

Research Paper

The Effect of Local-indigenous Games and Neuro-muscular Exercises on Static and Dynamic Balance in Obese Children



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ABSTRACT

Purpose: This study aims to investigate the impact of neuromuscular exercises (NE) and local-indigenous games (LIG) on the static and dynamic balance of obese children.

Methods: Thirty obese children were randomly assigned to NE (n=15, mean age 10.47±2.1 years, body mass index (BMI) 29.15±3.01 kg/m²) or LIG (n=15, mean age 10.67±1.52 years, body mass index (BMI) 29.45±3.41 kg/m²) groups. Both groups underwent 12 training sessions, during which dynamic and static balance were measured with the Biodex device before and after training. Analysis of covariance (ANCOVA) and independent t-test were used to compare balance indices between the two groups.

Results: No significant differences were observed in static anterior-posterior balance between NE (0.82±0.10) and LIG (0.68±0.09). Similarly, no significant differences were found in static lateral-medial balance (NE: 0.82±0.10; LIG: 0.68±0.09) (P>0.05). Moreover, the dynamic anterior-posterior balance did not differ significantly between NE (0.79±0.08) and LIG (0.97±0.26) as well as the dynamic lateral-medial balance did not differ significantly (NE: 0.74±0.10; LIG: 0.93±0.15) (P>0.05).

Conclusion: This study suggests that both NE and LIG are effective in improving balance indices in obese children. However, no significant differences were observed between the two interventions.

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Highlights

- The effectiveness of the local indigenous games in increasing balance is not significantly different from the neuromuscular exercise.
- The local indigenous games are effective in enhancing the balance of obese children.
- Twelve sessions of the Local indigenous games are sufficient to promote balance in obese children.

Plain Language Summary

Nowadays, with the growth of technology and the shift in people's lifestyles from active and dynamic to machine-based and digital, it has led to decreased physical activity and consequently increased rates of diseases and movement disorders. This change is particularly impactful on children and statistics show a significant increase in childhood obesity due to inactivity. Today's children spend most of their time playing digital games that are static and inactive. Our country's culture has various local and traditional games that are highly attractive, but unfortunately unknown to the younger generation. Therefore, this study compared some of the local indigenous games based on balance preservation using neuromuscular training methods affecting balance. The results showed that these types of games have similar effects to neuromuscular training methods. Since local indigenous games are lively, attractive, exciting, etc. it is considered the best training method for children to become familiar with the rich culture of our country and to fight against physical inactivity during childhood. Therefore, teachers, coaches, and parents are advised to use local indigenous games during children's leisure time to improve their balance performance, which guarantees their physical health in the future.

1. Introduction

Balance, which consists of static and dynamic elements, is a fundamental and significant physical ability that underlies human movements in various age groups, from childhood to old age [1, 2]. Static balance refers to the individual's ability to maintain a stable standing position without displacing their body, while dynamic balance involves maintaining equilibrium while moving from one location to another. Anthropometric attributes, such as weight are crucial factors that influence balance, and obesity and overweight are widespread public health concerns worldwide [3]. Obesity, in particular, is associated with orthopedic issues causing an overload in the skeletal-muscular structure. Researchers have documented significant differences in the pressure exerted by the soles of the feet and the structure of the foot between obese and normal-weight individuals, which can potentially impact walking function. Thus, obesity during childhood can result in increased health risks [4-6]. Biomechanical investigations have demonstrated the effectiveness of therapeutic exercises in promoting balance [7-9].

Studies have demonstrated that children who become overweight or obese during childhood may experience adverse effects on their physical balance and body composition. Additionally, obesity can impede movement by impairing balance and stability during physical activity, making children more susceptible to injury and increasing the likelihood of falls [10, 11]. Neuromuscular exercises (NE) are used to enhance postural control and balance by improving muscle responses and sensory systems involved in motor control [12]. The combined utilization of various exercise types, such as plyometric, sensory, depth, balance, and resistance exercises, stimulate different muscle and joint receptors, leading to increased interaction within the neuromuscular system, ultimately improving both muscles and motor skills [13]. Evidence suggests that NE has been effective in enhancing postural control in individuals with musculoskeletal disorders [14].

According to a study conducted by Guzmán-Muñoz et al in 2019, NE is effective in improving both static and dynamic balance in children. However, the authors of the study noted that the effectiveness of such exercises is contingent upon their organization and execution. Therefore, recent approaches suggest that "exercises should be designed as game-like activities for children" [15].

One effective method involves incorporating exercises based on cultures, traditions, and customs that are meaningful to society. These traditional and native games are deeply rooted in the culture of each nation, race, and region, and have a strong relationship with their way of life, behavior, deeds, and occasions. Active games that incorporate local-indigenous games (LIG) are highly recommended because they not only strengthen the skeletal-muscular system but also improve the cardio-pulmonary system, providing motivation and freshness to those who engage in them [16].

Several LIG, such as Alakhtor, Ganiyeh, Game-Window, Seven Stones, Ghos-Castle, Dal-Pelan, Gheyghach, Alak-Dolak, etc. have been effective in enhancing the gross and subtle movements of their players. These games activate different parts of the sensory-motor cortex, thereby increasing their perceptual-motor abilities, strengthening proprioception, and improving sensory-vestibular systems critical to maintaining balance. These games in any way require various cognitive and performance skills, such as problem-solving [17-22].

Reviewing various scholarly sources, no observed effect of LIG on the balance of obese children was found, even though movement-based evidence suggests promise in terms of improving balance. However, a substantial number of studies have demonstrated favorable results regarding the effectiveness of NE in improving balance. Therefore, The first stage of this study was conducted to investigate the role of NE and LIG in enhancing the static and dynamic balance of obese children who struggle with maintaining balance due to excessive weight. The second stage of this study was conducted to analyze and contrast the differences between NE and LIG in terms of improving balance for obese children.

2. Materials and Methods

The present study was conducted using a quasi-experimental design consisting of a pre-test and post-test to investigate the impact of NE versus LIG on the balance of male and female students aged 10 to 13 years in Kerman City, Iran. Thirty obese children were randomly assigned to either the NE ($n=15$, comprising 8 girls and 7 boys with a mean age of 10.47 ± 2.1 years; height of 1.44 ± 0.17 cm; body mass of 61.72 ± 18.21 kg; and body mass index (BMI) of 29.15 ± 3.01 kg/m²) or LIG ($n=15$, comprising 8 girls and 7 boys with a mean age of 10.67 ± 1.52 years; height of 1.51 ± 0.12 cm; body mass of 67.91 ± 15.73 kg; and BMI of 29.45 ± 3.41 kg/m²) group. Before participation, all parents, students, and teachers were fully informed about the protocol and written informed consent

and assent were obtained from each subject before testing. The inclusion criteria included a BMI between 85-95%, an age range of 10-13 years, and overall physical and mental health. The exclusion criteria included musculoskeletal injuries, lower limb surgeries, pain in any part of the body during evaluation, vestibular disorders, uncorrected visual disorders, and the use of walking aids. Additionally, participants who attended less than 85% of the physical activity classes were excluded from the analysis. The sample size was determined via G*Power software, version 3.1.9.7 analysis and deemed sufficient to detect at least a medium effect size with the following parameters, the effect size of $f=0.25$, significance level $\alpha=0.05$, and power of $1-\beta=0.80$.

As illustrated in Figure 1, the participants completed two laboratory visits for the test-in-experiment process. One visit was designated for the pre-test and the other for the post-test, which occurred within 48 hours following the last training session. The exercise protocol comprised 12 sessions, with a frequency of three sessions per week and an average duration of 45 minutes per session. The program consisted of a 10-minute warm-up phase, a 35-minute training phase, and a 10-minute cool-down phase.

The participants' height and body mass was measured using a height meter and a scale, respectively, and their BMI was determined and verified with the z-score chart. The assessments for both static and dynamic balance were subsequently performed under the same conditions for both groups. In this study, the Biodex balance meter (ICC0.95), which is a device manufactured in the United States (Balance SD, System 15, VAC), was utilized to evaluate both dynamic and static balance. The device comprises a turntable on which the subjects stand and endeavor to maintain equilibrium according to the position of the indicator reflected on the monitor while keeping the turntable stationary. The turntable moves in both anterior-posterior and internal-external directions to assess four tests, namely standing on one leg, standing control, stability range, and fall risk. The level of support stability can be adjusted from 1 to 12, with position 1 being the most dynamic and unstable, while position 12 is the most static and stable.

In this study, the static equilibrium state was set at position 12, where each part comprised three 20-s efforts, followed by a 10-s rest period. To evaluate balance, the height control test was employed, whereby the subjects stood on the balance board with their feet a distance equal to 10% of their height apart and adjusted their feet to the optimal location to maintain balance while monitoring

the screen. The examiner recorded the spatial position of the foot heel on the screen and the angle of the foot axis along the second toe. Additionally, stature control in dynamic mode was evaluated at position 5.

The NE program implemented in this study was grounded on prior research into NE for overweight and obese school children, as reported by Guzmán-Muñoz, Sazo-Rodriguez [15]. The training regimen comprised a 5-minute dynamic warm-up involving jogging, jogging in place, and joint mobility exercises. These three exercises aimed at enhancing muscular strength and coordination of the lower limbs were followed, mini hurdle jumping, agility cone drills, and agility ladder drills. Then, exercises to improve postural balance were performed, including single-leg balance, marching in place, tandem walking, and single-leg squat.

On the other hand, the LIG practice session comprised warming up (same as NE group), the main program (consisting of Alakhtor, Ganiyeh, Game-Window, and Rotten-Egg as presented in Table 1), and cooling-down (same as NE group). Alakhtor's LIG is a two-player game aimed at improving balance retention and strengthening lower body muscles, while the LIGs of Ganiyeh, Game-Window, and Rotten-Egg are group games with different characteristics, execution methods, and rules designed to enhance neuromuscular coordination, balance, muscle agility, and speed [16-22].

The effect of NE and LIG on static and dynamic balance in obese children was determined using analysis of covariance (ANCOVA). When justified, independent t-tests were performed to confirm significant changes within each condition. A P of ≤ 0.05 was considered statistically significant for all analyses. SPSS software, version 20 was used to conduct all statistical analyses.

3. Results

Table 2 presents the results of the static anterior-posterior balance, which indicate no significant difference between NE (0.82 ± 0.10) and LIG (0.68 ± 0.09) ($P > 0.05$). Additionally, no significant differences were observed between NE (0.82 ± 0.10) and LIG (0.68 ± 0.09) for static lateral-medial balance ($P > 0.05$).

Furthermore, Table 3 presents the results of dynamic anterior-posterior balance, which showed no significant difference between NE (0.79 ± 0.08) and LIG (0.97 ± 0.26) ($P > 0.05$). Similarly, for dynamic lateral-medial balance, no significant difference is observed between NE (0.74 ± 0.10) and LIG (0.93 ± 0.15) ($P > 0.05$).

4. Discussion

This study was conducted to investigate the impact of NE and LIG on the static and dynamic balance of obese children. Postural sway is commonly regarded as an at-

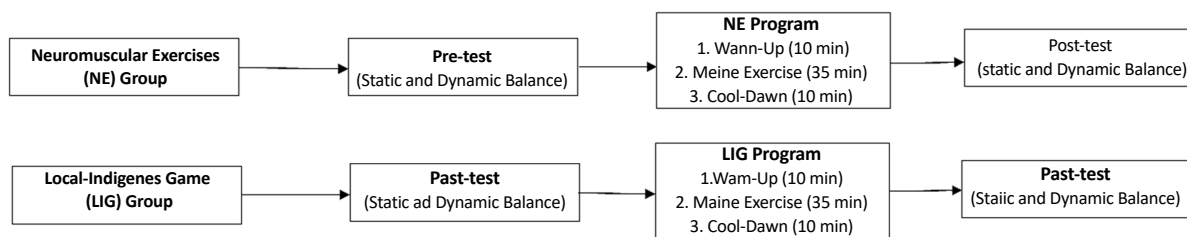


Figure 1. Follow chart of protocol for both participants of NE and LIG groups

Table 1. Program of selected LIG in this study

Type of Exercise	Week	Set
Alakhtor	1	3
Ganiyeh and Game-window	2	3
Local-indigenes games		
Alakhtor and Ganiyeh and Rotten-egg	3	3
Alakhtor and Ganiyeh and Game-Window and Rotten-egg	4	3

Table 2. ANCOVA and independent t-test of NE group and LIG group on static balance indexes

Balance Index	NE	LIG	Test Amount	P	
Static	Anterior-posterior	0.82±0.10	0.68±0.09	T=1.61	0.119
				F=0.49	0.500
	Lateral-medial	0.47±0.10	0.53±0.12	T=0.43	0.0672
				F=0.81	0.375

LIG: Local-indigenous games; NE: Neuromuscular exercises.

Table 3. ANCOVA and independent t-test of NE group and LIG group on dynamic balance indexes

Balance Index	Mean±SD		Test Amount	P	
	NE	LIG			
Dynamic	Anterior-posterior	0.79±0.08	0.97±0.26	T=0.659	0.515
				F=0.86	0.363
	Lateral-medial	0.74±0.10	0.93±0.15	T=0.65	0.520
				F=0.69	0.412

LIG: Local-indigenous games; NE: Neuromuscular exercises.

tempt by the body to maintain optimal balance during standing. Increased fluctuation points towards greater muscular effort and weaker balance. Previous research has shown that specific NE designed to enhance central stability and balance can activate distinct facets of the neuromuscular system that contribute to joint stability, in addition to improving sensory-motor and nervous systems. This increase in reflex contractions can ultimately reduce stress on joints during daily activities. It is believed that improper posture control and balance may partially account for disturbances in sports performance [23]. The results of the present research indicate a positive impact of 12 sessions of NE on obese children, which is consistent with the results of the previous article [3].

A study evaluated the impact of a four-week NE program on the performance of star balance tests in basketball players. The results revealed a significant improvement in average anterior, posterior, and medial direction scores, suggesting a positive impact on the dynamic balance of basketball players. Another study examined the effect of eight NE sessions conducted over four weeks on the static and dynamic balance of overweight children [15]. The results indicated a significant improvement in the static and dynamic posture of the children. Although the number of training sessions was fewer than those

in the present study, and the primary focus was only on central stability exercises, Guzmán-Muñoz et al.'s research suggests that such exercises can effectively promote balance.

The results of the present study highlight the effectiveness of a range of exercises, including NE and LIG, in promoting both static and dynamic balance in obese children. NE and LIG can be invaluable for enhancing both physiological and mental health. However, selecting appropriate NE, based on factors, such as exercise intensity, duration, number of sessions, age, and physical and mental conditions of the participants, can yield diverse effects on individuals' physiological and psychological aspects [24]. Additionally, evidence indicates that LIG can enhance brain structure interaction, improve neural functions, and foster learning in participants [17-22].

LIG are recognized for their ability to stimulate the motor cortex of the brain, which facilitates the establishment of numerous neural connections between the limbic region, as well as the visual, auditory, and speech areas of the brain. Consistent repetition and continuation of such stimulation promote new learning, resulting in an enhanced mutual influence of the brain and nervous system [17-22]. This ultimately leads to improvements

in both the quantity and quality of behavioral responses from the nervous system [25]. These results are consistent with the previous research which investigated the effects of LIG on physical fitness factors among students [19, 21, 22]. The study noted a significant improvement in average scores for physical fitness tests, including sitting, flexibility, balance, and agility.

The results of the present study are consistent with the previous research which highlighted the effectiveness of games in improving both static and dynamic balance indicators [26, 27]. Although relevant literature supports the greater influence of games in enhancing balance indicators, no similar research in scope and level of detail to the present study was identified by the researcher.

5. Conclusion

Based on the results of the present study and their comparability with relevant research, it can be concluded that both NE and LIG used in this investigation are effective in enhancing the balance of obese children. Furthermore, the findings suggest that 12 sessions of these training methods are sufficient to promote balance in overweight and obese children. Both NE and LIG show promise in improving static and dynamic balance in obese children, indicating either method can be employed to enhance balance in this population. Notably, incorporating group games to strengthen and enhance balance may benefit boys and girls more due to their greater affinity for sports that instill enthusiasm, as opposed to conventional legal sports exercises.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of [Shahid Bahonar University of Kerman](#) (Code: IR.UK.REC.1401.022).

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Authors' contributions

Conceptualization, visualization, methodology, validation, formal analysis, investigation, validation, resources, data curation, review, and editing: All authors; Software, writing—original draft preparation: Somayeh Ghotbzadehkermani and Mohammadtaghi Amiri-Khorasani; Supervision and project administration: Mohammadtaghi Amiri-Khorasani and Mahshid Zarezadeh;

Conflict of interest

The authors declared no conflict of interest.

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