitive function, mental wellbeing, and educational hope. Therefore, regular Pilates exercise effectively strengthens mental, physical, and socio-cultural harmony.

Ethical Considerations

Compliance with ethical guidelines

All ethical principles are considered in this article. The participants were informed about the purpose of the research and its implementation stages. They were also assured about the confidentiality of their informa- tion and were free to leave the study whenever they wished, and if desired, the research results would be available to them.

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Conflict of interest

The author declare that he has no conflict of interests.

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