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A comparative study of musculoskeletal imbalances in professional musicians

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Abstract

Introduction: Playing the instrument in different groups of society is increasing day by day. Therefore, it seems necessary to pay attention to musculoskeletal imbalances and their problems in musicians.

Martials and Methods: Ninety instrumentalists, including 26 wood wind players (age: 28.46±4.62 year, BMI: 26.59±2.11), 37 string players (age: 28.18±7 year, BMI: 24.92±3.60), and 27 percussionists (age: 31.88±6.6 years, BMI: 24.95±3.32) were selected to participate in this study. Upper and lower extremities were assessed. For statistical analysis ANOVA, Scheffe and Kruskal-Wallis statistical tests were performed in SPSS version 16 with a significance level of 0.05.

Results: The results of this study did not show significant differences between the degree of musculoskeletal imbalances of kyphosis and lordosis between the study groups (P>0.05). Results in musculoskeletal imbalances of scoliosis (sig= 0.001), forward head (sig= 0.001), uneven shoulder (sig= 0.001), torticollis (sig= 0.001), scapular dyskinesia (sig= 0.006) were showed the significant differences between the groups (P<0.05).

Conclusion: According to the results, some musculoskeletal imbalances in the group of wood wind instrumentalists showed a higher intensity and prevalence. These variabilities between different groups of musicians indicate different physical and postural needs to play different instruments.

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1. Introduction

On the base of definition, the musicianship is playing by using an instrument, and the musician is an individual who plays a musical instrument [1]. The postural alignment can be one of the physical risk factors for musculoskeletal disorders. In the industry section, keeping posture in static position, incorrect or repeated movement in long time can be exacerbated musculoskeletal disorders such as over hand movement pattern or sustain sitting which are common in workers [2].

Three primary risk factors- including physical, psychological, and individual- are the most common risk factors that contribute to musicians' musculoskeletal disorders. Four basic physical risk factors can lead to playing-related musculoskeletal disorders (PRMD) including improper postures, excessive repetitiveness, great forces, and vibrations during the performance. The other risk factors of PRMD are psychological factors, including job demands which may lead to stress and anxiety. The last risk factors are individual ones, including age and gender. Moreover, obesity, smoking, muscular strength, and other dimensions of work capacity are significant [2]. Therefore, the development of musculoskeletal disorders and PRMDs is a multimodal issue, and the performance environment and procedure can be significantly effective in the onset of such disorders [3].

In research on the influence of players' physical posture on musculoskeletal disorders, it is necessary to give attention to differences between instruments since the physical demands differ significantly based on different instruments' risk factors [4]. Three main categories of playing-related discomforts are musculoskeletal injuries resulting from overuse (over 50% of problems), Thoracic Outlet Syndrome (TOS) (50% of problems), and focal dystonia (30% of problems) that can disable this group and has been defined as an involuntary movement or a muscle cramp caused by specific activity such as playing musical instrument [5]. The playing-related musculoskeletal disorders are developed due to different factors, including musicians' physical dimensions, muscular strength, flexibility, and severe disease [6]. In a review, Baadjou et al. (2016) investigated the risk factors of musculoskeletal disorder in musicians. They examined the determinants associated with playing-related musculoskeletal disorders resulting from playing musical instruments and concluded: "Because of the lack of prospective studies, no causal relations could be identified in the etiology of playing-related musculoskeletal disorders in instrumental musicians" [7].

Other studies have investigated the ergonomic factors and variation in playing postures and their influence on musicians' physical posture. For instance, Ohlendorf et al. (2018) researched the effect of the ergonomic layout of musician chairs on posture and seat pressure in musicians of different playing levels. The total dataset of 47 musicians (3 playing levels: professional, amateur, student) was analyzed on six musician chairs with a different ergonomic layout. Sitting on each chair without an instrument (condition 1) and with instrument (condition 2), the upper body posture and the seat pressure were recorded. Two measurements of the upper body posture (scapular distance and scapular height) differentiated between playing levels. Four of the pressure measurements (pressure under the ischial and femur bones in the left and the right sides) differentiated between chairs and the two conditions (with and without instrument). Chairs with soft cushioning had a mean pressure reduction of about 30%. The pressure was increased by about 10% while playing an instrument [8].

In another study, Kok et al. (2018) studied the difference between violinists with and without neck and shoulder complaints regarding violin fixation force and muscular activity. In this research, twenty professional violinists were included: ten with current complaints of the neck-shoulder region and ten without these complaints. According to the results, violinists with complaints had more muscle activity of all evaluated muscles than violinists without complaints. Complaints were significantly associated with the muscle activity of all evaluated muscles. Complaints were not significantly associated with the violin fixation force [9].

Zięba et al. (2019) did a systematic review of recent studies about the etiology and epidemiology of playing-related musculoskeletal disorders or pains in musicians. An overview of the literature showed that musculoskeletal disorders concerned women more often than men. The instruments related with more frequent occurrences of pain were violins/ violas and wood wind instruments. The most frequently affected body areas were: neck, back, and upper limbs [10].

By studying the researches on playing-related musculoskeletal imbalances in different groups of musicians, it is revealed that no research has reflected these issues in Iranian musicians. Further, the studies on overseas are scarce and have not investigated the difference between different musicians. The research question is: in which group of professional musicians, the severity of musculoskeletal imbalances is high? To answer this question, the researchers compared the musculoskeletal imbalances in Iranian professional musicians of wood wind, string, and percussion instruments.

2. Materials and Methods

After screening, 90 musicians were selected by purposeful random sampling from among the professional musicians of Rasht city, using G-power sample size software and considering $\alpha \leq 0.05$, power= 0.8, and Effect size f^2= 0.15. This research was approved by Ethics Committee in Research. The subjects were included 26 wood wind instrument musicians, 37 string instrument musicians, and 27 percussion instrument musicians. The samples were selected considering the inclusion criteria (age group of 18-40 years old, music playing experience for at least three years, practicing at least 5 h a week, and informed consent for participation in research) and exclusion criteria (orthopedic injuries such as fractures and dislocations in shoulder girdle bonds, strains and ruptures in the shoulder girdle and spine muscles, dissatisfaction of participant, family, or coaches, participant inappropriate cooperation and disinclination to keep participation in tests).

2.1. Assessment of musculoskeletal imbalances

Scoliosis measurement. Adam's Forward Bend Test was used for examining scoliosis. The participants were asked to slowly bend forward until the shoulders came in the horizontal plane with the pelvis. The Scoliometer was placed perpendicular to the body along with the abnormality so that zero number was placed over the spinous process tip of related vertebra. Regarding the specific landmarks, we divide the spinal cord into four regions: seventh cervical vertebra to fourth thoracic vertebra, eighth thoracic vertebra, twelfth thoracic vertebra, and fifth lumbar vertebra. Then, these regions were marked by a marker or landmark [11].

Measurement of thoracic kyphosis and lumbar lordosis. To measure the dorsal curvature of the spine, a flexible ruler is used which has features such as fast, inexpensive and non-invasive measurement and has suitable inter-class validity and reliability (r= 0.82). While the upper body of the subject was completely naked, she/he was asked to bend her/his head forward while standing; then, the subject's most prominent vertebra (C7) was found, and the 2 vertebrae below (T2) were marked by touching with the fingers. Subsequently, to find the T12 vertebra, the subject was asked to place her/his hands on the edge of the table and to transfer her/his weight to hands while standing in half forward bend position; the examiner touched the twelfth rib of the subject on both sides with his thumb, and simultaneously followed the path of the ribs upwards and inwards to the point where they disappeared into the soft tissue of the body. At this point, the tips of two thumbs were connected by the researcher by drawing a straight line, and consequently, the location of the T12 spinous process was determined. The flexible ruler was put on a piece of paper. Using a pen, the curve was drawn, and the points T2 and T12 were reflected on the curve. Then, a line was drawn connecting T2 and T12 points. The length of this line was measured and called "L". Then the deepest point of the curve was measured as "H". Ultimately, using the equation below, the magnitude of the angle of thoracic kyphosis and lumbar lordosis was measured [12, 13, 14]:

$$\theta = 4 \arctan [2H/L]$$

To measure the lumbar lordosis, first, the researcher touched and marked the *posterior superior iliac spines (PSIS)* and then drew a horizontal line at the center of both spines. The second sacral vertebra (S2) was the point equivalent to the lower part of the vertebra. Then, the researcher touched the spinous process of the first lumbar vertebra (L1) and marked the vertebra lower than T12. The flexible ruler was placed in the middle of two marked points. Two points marked on the lumbar and sacrum were marked on the ruler. To continue, this angle was also calculated using the kyphosis measurement equation.

Torticollis measurement. To measure the torticollis, a frontal imaging technique was applied. It was performed standing. The angle between the interface line between two tragus and the horizon line was measured in AutoCAD 2012 [15].

Forward head measurement. Imaging method which has good reproducibility was used to measure the forward head. In this technique, the subject was standing, and the photograph was taken of the subject in sagittal view. Then, the angle between the interface line of C7 and the ear tragus with the horizon line was measured in AutoCAD 2012 [16].

Lateral Scapular Slide Test (LSST). Kibler and his colleagues proposed this test to assess scapular dyskinesia. In this test, the distance of scapular inferior angle and spinous process of its adjacent vertebra was measured by a measuring tape in standing position and at the three abduction angles in the following three conditions:

1. Hands next to the body
2. Hands on the pelvis with the thumb on the back and the other four fingers on the front.

3. Hands at a 90-degree abduction angle, with the thumb facing down.

If the difference between two scapulae is equal or more than 1.5 cm, the test result would be positive [17].

Uneven shoulders. To measure the uneven shoulders, the angle between two coracoid processes and horizon line identified by marker was measured at frontal level, applying AutoCAD 2010 application [17].

Statistical analysis. The descriptive and inferential statistical tests were used for analyzing the data. The data description included the mean and standard deviation and drawing diagrams in Excel software. The inferential analyses were done by ANOVA, Scheffe, and Kruskal-Wallis post-hoc tests in SPSS (16th version) software. The significance level was considered 0.05.

3. Results

The research participants personal (demographical) information- including age, height, weight, experience, and so forth- were presented in Table 1. The personal information did not differentiate between the three investigated groups significantly. Therefore, three groups of this research were homogeneous (Table 1).

According to Table 2, the results revealed that there is significant difference between the groups in terms of scoliosis severity (sig= 0.001), forward head (sig= 0.001), uneven shoulders (sig= 0.001), scapular dyskinesia (sig= 0.006), and torticollis (sig= 0.001). Nevertheless, there was no significant difference between the investigated groups in kyphosis and lordosis severity (*P*> 0.05).

The results of post hoc tests for investigating the difference between the groups have been reported in Figure 1 (results of Scheffe post hoc test) and Figure 2 (results of U-Mann Whitney post hoc test).

Table 1. Participants' characteristics

Variable	Groups	Mean±SD	Confidence interval	*P*
Age (year)	Wood wind	28.46±4.62	26.59-30.32	0.054
	Percussion	31.88±6.81	29.19-34.58	
	String	28.18±7.00	28.85-30.52	
Height (cm)	Wood wind	80.38±7.66	77.28-83.47	0.052
	Percussion	72.51±14.14	66.92-78.11	
	String	74.10±13.51	69.60-78.61	
Weight (kg)	Wood wind	1.74±0.05	1.72-1.77	0.105
	Percussion	1.70±0.10	1.66-1.74	
	String	1.72±0.07	1.69-1.74	
BMI	Wood wind	26.59±2.11	25.74-27.44	0.084
	Percussion	24.95±3.32	23.60-26.26	
	String	24.92±3.60	23.72-26.12	
Playing history (year)	Wood wind	7.88±3.80	6.34-9.42	0.671
	Percussion	9.22±6.27	6.73-11.70	
	String	8.24±6.30	6.14-10.34	

* Data are reported as mean ± standard deviation.

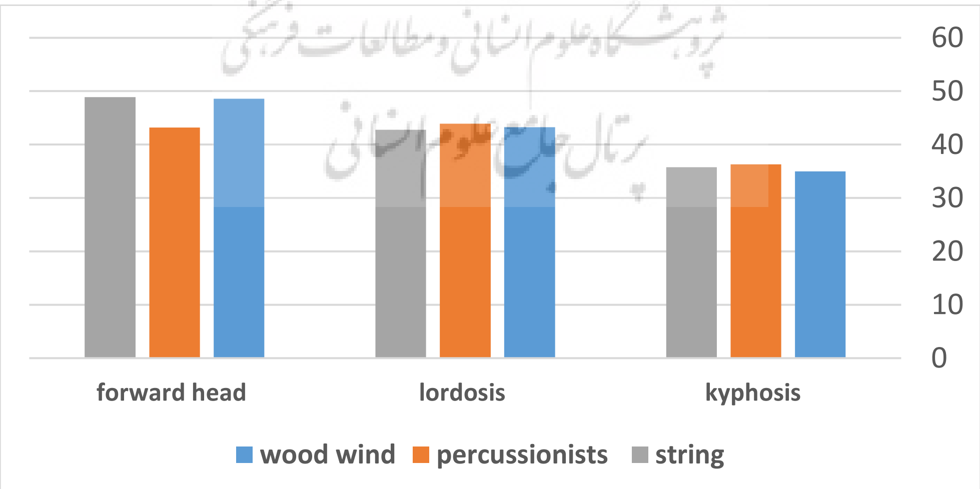
Table 2. Intergroup comparison of musculoskeletal imbalances

Variable	Wood wind group	Percussion group	String group	*P*
Kyphosis (degree)	34.96±4.86	36.27±5.07	35.77±5.44	0.302
Lordosis (degree)	43.27±4.28	43.89±3.54	42.77±4.15	0.172
Scoliosis (degree)	1.98±0.67	2.22±0.81	3.20±0.92	0.001*
Forward head (degree)	48.57±5.17	43.22±3.34	48.86±4.81	0.001*
Torticollis (degree)	2.96±0.86	2.84±0.81	2.22±0.55	0.001*
Uneven shoulder (degree)	2.69±0.73	1.46±0.31	1.54±0.39	0.001*
Scapular dyskinesia (degree)	1.77±0.46	1.47±0.35	1.52±0.41	0.006*

*Significant difference (P<0.05).

Figure 1 indicates a significant difference between the wood wind instrument group with the string instrument group (sig= 0.001) and the percussion instrument group with the string instrument group (sig= 0.001) in terms of scoliosis severity. Further, there is a significant difference between the wood wind instrument group with the percussion instrument group (sig= 0.004) and the percussion instrument group with the string instrument group (sig 0.001) in terms of forward head severity.

Figure 2 reveals the significant difference between the wood wind instrument group with the percussion instrument group (sig= 0.001) and the wood wind instrument group with the string instrument group (sig=0.001) in terms of uneven shoulders severity. Moreover, the difference is significant between the wood wind instrument group with the percussion instrument group (sig=0.002) and the wood wind instrument group with the string instrument group (sig=0.014) in terms of scapular dyskinesia. Furthermore, there is a significant difference between the wood wind instrument group with the string instrument group (sig=0.039) and the percussion instrument group with the string instrument group (sig= 0.012) in torticollis severity.



* Significant difference at the level of P<0.01

Figure 1. Comparison of the severity of forward head, lordosis and kyphosis between three groups of musicians

* Significant difference at the level of $P<0.01$

Figure 2. Comparison of the severity of scapular dyskinesia, uneven shoulders, torticollis and scoliosis between three groups of musicians.

4. Discussion

The research results show a significant difference between the investigated instrument groups regarding musculoskeletal imbalances, including scoliosis, forward head, uneven shoulder, scapular dyskinesia, and torticollis. However, there is no significant difference between the investigated groups regarding kyphosis and lordosis. In addition, according to the results, the forward head severity was significantly higher in the wood wind and string instruments musicians than the percussion instruments musicians. Further, scoliosis and torticollis severity were higher in the wood wind and percussion instruments musicians compared to the string instrument group. Moreover, the uneven shoulders and scapular dyskinesia severity were higher in wood wind instruments musicians than the string and percussion instruments musicians.

Regarding the position adopted by different instruments musicians during plying, it can be expected that the posture is changed along with the playing style and manner. The simultaneous and temporary change in body posture while playing an instrument gradually becomes the postural habit and influences the musicians' physical condition without musicians' being aware of that. Ohlendorf et al. (2018) found out that playing an instrument changes the static seating position by increased rotation of the spine and specific shoulder adaptations holding the instrument (left arm) and the bow (right arm), with minor effects on the pelvis. This forced position may result in chronic health effects [18].

Although few studies has compared the musculoskeletal imbalances in different instrumental musicians, the existing researches correspond to the results of present researches. For instance, Blanco-Piñeiro et al. (2018) compared posture quality required by different instruments or families of instruments. They showed a significant association between instrument families and seated posture concerning pelvic position, dorsal curvature, and head alignment in sagittal and frontal planes. This analysis also showed an association between instrument families and standing posture concerning the frontal plane of the axis of gravity, pelvic position, head alignment in the frontal plane, shoulders alignment in the sagittal plane, and overall posture [19]. In a pilot study, Teixeira et al. (2011) compared the head and scapular postures of flutists with the singers. Results suggest that flutists have significantly more forward head posture than singers. No significant differences were found for any other head or scapular posture measurement. Contrary to hypothesized, years of instrumental practice did not contribute to a more asymmetrical posture [20]. This research revealed that regarding the postural requirements for the optimal playing of an instrument, the severity of musculoskeletal disorders varies in different groups of musicians.

Despite the research corresponding to the present research results, Kaya et al. (2015) investigated the influence of playing different musical instruments on arm asymmetry. The main research question was whether playing a different musical instrument, string, and piano can alter arm asymmetry. Besides, it was also questioned whether string and piano players overall have less asymmetry than non-musicians. To answer these questions, 30 right-handed participants from three groups (10 from each group) took part and were asked to reach one of three targets in front of them with either right or left arms. Their movements' accuracy and linearity were analyzed by an electromagnetic movement tracker system. A significant difference was not seen in the arms of musicians who play piano and string instruments. Further, it was found that musicians make use of their arms better compared to non-musicians with both arms. Thus, they argued that playing a musical instrument can decrease arm asymmetry regardless of the type of the instrument [21]. However, the symmetry between hands was examined in mentioned research, and no comparison was done between musculoskeletal imbalances to be comparable with the findings of the present study.

5. Conclusion

Overall, the present study results revealed a significant difference between the investigated instrument groups regarding musculoskeletal imbalances, including scoliosis, forward head, uneven shoulder, scapular dyskinesia, and torticollis. However, there is no significant difference between the investigated groups regarding kyphosis and lordosis. According to the results, the forward head severity was significantly higher in the wood wind and string instruments musicians than percussion instruments musicians. Further, scoliosis and torticollis severity were higher in the wood wind and percussion instruments musicians compared to the string instrument group. Moreover, the uneven shoulders and scapular dyskinesia severity were higher in wood wind instruments musicians than the string and percussion instruments musicians.

Considering the research findings, the musicians are suggested to organize and manage the playing programs so that they do not play for long periods and attempt to consider the rest time in the intervals between their practices. They are suggested to prevent musculoskeletal imbalances by changing the playing position and adopting proper postures and stretching exercises. Further, the researchers interested in this field are proposed to design special practice programs considering the research results and investigate the influence of such interventions on improving the musicians' musculoskeletal imbalances.

Conflict of interest

The authors declared no conflicts of interest.

Authors' contributions

Conceptualization, Data collection and writing article: Zahra Noori

Scientific Guide and suggestions: Hasan Daneshmandi

Review & Editing: Seyyed Hossein Hosseini

Ethical considerations

The study was approved by the Research Ethics Committee of Sport Science Research Institute of Iran (Code No.: SSRI.REC-2106-1060 (R1)).

Data availability

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

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