Spor Hekimliği Dergisi, 60(2):50-56; 2025
Turkish Journal of Sports Medicine
Turk J Sports Med. DOI: 10.47447/tjsm.0890

Research Article / Araştırma Makalesi

An examination of balance, flexibility, and proprioception in Latin dancers: cross sectional case-control study

Latin dansçılarında esneklik, denge ve diz eklem propriosepsiyonu: olgu-kontrol çalışması

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ABSTRACT

Objective: The purpose of this study was to assess the flexibility, balance, muscle strength, and knee joint proprioception of Latin dancers, and compare them with sedentary individuals.

Material and Methods: The study involved 11 Latin dancers and 11 sedentary individuals from Isparta, Türkiye. Information was collected through face-to-face interviews. The REGICOR physical activity questionnaire was used to assess participants' physical activity levels. Flexibility was measured using the sit-and-reach test, balance by means of the lower extremity Y-balance and Stork tests, knee proprioception with active and passive knee proprioception measurements using an isokinetic dynamometer, and muscle strength using the squat test.

Results: The flexibility of Latin dancers was significantly higher than that of sedentary individuals (p=0.001). In the Y-balance test, Latin dancers scored significantly higher on both the right (p=0.007) and left (p=0.008) sides. In the Stork test, no significant difference was found for the left leg, but Latin dancers performed significantly better on the right leg (p=0.009). No significant difference was observed in the squat test. Proprioception measurements revealed that Latin dancers had better knee proprioception than sedentary individuals, with significant differences in left knee active 75° (p=0.045), left knee passive 75° (p=0.001), and right knee active 45° (p=0.030).

Conclusion: Latin dancers have better balance, flexibility, and knee proprioception. Latin dancing may be recommended as a recreational activity for individuals with balance and flexibility issues, and Latin dancers can improve their physical fitness while socializing through dancing.

Keywords: *Latin dancers, proprioception, balance, flexibility*

ÖZ

Amaç: Bu çalışmanın amacı, Latin dansçılarının esneklik, denge, kas gücü ve diz eklemi propriosepsiyonunu değerlendirmek ve sedanter bireylerle karşılaştırmaktı.

Gereç ve Yöntem: Çalışmaya Isparta, Türkiye'den 11 Latin dansçı ve 11 sedanter birey alındı. Özellikler yüz yüze görüşmelerle toplandı. Katılımcıların fiziksel aktivite düzeyleri REGICOR fiziksel aktivite anketi ile değerlendirildi. Esneklik otur ve uzan testiyle, denge alt ekstremite Y-denge ve Stork testleriyle, diz propriosepsiyonu izokinetik dinamometre kullanılarak aktif ve pasif diz propriosepsiyon ölçümleriyle, kas gücü ise squat testiyle ölçüldü.

Bulgular: Latin dansçılarının esnekliği, sedanter bireylere göre anlamlı derecede daha yüksekti (p=0.001). Y-denge testinde Latin dansçıları hem sağ (p=0.007) hem de sol (p=0.008) taraflarda anlamlı olarak daha yüksek puan aldı. Stork testinde sol bacakta anlamlı bir fark bulunmazken, Latin dansçıları sağ bacakta anlamlı olarak daha iyi performans gösterdi (p=0.009). Squat testinde anlamlı bir fark gözlenmedi. Propriosepsiyon ölçümlerinde Latin dansçılarının diz propriosepsiyonu, sedanter bireylere göre daha iyiydi ve sol diz aktif 75° (p=0.045), sol diz pasif 75° (p=0.001) ve sağ diz aktif 45° (p=0.030) ölçümlerinde anlamlı farklılıklar bulundu.

Sonuç: Latin dansçılarının denge, esneklik ve diz propriosepsiyonu daha iyi bulundu. Latin dansı, denge ve esneklik sorunları olan bireyler için rekreasyonel bir aktivite olarak önerilebilir ve dansçılar sosyalleşmenin yanında fiziksel sağlık durumlarını da geliştirebilir.

Anahtar Sözcükler: *Latin dansçılar, propriosepsiyon, denge, esneklik*

INTRODUCTION

Physical activity is recognized as one of the fundamental components of health (1). Regular physical activity is associated with a reduced risk of chronic diseases, such as cardiovascular disease, diabetes, and various types of cancer (2). Dance, a physical activity consisting of artistic and aesthetic elements performed in a specific rhythm, is considered a promising form of physical activity that promotes physical movement and improves health outcomes. Latin dance, originating from Latin America, encompasses various vigorous dances, such as rumba and samba (3). During

Received / Geliş: 01.12.2024 · **Accepted / Kabul:** 06.01.2025 · **Published / Yayın Tarihi:** 27.05.2025

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Cite this article as: Erdas RK, Tuncbilek GI, Eroglu E, Korkmaz F, Arslan E, Ercan S. An examination of balance, flexibility, and proprioception in Latin dancers: cross sectional case-control study. *Turk J Sports Med.* 2025;60(2):50-6; https://doi.org/10.47447/tjsm.0890

dance, different parts of the body are moved in harmony with a rhythm or are expressed with improvising, reflecting internal emotions and feelings, independent of rhythm and melody. Creating and performing dance sequences and choreographies require prolonged practice and effort.

Balance is defined as the ability to maintain the body in a desired position based on various parameters. Dancers require good balance to accurately perform movement sequences and choreographies. During dance, the ability to maintain balance through both poses and movements can be tested. To achieve an aesthetic appearance and provide an enjoyable experience for the audience, dancers must exhibit high-level flexibility and balance skills (3). In Latin dances, movements are performed in a coordinated and fluid manner in harmony with the rhythm of the music. With these rhythms, the body's center of gravity shifts, and turns are introduced. These turns are often performed on one foot, emphasizing lower extremity balance. In Latin dance, speed, balance, and well-developed proprioceptive senses are essential (4).

Balance is maintained through various neurological pathways, with proprioception being the primary factor in achieving static balance. Proprioception is a specialized type of tactile sense that encompasses sensory perception and position sense (5). It involves the conscious or unconscious perception of position and movement in space, derived from inputs sent to the central nervous system by mechanoreceptors located in joints, skin, tendons, and muscles. The proprioceptive system generally maintains muscle tone, ensures correct body movements during dance activities, and aids in the perception of different body movements, especially in choreographies (6).

Flexibility can be defined as the capacity for increased range of motion and suppleness in joints and muscles. Flexibility has long been a crucial physical parameter for dancers (7). Many factors can influence flexibility, including age, gender, and level of physical activity. For dancers, particularly those performing choreographies involving lower extremity movements, a high degree of flexibility is essential not only for executing movements with aesthetic and technical accuracy but also for reducing the risk of injury (8).

The aim of this study, therefore, is to evaluate the flexibility, balance, and proprioception of Latin dancers living in the Isparta province and compare them with sedentary individuals.

MATERIAL and METHODS

The study included 11 volunteer Latin dancers residing in Isparta and 11 sedentary individuals of similar age to the dancer group, who were diagnosed with upper extremity injuries at a sports medicine clinic. Personal information (age, gender, height, body weight, body mass index, exercise habits, dominant extremity, medical history, start date of dancing, and frequency of dancing) was collected through face-to-face interviews with each participant and recorded on a data collection form. To document participants' physical activity levels as a descriptive characteristic, the Regicor physical activity questionnaire was administered. The study includedparticipants divided into two pre-defined groups: Latin dancers, who formed the experimental group, and non-dancing sedentary individuals, who made up the control group.

Tests were administered to the participants in the following sequence; first, the lower extremity Y-balance test and the Stork test for balance measurements, afterwards isokinetic dynamometer was used to assess knee proprioception; the sit-and-reach test was used to measure flexibility. Finally, the squat test for muscle strength was applied so that the participants would not be affected by the fatigue factor. All tests were conducted at the same time of day, in the same place, and within the same period to ensure a consistent ambient temperature during data collection (9). The research was approved by Süleyman Demirel University Faculty of Medicine Clinical Research Ethics Committee with the decision dated 05/12/2023 and numbered 243.

Regicor Short Physical Activity Questionnaire

The questionnaire includes questions that classify leisure-time physical activity into low, moderate, and vigorous levels. It provides categorical classification of occupational physical activity, and gathers information on sedentary behavior. The Turkish validity and reliability of the questionnaire were confirmed by Uyan et al. (10).

Sit-and-Reach Test

A bench was used for this test with a ruler attached. It measured 32 cm in height, 45 cm in width, 55 cm in length on the top, and 35 cm on the bottom. During the test, the bench was positioned against a wall for stability. Before the test, participants did not perform warm-up. They were asked to sit with the soles of their feet flat against the bench and to reach forward with both hands, pushing the ruler forward while keeping their knees fully extended (Figure 1). The measurement on the ruler was recorded, with negative values recorded if participants could not reach the bench. The test was repeated three times, average score was recorded (11).

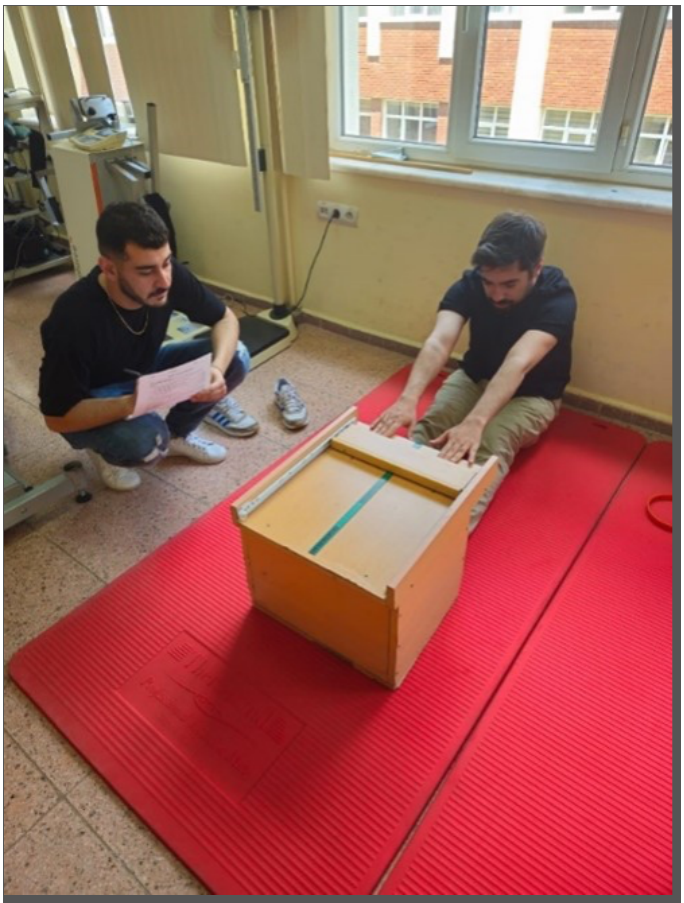

Figure 1. Sit-and-reach test

Lower Quarter Y-Balance Test

The Y-balance test was used to evaluate the balance and stability of participants. During the test, participants placed their hands on their hips, balancing separately on each leg (right and left), and were asked to reach as far as possible with the opposite foot in three directions: anterior, 135° posteromedial, and 135° posterolateral (Figure 2). To ensure understanding of the test, each participant completed six warm-up trials in each direction. The test was then performed three times in each direction, and the highest value was recorded in cm for analysis. To determine the difference between the total scores of the first and last measurements, the following formula was used:

(Anterior + Posteromedial + Posterolateral) / (3×lower extremity length)×100

During the tests, care was taken to ensure that the foot of the stationary extremity did not lift off the ground, that no external support was used, and that the participant was able to return to the starting position. Measurements in which any of these steps could not be performed were excluded from evaluation, and the test was repeated (12).

Stork Balance Stand Test

Another test used to evaluate the balance and stability of the participants was the Stork balance stand test. Participants stood barefoot with their hands on their hips in a balanced position on both feet. They were instructed to keep their bodies upright, facing forward, with the measuring leg positioned over the knee of the other leg (Figure 3). Upon command, the position was assumed, and a timer was started. The timing was stopped, and the test was concluded if hands moved away from the hips, if the foot lifted off the knee, or if the heel touched the ground. The test was conducted for both legs, and the times were recorded (11).

Figure 2. Lower quarter Y-balance test

Figure 3. Stork balance stand test

Measurement of Active and Passive Proprioception with an Isokinetic Dynamometer

Knee joint proprioception measurements were conducted using an isokinetic dynamometer (Isoforce, Tur Kinetics, Germany). The sense of joint position was measured both actively and passively with the dynamometer. For the passive measurement of proprioception, participants were seated while the continuous passive motion mode of the isokinetic dynamometer was utilized. To ensure concentration and eliminate visual stimuli, participants' eyes were closed. The device's arm moved in flexion and extension directions at an angular speed of 1°/s between 0°-90°. When the arm reached angles of 15°, 45°, and 75°, participants were verbally informed, and they were instructed to signal when the device's arm returned to the same angle (Figure 4).

Six repetitions were performed for each angle. The deviation values from these angles were recorded as absolute values, and the average was calculated during analysis. The same method was used for active measurements, but testing was conducted actively instead of the continuous passive motion mode. Participants were informed that the target angles of 15°, 45°, and 75° would be identified with their eyes closed within a joint range of motion from 0° to 90°. They were then asked to return the joint to 0° and identify these angles again. Again, six repetitions were recorded for each angle. The deviation values from these angles were recorded as absolute values, and the average was calculated during analysis.

Squat Test

The squat test was administered to the participants to assess muscle strength. Participants were instructed to stand in front of a chair with their back facing it, feet shoulder-width apart. They were asked to squat down and lightly touch the chair with their hips before standing up again. They were instructed to repeat this series of movements until they could no longer continue (Figure 5). The total number of completed squats was counted and recorded (11).

Figure 4. Proprioception measurement

Figure 5. Squat test

Statistical Analysis

Data were analyzed using IBM SPSS v26.0 (IBM Corp., Armonk, New York, USA) statistical software. Descriptive statistics are presented as numbers (n), mean ± standard deviation (x ± SD) values. The normality of the numerical data was assessed using Skewness-Kurtosis values, and the Shapiro-Wilk normality test. For comparisons between groups, the independent samples t-test was used when parametric conditions were met, while the Mann-Whitney U test was employed when parametric conditions were not satisfied. Results were evaluated at a significance level of $p<0.05$.

RESULTS

A total of 11 dancers and 11 sedentary individuals participated in the study, with an average age of 23.6 ± 1.4 years. There were no individuals with low physical activity levels in the dancer group, while no participants with high physical activity levels were identified in the sedentary group (Table 1).

Significant differences were found between the Latin dancers and sedentary individuals in the sit-and-reach test, both extremity Y-balance test, and right lower extremity Stork test. No significant differences were observed in the left lower extremity Stork test and the squat test ($p<0.05$) (Table 2).

Table 1. Descriptive data of participants

Parameters	Dancers (n=11)	Sedentary (n=11)	p
Age (yrs)	23.6±1.4	23.6±1.4	1.000
BMI (kg/m²)	22.3±2.8	21.5±3.6	0.613
Dominant extremity (R/L)	8/3	10/1	0.291
Gender (F/M)	5/6	6/5	0.687
Smoking (yes/no)	4/7	4/7	1.000
Alcohol use (yes/no)	6/5	2/9	0.083
Exercise frequency (d/wk)	4.36±1.69	1.00±1.34	**<0.001***
Number of years dancing	3.64±1.43	-	**<0.001***
Weekly dance days	2.45±1.86	-	**<0.001***
Regicor physical activity level (low/medium/high)	0/6/5	4/7/0	**0.008***

BMI: body mass index, d: days

Table 2. Functional test results

Tests	Dancers (n=11)	Sedentary (n=11)	p
Sit and reach test (cm)	24.2±8.4	14.0±3.8	**0.001***
Y-balance test (right) (cm)	103.1±7.1	94.8±5.6	**0.007***
Y-balance test (left) (cm)	101.9±5.1	95.1±5.7	**0.008***
Stork test (right) (s)	157.1±62.0	82.2±58.8	**0.009***
Stork test (left) (s)	155.3±49.2	103.7±87.8	0.105
Squat test (repetition)	87.6±30.2	64.6±26.4	0.073

In the active knee proprioception measurements, a difference was found between the Latin dancers and sedentary individuals at the right knee 45° measurement and the left knee 75° measurement ($p<0.05$) (Table 3).

Table 3. Results of active knee proprioception measurements

Parameter	Dancers (n=11)	Sedentary (n=11)	p
Active proprioception 15° R	1.92±1.29	2.77±1.93	0.235
Active proprioception 15° L	3.05±0.98	3.49±1.82	0.486
Active proprioception 45° R	2.09±1.03	3.55±1.79	**0.030***
Active proprioception 45° L	2.52±1.15	4.11±1.35	0.603
Active proprioception 75° R	1.91±1.34	3.40±2.21	0.070
Active proprioception 75° L	2.25±0.80	3.69±2.08	**0.045***

R: right, L: left

In the passive knee proprioception measurements, a significant difference was found between the Latin dancers and sedentary individuals at the left knee 75° measurement ($p<0.05$) (Table 4).

Table 4. Results of passive knee proprioception measurements

Parameter	Dancers (n=11)	Sedentary (n=11)	p
Passive Proprioception 15° R	4.05±1.98	4.46±2.41	0.668
Passive Proprioception 15° L	3.74±1.27	4.09±1.74	0.591
Passive Proprioception 45° R	4.42±1.55	4.11±1.90	0.680
Passive Proprioception 45° L	3.75±1.26	4.53±2.05	0.299
Passive Proprioception 75° R	3.47±1.28	3.54±1.49	0.912
Passive Proprioception 75° L	2.55±1.44	4.79±1.17	**0.001***

R: right, L: left

DISCUSSION

The results of this study indicate significant differences between Latin dancers and sedentary individuals in the sit-and-reach test, both extremities' Y-balance test, and the right lower extremity Stork test, as well as in active knee proprioception at the right knee 45° and left knee 75° measurements, and in passive knee proprioception at the left

knee 75° measurement. No significant differences were found in the left lower extremity Stork test and squat test. The similarity in muscle strength assessed by the squat test suggests that the effects of muscle strength on other components of physical fitness may have been mitigated.

Reviewing the literature on Latin dance, it was found that several studies had examined various parameters across different age groups. Liu et al. (13) concluded in their systematic review that Latin dance activities positively impact various factors, including cardiovascular health, flexibility, balance, and weight loss.

Özkal et al. (14) evaluated the flexibility of Latin dancers using the sit-and-reach test, finding significantly higher test scores in the dance group compared with the control group. Muyor et al. (15) demonstrated that professional Latin dancers have more flexible spine comparing to non-dancers, especially in flexion positions, and are more suited for hamstring muscle extensibility. Wang et al. (16) conducted an 8-week randomized controlled study on university students and concluded that the rhythmic and fluid movement characteristics of Latin dance could facilitate muscle elongation and joint mobility, thereby improving flexibility. In our study, the flexibility parameter assessed by the sit-and-reach test was also found to be significantly higher in the dancer group.

Baştuğ (17) conducted a study on university students, assessing those who participated in 12 weeks of Latin dance activities for 3 hours weekly using the flamingo balance, and the sit-and-reach tests. The results indicated positive improvements in flexibility and balance in the pre-test and post-test average values of the students engaging in dance exercise. Kutlay et al. (18) evaluated balance in dancers aged 20-26 years, who were part of university dance groups. They observed positive differences in balance parameters favoring dancers when comparing with normative values of healthy sedentary individuals, concluding that dance activities could enhance balance ability. In Türkeri's study (19), university students aged 22 on the average participated in a 12-wk dance program. At the end of the balance program, post-test measurements revealed statistically significant differences between participants and non-participants, suggesting that regularly conducted salsa dance exercises improve static balance. Stawicki et al. (20) compared the static balance of female dancers aged 20-24 years with a non-dancer control group and concluded that regular dancing improves static balance.

Although our study participants were individuals in their twenties, it has also been reported in the literature positive effects of Latin dance on balance in older populations. Sofianidis et al. (21) found that a 12-week Latin dance intervention improved balance in older adults. Granacher et al. (22) noted that an 8-week salsa-based training positively affected the balance of older individuals and reduced risk of falls.

A systematic review concluded that Latin dance includes figures that can enhance flexibility and range of motion, and as the movements require coordination and balance, allowing foot movements and weight shifts to improve individuals' internal perceptions and balance control (12). Another study investigated the effects of Latin dance training on gait behavior and body balance using gait analysis and the one-leg stance test, revealing that Latin dancers outperformed a healthy control group members in gait symmetry and balance stability (23).

When the literature was reviewed, it has been determined that no prior research has been conducted on the physical fitness of Latin dancers in the Isparta province. Similarly, no research has been conducted on the proprioception assessment of knee joints in Latin dancers using computerized isokinetic testing. A related study assessed shoulder and hip joint position sense in ballet dancers using inclinometer and goniometer measurements (24). In their findings, the ballet group revealed statistically lower error rates than the control group in measurements at 50° flexion and 50° abduction in both arms, and 55° flexion and 70° abduction in both legs, indicating that dancers have significantly higher accuracy in joint position sense (24). In our research, significant differences were found in active knee proprioception measurements in right knee 45° and left knee 75° measurements, as well as in passive knee proprioception in left knee 75° measurement. The dancer group exhibited lower deviations at these angles, suggesting they possess more precise proprioception. This finding constitutes the unique aspect of our research. However, the cross-sectional nature of the study and the narrow age range represent limitations.

In conclusion, it can be stated that Latin dance has positively influenced the specified parameters of physical fitness, with significant differences found in flexibility, balance, and proprioception measurements between university students engaged in Latin dance and a control group with similar demographic characteristics.

Acknowledgements

We would like to express our gratitude to all those who participated in our study.

Dissemination

This study was presented as an oral presentation at the Süleyman Demirel University, Faculty of Medicine, Project and Science Days at 16th May 2024.

Ethics Committee Approval / Etik Komite Onayı

The approval for this study was obtained from Süleyman Demirel University Non-Interventional Clinical Research Ethics Committee, Isparta, Türkiye (Decision no:243, Date: 05/12/2023).

Conflict of Interest / Çıkar Çatışması

The authors declared no conflicts of interest with respect to authorship and/or publication of the article.

Financial Disclosure / Finansal Destek

The authors received no financial support for the research and/or publication of this article.

Author Contributions / Yazar Katkıları

Concept/Design: RKE; Design: RKE, SE; Supervision/Consultancy: RKE, EA, SE; Funding and Resources: SE; Materials: RKE, GİT, EE, FK; Data Collection and/ or Processing: RKE, GİT, EE, FK; Analysis and/ or Interpretation: RKE, GİT, EE, FK; Literature Review: RKE, GİT, EE, FK, EA; Writing: RKE, GİT, EE, FK, EA; Critical Review: SE, EA

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