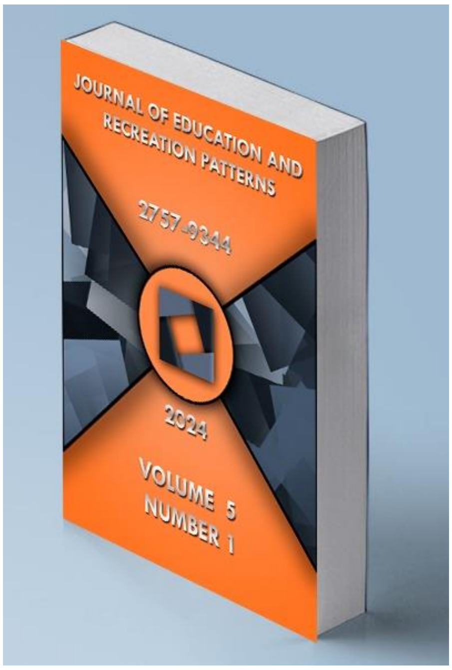

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Investigation of Balance Assessment of TecnoBody Devices in Athletes

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ABSTRACT

Virtual reality (VR) is an advanced user-computer interface that includes real-time simulation and interactions through visual and auditory senses. VR is increasingly being used on athletes for assessment and training. Balance refers to maintaining the position of the body's center of gravity. Static and dynamic balance is the basis of postural stability and mobility and is an important skill in sport. Balance impairment increases the risk of falls and is clinically assessed using the Berg Balance Scale. However, more objective methods need to be developed. For this purpose, technologies such as posturography, which measures the center of pressure trajectory, are used. TecnoBody devices play an active role in the assessment and rehabilitation processes. In particular, proprioceptive and stability analyses are performed with ProKin devices, dynamic balance analyses are performed with D-Wall device and audiovisual feedback is provided with exergame. These devices are effective in rehabilitation and can increase patients' interest in treatment. As a result of the studies conducted in the literature review, TecnoBody Prokin has also been used in the field of sports sciences. In the studies conducted with Prokin, it was seen that it was generally used in dynamic and static balance evaluations. However, no studies on TecnoBody's other devices were found in the literature. In addition, in the studies examined, it was seen that TecnoBody devices were used as a evaluation tool instead of being used in exercises. With the advancement of technology, it is thought that TecnoBody devices can be more effective in people through exercise feedback.

Keywords: Athlete Balance, Balance, TecnoBody,

INTRODUCTION

Virtual reality (VR) is an innovative technology featuring a sophisticated user-computer interface incorporating real-time simulation and interactions via visual and auditory sensory channels (Mazurek, et al., 2019). Moreover, VR is a foundational technology that enables users to immerse themselves completely in a simulated environment, experiencing a genuine sense of presence through multimodal stimuli (Li et al., 2011). Evaluations and exercises on athletes using virtual reality are increasingly being used in technology development. It is observed to be more effective than classical/conventional assessments and exercises (Fandim et al., 2021, Gazendam et al., 2022, Rutkowski et al., 2020). TecnoBody (SRL, Dalmine, 24044 Bergamo, Italy) produces effective devices in the field of assessment and exercise in virtual reality, and these devices are becoming widespread.

Our study's hypothesis is that the data from TecnoBody devices are effective, objective, and detailed in athletes undergoing balance assessment. Therefore, this study examined the effectiveness and objective data of balance evaluations applied to athletes with TecnoBody devices.

Balance

Balance is the ability of visual feedback and vestibular and somatosensory systems to position the body's center of gravity (Nashner, 2014). Static or dynamic balance is among the factors limiting performance and skill in some sports branches, and rapid adjustment of sport-specific balance is expressed as an important skill (Zemková & Hamar 2006). Balance is the basis of the ability to provide postural uprightness and movement (Chaudhry et al., 2008). Impaired dynamic balance is an important fall risk factor for athletes. Balance is evaluated in two ways: static and dynamic. Different clinical assessment methods, such as the Berg Balance Scale (BBS) (Berg et al., 1992) and Timed Up and Go Test (TUG) (Podsiadlo & Richardson, 1991), have been developed to evaluate static and dynamic balance functions and are widely used in rehabilitation. Although these methods are used clinically, more detailed objective methods and devices will be needed to provide better and more objective assessments for the impairment of the balance mechanism. Posturography, which measures the trajectory of the center of pressure (COP), is used for a more objective measurement of the balance mechanism (Visser et al., 2008). In the dynamic balance function, the control of the center is usually referred to as the stability of the acceleration of gravity (COG) (Menz et al., 2003; Toebes et al., 2012). In light of these scopes, TecnoBody devices play an active role in assessment and rehabilitation.

TecnoBody

TecnoBody devices are particularly involved in the assessment processes. ProKin devices are used to perform proprioceptive and stability analyses, while the D-Wall device performs balance analyses. It is seen that the D-Wall device is effective in rehabilitation, exergame, and treatments by providing audio-visual feedback. The data seen on a monitor controlled by the individual is analyzed by a special algorithm. This analysis allows the evaluation of proprioceptive and balance parameters. The ability to control the individual during Tecnobody virtual exercises and tips on performing the exercises can be presented with realistic images through digital screens (Üzümcü et al., 2024). The D-Wall digital display instantly shows the strengths and weaknesses of the users with objective biological feedback and real-time data provided by the software. TecnoBody's D-Wall device allows users to perform each movement with maximum control and share the results with experts (Fizzotti et al., 2022).

Figure 1

TecnoBody ProKin (Arol, 2018).

Postural stability is evaluated using a stabilometric platform known as the TecnoBody ProKin (Figure 1), a force platform designed to measure postural sway by analyzing the center of pressure (Toprak et al., 2019).

METHOD

This study was meticulously searched in Pubmed, Dergipark, Google Scholar and ResearchGate search engines between 2010-2024 using the keywords ‘TecnoBody’, ‘Static Balance’, ‘Dynamic Balance’ and ‘Balance’ in Turkish and English. The literature review was conducted by G. A., analysed in detail by B. Ü. and checked by S. S. This comprehensive process took 3 months for the search, 4 months for analysis, and 2 months for checking. In total, data analyses took 9 months. Articles whose full texts were found as a result of the searches were included, ensuring a comprehensive and thorough review.

From the extensive search, 21 studies were found. Of these, 13 were meticulously included because they were conducted on healthy people and athletes. The exclusion criteria of the studies were; not being related to athletes (4 articles), not mentioning the data of the study in detail (1 article), uncertainty of the study data (2 articles) and incomplete entry of the study data (1 article). This careful selection process ensures the reliability and relevance of the studies included in our research.

DISCUSSION & CONCLUSION

Balance Evaluations with Tecnobody Devices

In a 2019 study by Aktaş, the relationship between isokinetic leg strength and dynamic balance in elite male volleyball players was investigated. Thirteen players, averaging 26.50 ± 4.10 years old, participated. Isokinetic muscle strength was assessed using the IsoMed system, and body composition was measured with a Bioelectrical Impedance Measurement Device. Dynamic balance was evaluated using the TecnoBody ProKin device. During strength assessment, players warmed up on a bicycle ergometer before performing stretches. Isokinetic leg strength was measured for five repetitions at 60°/s and ten repetitions at 120°/s for both legs. In dynamic balance assessment, participants balanced on a moving platform for 25 seconds in a flat and double-leg squat position, preceded by 10-second repetition tests. Results showed no significant relationship between dynamic balance and bilateral differences in quadriceps and hamstring muscles at 60°/s ($p>0.05$) but a significant relationship at 120°/s ($p<0.05$). Additionally, no significant relationship was found between dynamic balance and the

Hamstring/Quadriceps (H/Q) strength ratio (p>0.05) (Aktaş, 2019). Dülger and Baş examined leg strength and jump performance's influence on handball players' balance. Forty male handball players were studied. Balance was assessed statically and dynamically using TecnoBody ProKin, analyzing postures with open/closed eyes and bipedal stances. Jump parameters in horizontal and vertical dimensions were measured, along with muscle strength using a dynamometer. Anaerobic power in kg-m/s was calculated. Findings revealed negative correlations between vertical jump values, bipedal mean track error (ATE), and balance indicators, as well as between horizontal jump values, bipedal ATE, leg strength, and mean medial-lateral velocity values with closed eyes. Anaerobic power correlated negatively with mean forward-backward velocity with closed eyes, closed-eye PM, and bipedal ATE values (p<0.05). Analysis indicated decreasing balance values with increasing vertical jump, horizontal jump, leg strength, and anaerobic power (Dülger & Bas, 2021). In a study by Kesilmiş and Akın, the influence of gymnastics training on dynamic balance ability and hypermobility in preschool children was examined. A total of 162 children participated, with 76 males and 86 females. Among them, 47 children underwent 12 weeks of gymnastics training, while 115 followed regular school programs. Dynamic balance was assessed using the TecnoBody ProKin device, and hypermobility was evaluated using the Beighton test. Significant differences in dynamic balance skills were found between 6-year-old children who received gymnastics training and those who did not (p<0.001). Additionally, girls displayed significantly better dynamic balance skills than boys (p<0.005). There was a notable difference in hypermobility between children in gymnastics training (p<0.05). Hypermobility rates were 23.7% in males, 43% in females, 51.1% in gymnasts, and 27% in non-gymnasts. However, no correlation was found between dynamic balance ability and hypermobility. Despite similar age groups and physical characteristics, children's dynamic balance performance and hypermobility varied based on participation in gymnastics training. Furthermore, girls exhibited higher dynamic balance performance compared to boys (Kesilmiş & Akın, 2018). In a study by Demir and Akın, dynamic balance performances were compared among healthy boys aged 11-12 years based on somatotype characteristics. A total of 123 boys participated, with a mean age of 11.66 ± 0.699 years. Somatotype characteristics were determined using the Heath-Carter Anthropometric Somatotype Calculation technique. Dynamic balance was measured using the TecnoBody Prokin device, assessing postural limit (PL) values on both right and left feet and various anthropometric measurements such as skinfold thickness (SCT), diameter, length, and circumference. The mean somatotype of the boys was determined as endomorph=4.17, mesomorph=4.38, and ectomorph=2.62. Participants were grouped based on dominant endomorph, mesomorph, and ectomorph characteristics, and dynamic balance comparisons were conducted. It was found that the group with dominant mesomorph characteristics exhibited a statistically significant difference in dynamic balance compared to the other groups (Demir & Akın, 2019). In a study by Kaya and Peker, the impact of core training on static balance and vertical jump performance in male football players was investigated. Twenty amateur male football players participated, divided into two groups. The first group (n=10) underwent core training three days a week for eight weeks, alongside regular training, while the second group (n=10) did not perform core exercises. Body composition was assessed using the Bodystat®1500 body analyzer, balance was evaluated using the Tecnobody ProKin device, and vertical jump performance was measured with the Powertimer PC 1.9.5 Version Newtest device. Pre-test and post-test evaluations were conducted for both groups. Results revealed a significant improvement in static balance and jump performance among participants who received core training (Kaya & Peker, 2024). In a study by Kesilmiş and Akın, the impact of Kangoo jump shoes on plantar flexion-dorsiflexion strength and dynamic balance in female badminton players was explored. Sixty participants, with a mean age of 12.78 ± 0.88 years, were divided into three groups: Kangoo badminton (KBG) group (n=20), badminton (BG) group (n=20), and control group (CG) (n=20). The KBG group wore Kangoo jump shoes during badminton training, the BG group received only badminton training, and the CG did not engage in any specific training as the control group. Dynamic balance assessment was conducted using the TecnoBody Prokin device, evaluating bipedal, right, and left foot balance, while Lafayette's manual muscle strength test was employed for muscle strength evaluation. Pre-test and post-test assessments were conducted for each group over eight weeks, with training sessions lasting 2 hours a day, twice a week. Results revealed significant improvements in bipedal dynamic balance skill, right-left plantar flexion peak, and left dorsiflexion peak in the KBG group. Significant differences were observed between pre-test and post-test comparisons in various dynamic balance measures and plantar flexion-dorsiflexion forces across all three groups. The study concluded that training with Kangoo jump shoes increased balance and plantar flexion-dorsiflexion muscle strength development in badminton players (Kesilmiş & Akın, 2019). In another study by Vora et al. (2019), which focused on the biomechanics of squat jumps in young badminton players, 100 participants (59 males and 41 females) aged 8-15 years were involved. Biomechanical assessment of the squat jump was conducted using the TecnoBody Iso Lift system, comprising a sensorized platform equipped with four load cells for real-time detection of load distribution. Athletes stood on the Iso Lift platform and were scanned with a 3D camera. Parameters such as maximum height, force, acceleration, and relative power were recorded during each squat jump. The analysis revealed no significant difference in maximum strength and maximum relative strength of squat jumps concerning body mass index and competitive level. Furthermore, various other factors did not significantly affect the squat jump (Vora et al., 2019). In a study by Erkılıç and Şener, the relationships among body composition, anaerobic performance, and balance in wrestlers were investigated. Fourteen wrestlers aged 17 to 20 years participated in the research. Anaerobic performance was assessed using the Wingate Anaerobic Power Test (WAnT), balance was evaluated using the Tecnobody ProKin device, and body composition analysis was conducted using Tanita scales. Results revealed significant correlations between lower body absolute peak power values and body height, weight, left and right leg muscle mass, as well as left and right arm muscle mass ($p<0.01$). However, no significant correlation was found between balance and other variables ($p>0.05$). The findings suggested that leg and arm muscle mass play a crucial role in balance and may influence anaerobic performance (Erkılıç & Şenel, 2019). In a study by Isbilir et al., the relationship between dominant and non-dominant ankle muscle strength and dynamic balance in football players was explored. Seventeen amateur football players participated, and the Waterloo Foot Endurance Questionnaire-Revised (WFQ-R questionnaire) was used to determine limb dominance. Dynamic balance assessment was conducted using the Tecnobody ProKin device, while ankle joint muscle strength was measured with the Cybex Norm isokinetic dynamometer. Results revealed significant differences between limbs for ankle plantar flexors, indicating greater strength in plantar flexors on the non-dominant side. Additionally, dynamic balance ability was found to be superior for the dominant foot compared to the non-dominant foot. Correlations were observed between ankle plantar flexors, evertors, inverters, and dorsal and plantar flexors for both limbs (Isbilir et al., 2015). In a study by Kesilmiş et al., the correlation between ankle range of motion and dynamic balance was explored in rhythmic gymnasts. The study involved 17 female rhythmic gymnasts (8.82 ± 1.42 years) and 19 sedentary females (8.73 ± 1.36 years). Active dorsiflexion and plantar flexion range of motion were measured in both ankles of all participants using a goniometer. Monoaxial dynamic balance scores were evaluated with the Tecnobody Prokin device for an anteroposterior swing on a monoaxial basis for both feet. Additionally, a slalom test was conducted for 30 seconds. In rhythmic gymnasts, results showed a significant correlation between slalom circumference length, right dorsiflexion, and left plantar flexion. However, no correlation was found between balance and ankle range of motion in sedentary females. Significant differences were observed in rhythmic gymnasts compared to sedentary females regarding bipedal circumference, right foot circumference, right plantar-dorsal flexion, left plantar flexion, and left dorsal flexion ($p<.05$) (Kesilmiş et al., 2017). A 2018 study by Kesilmiş and Akın investigated the hypermobility, broad jump, and dynamic balance skills of 240 children (120 boys and 120 girls) aged 11 to 14 years. Hypermobility was assessed using the Beighton criteria with a cut-off point of 5, while dynamic balance was evaluated using the TecnoBody Prokin device. Standing broad jump measurements and leg length assessments were also conducted. Non-hypermobile participants in both genders demonstrated better dynamic balance results for right-left circumference length, whereas hypermobile participants exhibited superior explosive leg strength. Female participants achieved better dynamic balance test results ($p<.005$), while males outperformed females in standing broad jump results, with no significant difference observed when corrected for leg length. However, no correlation was found between hypermobility and other variables (Kesilmiş & Akın, 2018). In a 2020 study by Akın and Kesilmiş, the effects of blood flow restriction and plyometric training on dynamic balance in taekwondo athletes were explored. Thirty-one taekwondo athletes (19 males and 12 females) aged 15 to 19 years were divided into blood flow-restricted exercise, plyometric training, and control groups. Dynamic balance was assessed using the TecnoBody Prokin device for bipedal dynamic balance measurements. Results revealed a statistically significant difference between pre-test and post-test values for dynamic balance (anteroposterior swing) in the blood flow-restricted exercise group ($p<.05$). However, no significant difference was found in the plyometric training group ($p>.05$), and no gender difference was observed ($p>.05$) (Akin & Kesilmiş, 2020). A study by Arol and Kolayış examined the effect of balance exercises on amateur canoe athletes. Twenty-five women (mean age 14.92 ± 0.39 years) were divided into intervention and control groups. Balance exercises were conducted for 40 minutes a day, three days a week for eight weeks, alongside ski training twice a week. Dynamic and static balance assessments were performed using the TecnoBody Prokin device, and balance testing was conducted using a ski prototype. Both groups showed improvements in static and dynamic balance as well as kayak-specific balance values. The intervention group exhibited significantly higher kayak-specific balance improvements ($p<0.05$) (Arol, 2018).

The studies have shown that TecnoBody devices provide objective and effective data in the field, especially in balance assessment, because they are accessible, portable, low-cost, simple, and readable.

However, when the studies were examined, the results of the studies conducted with low sample groups were heterogeneous. Therefore, scientific studies need to be conducted with a larger sample group.

Conclusion

When the studies were examined, it was found that TecnoBody devices were used in the literature before and after training or exercise or instant evaluations in athletes. It was observed that these evaluations were generally made on balance evaluations. However, it was observed that no exercise or training was performed on the performance or balance parameters of athletes with TecnoBody devices. However, it is thought that exercises or training with TecnoBody devices may be effective on athletes' performance and balance, and these effects may increase bio-motor skills. It is thought that using TecnoBody devices in exercises or training and evaluation in future studies may be effective.

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