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ARTICLE

The Effect of a 6-week AI-generated Core Stability Training Program on Balance and Flatfoot in Blind Female Students

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ABSTRACT: Over the past decade, there has been a rapid increase in the study of using artificial intelligence (AI) to improve the quality of life of individuals with disabilities. Therefore, the study aims to investigate the effect of a 6-week AI-generated core stability training program on balance and flatfoot in blind female students. This quasi-experimental study selected 30 female students aged 9-12 years with flatfoot in Tehran City, dividing them into two groups: one for experimental (N = 15) and another for control (N = 15). The experimental groups had six weeks of AI-based intervention with three sessions per week. During this period, the control group engaged in the routine activities of the physical education class. The navicular drop index and Y balance test were done as pre-posttest, respectively. The Covariance (ANCOVA) was used for inferential statistics. Data analysis was conducted at a significance level of 95% with an alpha level less than or equal to 0.05. The findings showed that there was a significant difference between the two groups in the scores of the Y balance test ($p<0.035$) and the navicular drop test ($p<0.001$), even when the pre-test effect was taken into account (covariate). By leveraging AI to design tailored exercise regimens, practitioners can enhance postural control and musculoskeletal health in visually impaired individuals. These results underscore the potential of AI-assisted rehabilitation strategies in special education settings, highlighting the need for further research to optimize program parameters and expand their applicability across diverse populations.

KEYWORDS: Artificial intelligence (AI), Balance, Flatfoot, Visually Impaired .

1 Introduction

Visual impairments (VI) encompass a wide range of vision problems, from low vision to complete blindness, caused by various factors including hereditary conditions, trauma, and eye diseases [1]. According to the WHO, visual impairment is one of the most common health conditions, affecting nearly one-sixth of the world's population [2]. Vision is crucial for maintaining physical posture and balance, and its disruption can lead to improper movement patterns and postural abnormalities, which manifest in VI individuals as muscle weakness, joint deformities, and balance issues, ultimately causing various physical problems

[3]. The crucial role of balance in motor performance and injury prevention among VI individuals is increasingly recognized, as they rely on proprioception to compensate for the lack of visual input [4]. In VI individuals, the absence of visual input impairs body position awareness, forcing reliance on other senses, which disrupts balance and alters dynamic movement mechanics like walking [5-7]. Imbalance and the inability to maintain proper body posture may lead to inappropriate pressure on the feet, resulting in the development of flatfoot [8, 9]. In a study, it was shown that individuals with flatfoot have more difficulty maintaining their balance compared to those with normal foot arches [10]. In a systematic review, it was demonstrated that core stability has a direct relationship with maintaining balance [11]. In another study, Daneshmandi et al., (2021) demonstrated that core stability exercises have a significant impact on improving both dynamic and static balance, as well as walking speed in individuals who are blind [12].

AI is transforming the field of sports medicine and can aid in mass personalization and improving the outcomes of personalized rehabilitation protocols and injury prevention strategies [13]. AI-driven exercise prescription, using neural networks and logistic regression, tailors training programs to user needs and is expanding in the fitness domain [14]. Furthermore, findings from previous studies indicate that Ai has been effective in promoting physical activity among various populations, including children, adolescents, adults, the elderly, and individuals with disabilities [15, 16]. Further validation in real-world settings is essential, as findings indicate that AI technology, particularly GPT-4, can generate safe exercise routines [17].

Despite the well-documented role of core stability in enhancing balance and addressing musculoskeletal conditions such as flatfoot, research on AI-generated training programs remains scarce. Most existing studies focus on traditional or therapist-guided interventions, with limited exploration of AI-driven exercise prescriptions, particularly for individuals with visual impairments. Given that blind individuals rely heavily on proprioception and other sensory inputs for postural control, the effectiveness of AI-generated core stability programs in this population remains unclear. Moreover, such interventions' safety, adaptability, and long-term impact have not been thoroughly examined. This gap underscores the need for rigorous research to assess the feasibility and efficacy of AI-generated training programs in improving balance and mitigating flatfoot in blind female students.

2 Methods

2.1 Participants

The present study was quasi-experimental and conducted in the field. We purposefully selected 30 female students aged 9-12 years with flatfoot in Tehran City, dividing them into two groups: one for experimental (N = 15) and another for control (N = 15). For this purpose, by visiting schools and screening students from the 4th to 6th grades of primary school, individuals with flatfoot were initially identified using observational methods and the Chippaux-Smirak index [18]. The study's inclusion criteria included being 9-12 years old, having a navicular drop of more than 10 millimeters, having a visual impairment based on medical records, and not participating in parallel training and therapeutic programs. The exclusion criteria were a history of injury, fracture, or surgery in the lower extremities, non-participation in two consecutive training sessions, and engaging in activities outside the participants' training program. In the first step, the demographic information of the samples was recorded. Navicular drop test, and Y balance test were conducted on the subjects, respectively, and the data of these tests were recorded as a pre-test for each individual. Then, the experimental group did the selected AI-based core stability exercises for 6 weeks, but the control group engaged in the routine activities of the physical education class. After 6 weeks, all the tests were repeated, and the results were recorded as post-test data. Additionally, for ethical considerations based on the Declaration of Helsinki, all stages of the study were discussed with the subjects. Then, written informed consent was obtained from their parents as participants were under legal age. Also, parents were told that in case of any issues during the tests, all necessary actions would be taken by the examiner, a sports science expert studying for a master's degree in kinesiology. The subjects were instructed on how to perform each test. All steps were explained verbally to the participants. Before starting the tests, the procedure was presented to them verbally. Also, all measurements were performed three times, and the mean average of each variable taken was counted as study data.

2.2 Measurement and Tools

Navicular Drop index

First, the navicular tuberosity was identified. Then, the navicular bone height was measured while the subtalar joint was in a neutral position, with the participant primarily bearing weight on the opposite leg. Next, the participant was instructed to distribute weight on both feet evenly, and the navicular height was reassessed. The difference between the two measurements represented the navicular drop. Participants with a navicular drop exceeding 10 mm were categorized as having flatfoot. The measurement was repeated three times for each participant to ensure accuracy, and the average value was recorded for analysis. This test's intra-rater and inter-rater reliability has been demonstrated to range from 0.73 to 0.96 [19].

Y balance Test

The Y-Balance Test (YBT) is an objective measure used to assess balance during functional movement. Participants position themselves at the center of the YBT apparatus and are instructed to extend their foot as far as possible while maintaining contact with the designated markers. After each reach, they return to the starting position. This process is performed in three directions: anterior, posterolateral, and posteromedial, and is conducted separately for each leg. The measuring scale's farthest point of contact—typically the toe—represents the maximum reach distance. Attempts are considered unsuccessful if balance is lost, the foot is placed on the measurement indicator, or the measuring device is struck. The composite score is calculated by summing the distances reached in all three directions, dividing by three times the participant’s leg length, and multiplying by 100, ensuring a standardized and objective assessment. Limb length is measured using tape, with the participant in a supine position, from the anterior superior iliac spine to the most distal point of the medial malleolus [20]. The person's preferred leg for kicking a ball is evaluated to identify the dominant lower limb. Also, YBT has excellent inter-rater and test-retest reliability [21].

Implementation of the training programs

A day after the pre-testing, the implementation of the respective training programs for the experimental group commenced. The experimental group was administered the 6-week Ai-generated core stability training program, which was created using Scopus Ai. The prompt includes the specifics of the training program using the principles of frequency, intensity, time, and type. Below is the exact prompt inputted in the Scopus AI. It should be noted that the training sessions were 30–40 minutes, including a warm-up (10 minutes), core stability exercise (20 minutes), and a cool-down (10 minutes). Moreover, we provided clear, concise verbal instructions for each movement and used tactile cues to guide body positioning. Also, we ensured a clutter-free space to prevent falls and used a non-slip mat for stability.

Prompt: Write an 6-week core stabilty exercise program for a blind student who is 9-12 years, with flatfoot (having a navicular drop of more than 10 millimeters) based on FITT principles (Frequency, Intensity, Time, and Type) for optimal results. Please ensure the program includes specific exercises targeting the identified postural issues and adheres to the FITT principles. Additionally, provide explanations for a better understanding of each exercise, emphasizing proper form and technique.

Table 1. Table 1. Ai-generated core stability training program

Week	***Exercise***	***Type***	***Frequency***	***Intensity***	***Time (Reps/Sets)***	***Instructional Cues & Considerations***
Week 1-2 (Foundation Phase: Awareness & Strength)	Standing Heel Raises	Foot Arch & Lower Limb Strength	3x/week	Moderate	15 reps × 2 sets	"Push through your toes and lower slowly."
	Glute Bridge	Core & Glute Strength	3x/week	Low to Moderate	12 reps × 2-3 sets	"Lift your hips while squeezing your glutes."
	Seated Ball Squeeze	Inner Thigh & Core Activation	3x/week	Low	10 reps × 2 sets	"Gently squeeze the ball and hold."
Week 3-4 (Progression Phase: Stability & Coordination)	Bird Dog (Quadruped Arm/Leg Raises)	Core Coordination & Balance	3x/week	Moderate	10 reps/side × 3 sets	"Keep your back straight and extend opposite arm and leg."
	Toe Walking & Heel Walking	Foot Arch Strength & Postural Control	3x/week	Low to Moderate	5 steps on toes, 5 on heels × 3 rounds	"Feel the ground under your toes and heels."
	Seated Marching on Stability Ball	Dynamic Core Engagement	3x/week	Moderate	12 reps/side × 3 sets	"March in place while keeping balance."
Week 5-6 (Advanced Stability & Functional Strength Phase)	Side-Lying Leg Lifts	Hip Stabilizer Strength	3x/week	Moderate	12 reps/side × 3 sets	"Raise your leg like reaching for something."
	Standing Balance on Foam Pad	Proprioception & Core Stability	3x/week	Moderate	15 sec/leg × 2 sets	"Maintain balance on one leg, focus on control."
	Plank (Modified or Full)	Core Endurance & Strength	3-4x/week	Moderate	15-30 sec × 2-3 sets	"Keep your body straight like a board."

2.4 Statistical Analysis

This research used descriptive statistics to describe the variables and inferential statistics for data analysis. If the data were normally distributed, the Covariance (ANCOVA) was used for inferential statistics. Data analysis was conducted at a significance level of 95% with an alpha level less than or equal to 0.05 using SPSS software version 27.

3 Results

The Shapiro-Wilk test results indicated that the data followed a normal distribution. Table 1 displays the demographic characteristics of participants in both groups.

Table 2. Demographic characteristics of participants

Variable	***Groups***	***Mean±SD***	***P-value***
Age (years)	*Experimental*	10.49±1.81	**0.57**
	Control	10.85±2.08	
Height (cm)	*Experimental*	146.93±8.17	**0.37**
	Control	145.25±1.50	
Weight (kg)	*Experimental*	43.13±8.39	**0.89**
	Control	44.12±4.13	
BMI (kg/m2)	*Experimental*	20.66±4.55	**0.59**
	Control	20.36±3.44	

Table 3. The Covariance (ANCOVA) test results

Variable	***Stage***	***Mean±SD***	***F***	***DF***	***ETA SQUARED***	***P-value***
Navicular drop test	*Pre-test*	14.25±2.25	595.041	1	0.938	0.001*
	Post-test	8.96±2.52				
Y balance test	*Pre-test*	64.72±10.60	5.273	1	0.250	0.035*
	Post-test	75.63±10.57				

*** Indicating a significant change from pre-test to post-test**

Table 3 found that there was a significant difference between the two groups in the scores of the Y balance test ($p<0.035$) and the navicular drop test ($p<0.001$), even when the pre-test effect was taken into account (covariate).

5. Discussion and Conclusion

This study found that AI-generated training program was effective among blind students' scores in flatfoot and balance. Rapid AI technology advancement presents a valuable opportunity to enhance the quality of life for individuals with disabilities. Beyond their primary goal of supporting those with disabilities, AI systems also promise to mitigate certain disabling conditions. Regarding this matter, a study investigating the role of AI in rehabilitation targeting the participation of children with disabilities showed AI can be potentially used in pediatric rehabilitation [22]. Another study by Almufareh et al., (2023) demonstrated that AI-based applications, including real-time captioning, sign language translation, robotic assistance, virtual reality, and brain–computer interfaces, are transformative tools that promote inclusivity and independence for individuals with intellectual disabilities [23]. Maintaining the interpretability and transparency of AI model decisions is essential in the healthcare sector. This is particularly important as medical professionals must not only rely on AI-generated outcomes but also clearly understand the reasoning behind them. Moreover, after an AI model is designed with a strong emphasis on transparency and interpretability, it can be incorporated into healthcare systems and digital platforms, including telemedicine services and mobile health applications [24]. Such integrations expand the accessibility of AI-powered healthcare solutions, benefiting medical professionals, caregivers, and patients alike [25]. Moreover, AI-driven robotic systems play a crucial role in therapeutic and educational settings for children with disabilities by enhancing social interaction, communication, and engagement through personalized and adaptive interventions [26]. A study highlighted the improvements in autistic children's attention, response to social cues, and willingness to interact with both the robot and their peers [27]. Another study indicated that a robot-based play-drama intervention can enhance the joint attention and play behaviors of children with autism [28]. Furthermore, developmental children demonstrated increased communication, turn-taking, and cooperative play when interacting with the robotic system [29]. The findings highlight the transformative role of AI-powered assistive robotics in improving therapeutic and educational outcomes for children with disabilities. Robotic systems can deliver tailored and engaging learning experiences through AI-driven adaptive interactions, promoting social and cognitive growth [30]. This aligns with the expanding integration of AI in assistive technologies, where intelligent systems play a crucial role in advancing inclusive education and rehabilitation initiatives [31]. The findings of this study have significant implications for integrating AI-driven training programs in adaptive physical education and rehabilitation. The demonstrated improvements in balance and flatfoot condition among blind female students suggest that AI-generated core stability exercises can serve as an effective, individualized, and scalable intervention. By leveraging AI to design tailored exercise regimens, practitioners can enhance postural control and musculoskeletal health in visually impaired individuals, ultimately promoting greater mobility and independence. These results underscore the potential of AI-assisted rehabilitation strategies in special education settings, highlighting the need for further research to optimize program parameters and expand their applicability across diverse populations.

Limitations and Future Directions

Despite the promising outcomes of this study, several limitations must be acknowledged. First, the sample size was relatively small, which may limit the generalizability of the findings to a broader population of blind female students. Additionally, the study focused on a short intervention period of six weeks, and the long-term effects of the AI-generated core stability training on balance and flatfoot correction remain uncertain. Another limitation is the potential variability in individual responses to the training, as factors such as baseline physical fitness, muscle strength, and adherence to the program could influence the results. Furthermore, while AI-generated programs offer personalization, they may not fully account for nuanced biomechanical and sensory adaptations unique to visually impaired individuals. Future studies should further incorporate larger sample sizes, extended follow-up periods, and comparisons with traditional rehabilitation methods to validate the efficacy and sustainability of AI-driven interventions.

Conflict of interest

The authors declared no conflicts of interest.

Authors' contributions

All authors contributed to the original idea and study design.

Ethical considerations

The authors’ parents have completely considered ethical issues, including informed consent, plagiarism, data fabrication, misconduct, and/or falsification, double publication and/or redundancy, submission, etc.

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