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Effect and Permanency of Core Stability Training on Static and Dynamic Balance in Blind Children

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ABSTRACT

Background: Maintaining balance is an important factor in blind people. The aim of the present study was to investigate the effects and permanency of core stability training on static and dynamic balance in the blind.

Methods: In Sepideh Norouzi School for the blind in Kermanshah, among the available students, 30 blind male and female students were selected and randomly divided into two groups: control (mean age: 9.81±1.31 years) and experimental (mean age: 9.78±1.11 years) groups. Firstly, static and dynamic balance were measured using Bess & Y balance tests respectively. Then, the experimental group performed core stability training for 8 weeks and 3 sessions per week (15 to 20 minutes per session). Static and dynamic balance tests were performed again after the end of the training and also two months later.

Results: Findings using repeated measures analysis of variance showed that core stability training, immediately after training had significant positive effects on static (p= 0.005) and dynamic (p= 0.001) balance. Also, two months after the end of the training, the positive effects of the training on static (p= 0.009) and dynamic (p= 0.012) balance were significant.

Conclusions: Based on this, it can be said that core stability training can be used to strengthen static and dynamic balance, with long-term effects in blind people. Therefore, it is recommended that trainers pay attention to these training to improve balance in the blind.

1. Introduction

Vision, as the most powerful source of perception of the outside world, is responsible for transmitting 80-90% of the information entered into the brain (Ayvazoglu, Oh, and Kozub 2006). Therefore, mild impairments in visual function cause psychological, motor and physical problems (Hallahan and Kauffman 1991). A lot of studies have shown that people with visual impairment have difficulty maintaining and controlling their balance. It is worth noting that balance is the ability to maintain the body's center of mass over the base of support during quiet standing and movement (Nagy et al. 2007).

In children, balance problems can be due to the development of inappropriate movement patterns, poor muscle tone, or related to maturity problems, all of which are associated with impaired visual acuity (Shinya et al. 2011). People with visual impairments need more somatosensory and vestibular information to maintain balance. Balance is an essential component of any motor system; it is one of the most important factors in the sensory-motor system modulating the complex relationship between sensory inputs and required motor responses. Balance is one of the key and integral components in daily activities (Rajabi, Goodarzi, and Mazidi 2017). It is an essential factor for the blind that helps to create spatial integration in them (Çolak et al. 2004). Human balance control depends on the integration of afferent information from the vestibular, visual, and somatosensory systems. When the activity of one of the systems involved in stature control is reduced or lost altogether, a decline in performance occurs in other mechanisms involved in stature control (Soares et al. 2011). The most common strategy of blind people is to use other senses to maintain stability and coordinate movements to regulate the position of the body in space (Shinya et al. 2011).

Reflex theory for maintaining posture and balance states that reflex responses stimulated by sensory inputs lead to balance in the individual. On the other hand, the theory of dynamical systems approach states that factors such as the individual, environment and task are effective on maintaining body condition and balance. It states that the relationship between these three factors is the most important principle for maintaining balance (Woollacott and Shumway-Cook 2002). According to this theory, the ability to maintain and control the position of the body in space occurs as a result of functioning between different musculoskeletal and nervous systems, and the importance of each system varies according to the purpose of movement and environmental conditions (Woollacott and Shumway-Cook 2002). As mentioned, vision plays a direct and substantial role in balancing the moment-to-moment information it gives to the nervous system from its surroundings; any reduction or impairment of vision leads to a change in the process of motor function and stability of human balance (Juodzbaliene and Muckus 2006). In addition, children's motor development is based on the development of their basic motor skills; different motor experiences develop basic motor skills and increase environmental awareness in children (Dastjerdi Kazem M. 2001). This is even more important for the blind because they are more physically restricted. Research to investigate the effect of physical exercise on the

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balance of the blind has been promising important findings in this regard (Jazi et al. 2012; Nikravan, A., Gholami Shahabi, A., Karimi 2016).

Restoration of balance after disturbing the posture of the body can be achieved by rotation of the body or doing compensatory movements. In addition, it should be noted that exercises that specifically address balance improvement goals may be more effective than general exercises (Carty et al. 2015). Moghaddam, Zarei and Mohammadi (2017) examined the effect of eight weeks of core stability training on the risk of falling elite goalball athletes; the results showed that these exercises reduce the risk of falls in blind people (Mahrokh Moghadam A, Zarei M 2017). In addition, Mansouri, Moqaddas Tabrizi, Karimizadeh Ardakani and Omidi (2021) studied the effect of four weeks of perturbation training on the balance of the blind. Their findings showed that the training had significant positive effects on the balance of them (Mansoori et al. 2021). Omidi, Shamsi Majelan and Karimizadeh Ardakani (2016), in a study on the blind, examined the effect of six weeks of vestibular stimulation training on dynamic balance and stated that the relevant exercises had positive effects on balance (Omidi, Majalan, and Ardakani 2019). Moffa et al. (2017) investigated the effect of one session of body vibration on the balance of sighted and blind individuals and concluded that the effects are not significant (Moffa et al. 2017).

Exercise program aimed at improving balance, in addition to upgrading posture control, may prevent people from falling by reducing balance loss during daily activities (Mansfield et al. 2015). Mavrovouniotis et al. (2013) examined the effect of an eight-week exercise program combining Greek dance and Pilates on static and dynamic balance in blind children and concluded that the exercises had significant positive effects on static and dynamic balance factors (Mavrovouniotis et al. 2013). Mirzade, Fathi and Hosseini (2017), by examining the effect of eight weeks of rock-climbing training on the balance of sighted and blind girls, showed that it significantly improved the static and dynamic balance of both groups (Mirzadeh et al. 2017). Ignacio (2020) also studied the effect of rhythmic exercises on static and dynamic balance of blind children and showed that the relevant exercises had positive effects on the balance of them (Ignacio 2020). In addition, Sonthikul (2019) studied the elderly concluded that the balance training program and core stability training had a positive effect on their balance (Sonthikul et al. 2019).

As it is known, the core area of the body (back, pelvis, thighs and surrounding muscles) and exercises related to its strengthening, can have positive effects on maintaining the balance of the blind, and since the center of gravity of the body lies in this area, its stability is of paramount importance (Hodges and Richardson 1997). Core body exercises increase strength, endurance and nerve control of this area, through which the control of the inner part of the spine, the control of internal abdominal pressure and the muscular control of trunk movements can be improved. In addition, it enhances the body's ability to maintain balance affects in different dynamic movements (McCaskey A. 2011).

According to the aforementioned researches, it can be expected that physical exercise may be able to strengthen the balance of the blind, and since the stability of the middle belt of the body can be important in this regard, a special look should be given to core stability exercises. Blind people may not be able to participate in regular physical activity programs in the community, and this is a big problem for them. Most of the time, they need a companion to help them participate in physical activity, so they may not have a chance for long-term physical activity. Since the conditions for physical activity for blind people are not easily available in different societies, it should be examined whether doing physical exercise in these people for a period of time can have lasting effects or not. A review of the research literature raises the question of whether the effects of exercise last for weeks or months, or will these positive effects disappear quickly if exercising is stopped? Our investigation shows that no research has been conducted on the permanency of training effects, especially core stability training, on the balance of the blind. Therefore, the current research tries to shed light on this fact that whether the effects of core stability training on the blind are permanent or temporary. By conducting such research, useful steps can be taken to improve the life process of the blind; in addition, useful information can be obtained for preventing the occurrence of possible injuries in them and some opportunities can be created to reduce the dependence of the blind on other people in society. The aim of the present study is to investigate the effect of a period of core stability training on static and dynamic balance in blind children and also to evaluate the persistence of the effect of these exercises after two months.

2. Materials and Methods

2.1. Subjects

The present study is quasi-experimental and is applied practical in terms of purpose. The statistical population of the study included blind male and female students of Sepideh Norouzi Primary School in Kermanshah province in the academic year of 2017-2018. Based on the information in the students' academic and medical records, those individuals were selected who had no specific illness or disability (physical or mental) other than blindness. In addition, they did not have a regular record of sports activities. Written consent was obtained from subjects and their parents and the necessary information was provided to them during the meeting and they were informed about the investigation. Among the school students, 30 volunteers were randomly selected and divided into two equal groups of control (eight boys and seven girls with an average age of 9.81±1.31) and experimental (eight boys and seven girls with an average age of 9.78 ±1.11). Subjects were allowed to leave the study at any stage of the study if they did not want to continue.

2.2. Apparatus and task

Static balance was measured by the Bess test (Figure 1). This test consists of three fixed stances, each performed on a fixed and also an unstable surface for the dominant foot. The unstable surface consists of compact foam pads and the stable surface consists of hard and thin carpet flooring. The test consists of 3 positions: double-leg stance with hands on hips and feet together, single-leg stance standing on non-dominant leg with 30-degree flexion in the thigh and 45-degree flexion in the dominant leg knee, and tandem stance with non-dominant foot behind dominant foot in heel-toe fashion. In all of these positions, the hands of the subjects are placed on the waist. The subject completes each position for 20 seconds and the total number of errors committed in these six situations is calculated as the subject's score. The errors include: moving the hands off of the iliac crests, step stumble or fall, abduction or flexion of the hip beyond 30°, lifting the forefoot or heel off of the testing surface, remaining out of the proper testing position for greater than 5 seconds. Before performing the test, the subjects took the test once to get acquainted with the test levels. The measured validity for this test is 88% to 92% and it has acceptable reliability (Cote et al. 2005).

Subjects completed the Edinburgh Questionnaire (Oldfield 1971) with the help of parents to determine the dominant foot.

To evaluate the dynamic balance, Y balance test was used (Figure 1); Cronbach's alpha test also revealed that the internal consistency of the test was 0.90. The test evaluates dynamic balance according to the anterior, posterior-medial and postero-lateral directions (Pleski et al., 2009). Before performing the test, the dominant leg was identified and the leg length was calculated by measuring the distance between the anterior superior iliac spine and the distal part of medial malleolus.

To perform the test, the subject stands on the center plate with the dominant foot and trials to reach with the other foot, and with the heel of the foot, moves the pointer to the farthest possible point, and then returns to the position of two feet in the middle of the screen. According to formula number one, distance between the center of the page to the access point, is considered as a person's score. The subject performs three trials and the average of these three repetitions is considered as the individual score. Subjects performed this task without shoes and there was a two-minute break between each trial (Plisky et al. 2009).

Formula 1. To Estimate the Overall Score in the Y Test (Plisky et al, 2009).

$$\text{Total score} = \frac{\text{anterior} + \text{posterolateral} + \text{posteromedi}}{3 \times \text{foot length}}$$

Core Stabilization Exercise Program used by Jeffrey was also utilized in the current study (Jeffreys 2002). This program is simple and has a good potential of application on the blind. This exercise program has also been used by Mansoori et al. (2021), and Sadeghi et al. (2016) on the blind (Mansoori et al. 2021; sadeghi, S., mahdavinezhad, R., Kamali 2016).

The duration of each training session was 15 to 20 minutes and one session included 3 to 5 minutes of warm-up, 10 minutes of core stability training and 2 minutes of cooling. The exercises consisted of three different levels of training. Level one included static contractions in a stable environment, level two included dynamic movements in a stable environment, and level three included dynamic movements in an unstable environment (Jeffreys 2002).

Table 1. Core Stability Exercise Program Used in the Present Study.

Core Stability Training for the First and Second Weeks
1- Contraction of the abdominal muscles in the supine position 2- Pulling the abdomen inward in a prone position 3- Pulling the abdomen inward in a squatting position Each exercise was performed for three sets and each set had 20 repetitions.
Core Stability Training for the Third Week
1- Lying supine, pulling the abdomen inward and Lift one leg to chest (three sets and 20 repetitions each set) 2- Lying prone position, pulling the abdomen inward and bending one knee (three sets and 20 repetitions each set) 3- Side plank for each side of the body (6 repetitions and 10 seconds of pause)
Core Stability Training for the Fourth Week
1- Pulling the abdomen inward in a supine position with keeping the limbs high and bringing the arms and legs closer (3 sets and 20 repetitions each set) 2- Being in crawling position and one leg raised from behind (3 sets for each leg and 20 repetitions each set). 3- Rotating the torso to the sides with a weight in hand (3 sets for each side of the body and 20 repetitions each set).
Core Stability Training for the Fifth Week
1- Sitting on the Swiss ball and pulling the abdomen inward (3 sets and 20 seconds for each set) 2- Scott while the ball is between the wall and the shoulders (3 sets and 15 repetitions each set) 3- Raise the arms and legs simultaneously in the prone position (3 sets and 10 repetitions each set).
Core Stability Training for the Sixth Week
1- Lunch movement in an inclined direction of 45 degrees to the left and right (3 sets and 12 repetitions each set). 2- Single leg hip bridge exercise (3 sets and 15 seconds of pause in each set). 3- Static contraction while lying on the Swiss ball as the sole of the foot is on the ground and the back is on the ball (3 sets and 20 repetitions each set).
Core Stability Training for the Seventh Week
1- Lying on the Swiss ball while the sole of the foot is on the ground and the back is on the ball and the trunk rotates to the sides (3 sets and 15 repetitions each set). 2- Lying on the Swiss ball while the sole of the foot is on the ground, the back is on the ball, the trunk rotates to the sides and there is a weight in each hand (3 sets and 15 repetitions each set). 3- Single-leg side plank (6 repetitions for each side of the body and pause for 10 seconds).
Core Stability Training for the Eighth Week
1- Lying on the Swiss ball while pulling the abdomen inward (3 sets and 20 repetitions in each set). 2- Raising the opposite leg and hand together (Opposite Arm and Leg Raise), (3 sets and 20 repetitions in each set). 3- Bridging while your feet are on the Swiss ball and raising one foot (Single Leg Bridge Ball Exercise), (3 sets and each set 15 seconds).

2.3. Procedures

First, a meeting was held with the Kermanshah Education Council together with the school principal, and the details of the research were explained and legal and ethical permission was obtained. Then, by referring to the school and coordinating with the authorities and parents and obtaining the letter of consent, the subjects were selected by convenient sampling method and randomly divided into two groups of control and experimental. As a pre-test, static and dynamic balances were measured using the Bess test and Y test respectively at a gym. In the training phase, the experimental group, led by the examiner, performed the Jeffrey core stability exercise program for 8 weeks (3 sessions per week and each session 20 minutes). In the meantime, the control group was engaged in their daily activities and did not do any exercises. Finally, after the exercises, post-test was taken from both groups. In addition, after two months of the post-test, the measurements were performed again from the groups to evaluate the permanency of the effects of the core stability training. Also, before the persistency test, the physical activity of the subjects during these two months was measured by a questionnaire and the subjects who had a planned activity were excluded from the research process.

2.4. Data analysis

Descriptive statistics methods were used to optimally present the research results. Observing the assumptions of using parametric statistical tests, 3 * 2 analysis of variance (ANOVA) with repeated measures test was applied. In addition, paired samples t-test and independent t-test were used to evaluate within group and between group differences respectively. The significance level was considered as $P \leq 0.05$.

3. Results

Table 2 shows the mean and standard deviation of research variables for control and experimental groups.

Table 2. Mean and standard deviation of the research variables in the two groups.

Variable	Group	Pretest (M ± SD)	Posttest (M ± SD)	Permanency (M ± SD)
Static Balance Error	Experimental	20.80 ± 2.07	12.20 ± 2.09	13.40 ± 1.19
	Control	21.80 ± 2.36	21.13 ± 1.88	22.02 ± 2.08
Dynamic Balance Score	Experimental	58.60 ± 7.76	83.46 ± 4.38	83.26 ± 7.57
	Control	56.26 ± 4.90	57.26 ± 3.53	56.10 ± 3.90

Kolmogorov-Smirnov test was used to evaluate the normality of data distribution; the results showed that the distribution of data for static and dynamic balance variables is normal in both groups.

The results of ANOVA with repeated measures are shown in Table 3. The main was significant for the error in static balance variable. The between group differences showed that there was no significant difference between groups in the pre-tests ($p = 0.231$), but in the post-test ($p = 0.001$) and permanency test ($p = 0.009$), a significant difference was observed between groups; showing that the performance of the experimental group has improved compared to the control group and its errors in performing the static balance task has decreased. In addition, paired t-test revealed that the differences between pre-test with post-test ($p = 0.005$) and the permanence test ($p= 0.009$) were significant in the experimental group; indicating that the relevant activity had positive effects on reducing static balance error. However, there were no significant within group differences in the control group ($p = 0.423$). The above results indicate that the positive effects of exercise on static balance have been stable for up to two months.

In the dynamic balance variable, the main effect of time, group, and interaction time*group was significant. The results of independent t-test showed that in the dynamic balance variable, there was no significant difference between groups in the pre-test ($p = 0.378$), but, in the post-test and permanence test, there was a significant difference between the two groups ($p = 0.011$), which indicates better performance of the experimental group compared to the control group. The results of paired t-test showed that in the experimental group, the differences between pre-test with post-test ($p = 0.001$) and the permanence test ($p = 0.012$) were significant, revealing that the relevant activity had positive effects on improving dynamic balance up to two months after the end of the activity. There were no significant differences between the tests in control group ($p\geq0.05$).

Table 3. Results of ANOVA with repeated measures for static and dynamic balance.

	Factor	F	p	Eta
Static Balance Error	Time	5.26	0.001	0.17
	Group	4.12	0.007	0.14
	Interaction	3.23	0.021	0.12
Dynamic Balance Score	Time	4.10	0.009	0.14
	Group	4.00	0.011	0.14
	Interaction	4.54	0.005	0.15

4. Discussion and Conclusion

The aim of the current study was to shed light on the effects of a period of core stability training on static and dynamic balance of blind children and also to evaluate the permanence of the effect of these exercises after two months of untraining. The results showed that the relevant exercise had significant positive effects on static and dynamic balance in blind children and these beneficial effects were lasting until two months after the end of exercise.

One of the important factors in maintaining balance is the existence of sufficient strength and endurance in the core area of the body. The core area of the body includes the rectus abdominis and transverse abdominal muscles, deep muscles of the back, the diaphragm, gluteus muscles, and the pelvic floor muscles. The 29 pairs of muscles in this area form the muscular ring and help stabilize the spine and pelvis as you move. When this muscular system functions properly, it leads to an effective transfer of force in the motor chain and stabilizes the spine (Veqar 2014); Therefore, strengthening the muscles of this area can play a crucial role in improving balance; it can be said that core stability training strengthens the muscles of the core part of the body and thus improve balance.

According to the theory of dynamic systems, having balance is the result of functioning between different musculoskeletal and nervous systems, and each system can be of different importance according to the purpose of movement and environmental conditions (Woollacott and Shumway-Cook 2002); therefore, it may be said that in the current study the muscle-strengthening factor created by exercise in interaction with the subjects 'balance tasks and physical condition, has led to positive effects on the subjects' balance.

In addition, reflex theory for maintaining physical condition and balance states that sensory inputs lead to the initiation of muscular reflex responses and maintain balance in the individual. In line with this hypothesis, the core stability training performed in the present study may have enhanced the monosynaptic and long-loop reflexes and played a role in improving balance.

Moghadam et al. (2017) showed that eight weeks of core stability training reduces the probability of falling in the blind (Mahrokh Moghadam A, Zarei M 2017). In addition, Mansouri et al. (2021) stated that balance-based perturbation exercises improve the balance of them (Mansoori et al. 2021), which were in line with the results of the present study. The findings of the present study were also in line with the results of Omidi et al. (2020) (Omidi, Majalan, and Ardakani 2019). In fact, it can be said that doing exercises, including exercises in the core part of the body, improves the strength, endurance and nerve control of the core areas of the body, enhances the control of the inner part of the spine and the internal pressure of the abdomen and muscle control and promotes balance (McCaskey A. 2011).

Mavrovouniotis et al. (2013) stated that eight weeks of combined training (Greek dance and Pilates) have significant positive effects on static and dynamic balance of the blind (Mavrovouniotis et al. 2013). Besides, Mirzadeh et al. (2017) also showed the positive effect of eight weeks of rock-climbing training on static and dynamic balance of sighted and blind girls (Mirzadeh et al. 2017), which were consistent with the present study. The findings of the present study were inconsistent with the results of Moffa et al. (2017), who examined the effect of one session vibration of body on balance in blind and sighted people, and did not observe significant effects (Moffa et al. 2017); the reason for this discrepancy could be that the duration of their training was only one session, and one session of training may not have been able to make the necessary physical changes to improve balance. Ignacio (2020), in his research on blind children, stated that rhythmic exercises had positive effects on static and dynamic balance (Ignacio 2020). In addition, Sonthikul (2019) positively evaluated the effect of balance training program and core stability training on balance in the elderly (Sonthikul et al. 2019), which were in line with the findings of the present study. Training that improves strength are effective in strengthening balance. Balancing helps with stability in daily activities

and job-related activities, and as a result, reduces the risk of falls and injuries (Smail KM 2005).

One of the important findings of this study is the permanence of the effect of core stability training on static and dynamic balance. In this regard, two months after the end of the exercises, the balance of the subjects was re-examined and the results showed that the effects of core stability training are still significant compared to the pretest. Therefore, it can be said that the strengthening effects of core stability training on various physical aspects have had a high permanence.

Kibler, Press & Sciascia (2006), say that core stability is defined as the ability to control the position and motion of the trunk over the pelvis to allow optimum production, transfer and control of force and motion to the terminal segment in integrated athletic activities (Kibler, Press, and Sciascia 2006). Core stability is seen as being pivotal for efficient biomechanical function to maximise force generation and minimise joint loads in all types of activities. Also, Ray et al state that, maybe in blind people due to lack of vision, the amount of storage of motor information and movement patterns in the central nervous system is less and this factor can affect the balance function of the blind and cause them to have a poorer balance compared to their visual counterparts (Ray et al. 2008). Taking into account all that was said and having in mind the limitations of the blind, trainers for the blind can take a big step in strengthening their static and dynamic balance by performing core stability training; the positive effects of these exercises are obvious even long after an untraining period.

The present study showed that performing eight weeks of core stability exercises has positive effects on the static and dynamic balance of the blind, and these positive effects of the exercise can be present up to two months after the end of the exercises. Therefore, educators can prescribe such exercises to strengthen the static and dynamic balance in the blind and reduce the risk of falling.

Conflicts of Interests

The authors have no conflicts of interest to declare which might have influenced the preparation of this manuscript.

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