Pain Perception in Clarinetists with Playing-Related Pain After Implementing a Specific Exercise Program

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BACKGROUND: Wind musicians suffer injuries resulting from muscle overuse and poor postural habits, often due to the lack of required physical fitness. For this reason, it is important to study and analyze the characteristics of their activity in order to select appropriate preventive exercises.
METHODS: 10 clarinetists, who were experiencing joint pain due to instrumental practice, followed a specific program of physical activity, 3 times a week for 2 months. To assess postural changes after its implementation, the Langlade test and muscle pain scale were used at the beginning and the end of the program.
RESULTS: The results show a significant decrease in perceived pain (p<0.001) and changes in the dorsal spine (p=0.001). Given the relationship between the improvement in the Langlade item, which refers to the correct position of the shoulder blades, and muscle pain, with a correlation level of 0.582, it can be said that a change in the shoulder girdle position leads to a decrease of pain in that area.
CONCLUSIONS: In this pilot study of 10 clarinetists, a regular program of physical activity for 9 weeks led to an observable change in posture and a reduction in pain using self-report measures.
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When a musician plays a piece, various muscle actions serving different functions are performed: holding the instrument, maintaining a position, etc.[1] However, during the musicians' learning process, their physical condition or postural habits necessary to prevent injuries associated to instrumental practice are not frequently considered.

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The concept of technique is used in many fields, including physical activity and music. Due to the different methodological approaches and the wide variety of existing movements, the concept of technique does not have a universal definition.[2] In the field of music, the concept of technique related to the human body/physical health is the postural technique, consisting in holding a posture as similar as possible to the correct bipedal standing position while playing the instrument.[3]

Musicians do not care much about having good physical conditioning while studying music, but it may present a risk of injury in the long term.[4,5] The emergence of lesions due to the time spent performing can be highlighted and may lead to the interruption of their future professional activity.

The most common injuries in clarinetists, by importance, are back pain, tendinitis in the hand that holds the instrument,[6] (including Quervain's tendinitis), muscle overuse,[7] and finally, focal dystonia.[8,9] These conditions are influenced, as reported, by the shape of the instrument,[10] chronic bad postural habits, absence of warm-up exercises, or mechanical stress due to the technical difficulty of the repertoire.[11] These injuries can also be caused by postural imbalances when musicians repeatedly use the same specific muscle groups.[12] These imbalances can be eased by healthy physical activity habits. To achieve effectiveness and efficiency contributing to better performance in clarinetists, some guidelines or recommendations must be followed, such as those proposed by the American College of Sports Medicine.[13] These guidelines state that many muscle-joint pains and disorders can be prevented by regular physical activity.[14] For this reason, specific exercises should be included in the musician's daily routine to improve the abilities usually involved.[15]

Few studies have been found where emphasis was given to preventive physical activity programs in musicians, and even less to the specific needs of each instrumentalist. However, authors such as Foxman and Burgel[16] considered there is a need to promote healthy habits in musicians. Indeed, Wynn Parry[17] suggested that physical fitness is an important element to maintain the intensity required to play an instrument, where intensity is understood as the hours of study or the musician's workload. Only relatively few studies have

analyzed the effect of physical activity on prevention of injuries in musicians, and most of these, which are summarized here, focused on mixed instrumental groups.

In the study by Lee, Carey, Dubey and Matz,[18] the self-reported survey (Physical & Musical-Performance Efficacy Assessment Survey, PME) was used for the measurement of physical efficacy (comfort about posture, tension, comfort levels of instrument, and repertoire). The students initially showed a poor physical condition but a high level of musical effectiveness, i.e., they had a better knowledge of the tone, the musical technique, but no knowledge of posture or body movement. After an 8-week exercise program of yoga, breathing, muscle strengthening, and flexibility, an increase in their physical conditioning due to the improvement of their body awareness was observed.

In the same vein, Martín and Farías[19] taught a course on injury prevention to superior-level music students at a music conservatory in Spain where information was provided to assess possible risks, create warm-up and postural hygiene habits, and implement prevention strategies. The students improved their body awareness due to the information about good posture habits received, and the frequency of their injuries decreased by 78%. A trial of Groningen exercise therapy for symphony orchestra musicians focused on relaxation activities and postural exercises for shoulders, neck, and lower back.[20] According to subjective report, the perceived physical competence of the participants increased, while injuries decreased due to the improvement of their physical condition.[20]

Chan, Driscoll, and Ackermann[21] conducted a study with 8 music orchestras in order to observe the effects of a physical activity program on occurrence of performance-related musculoskeletal disorders (PRMDs). The results obtained through initial and final questionnaires with questions related to changes in the frequency and severity of PRMDs, ratings of perceived exertion (RPE) during rehearsal, private practice, and performance, as well as nine performance-related factors proved that the performance of an exercise program for 10 weeks affected the frequency and severity of the PRMDs. In a different study, the same authors[22] evaluated the feasibility and effectiveness of a 12-week specific exercise program prescribed by DVD to musicians with injuries associated with instrumental practice. Improvements were found in their physical condition, but their perception of exertion during practice did not change.[22]

Meanwhile, Correa[23] recommended physical activity to compensate for the less active muscles but indicated that those sports with a postural alignment similar to that adopted when playing the instrument are not recommended. As an example, he mentioned the case of clarinetists, who present a kyphotic posture, and advised them against cycling since it accentuates that position.

After reviewing various sources, we observed that all the studies mentioned presented exercise interventions that were delivered across mixed instrumentalist groups, rather than purpose-designed exercise programs for specific instrumentalists. However, the specific features of a single instrumentalist group, such as clarinetists, require very specific exercise interventions to benefit and support their playing requirements. Hence the importance of this study. The goals of this pilot study were to identify the most common postural errors in clarinetists and to select specific exercises to improve the participants' postural alignment and then to evaluate the effectiveness of a specific exercise program for clarinetists by detecting aerobic and muscle-joint changes that may occur.

METHODS

The present study was a single-group pilot study with a quasi-experimental research design and with application of a pre-test and post-test. A nonprobability convenience sampling of participants was chosen for this research: all participants were local professional clarinetists in musical ensembles located in the province of Valencia, Spain. Inclusion criteria were: a minimum of 10 years' experience playing the clarinet, actively studying for 2–3 days/ week, and experiencing joint pain due to instrumental practice. Musicians who could not regularly play the instrument or who had postural injuries with medical diagnosis were excluded. The information was compiled with a questionnaire, including sociodemographic and health questions. From a total of 19 musicians initially identified, in this process 9 clarinetists were excluded.

Participants in the study were 10 clarinetists (6 men, 4 women) with a mean age of 28.4±8.11 yrs, studying 6.7±4.05 hrs/wk, and with 19.7±7.46 yrs of experience in playing the instrument. During the study, there were no drop-outs. The subjects signed an informed consent form ensuring that the procedures described in this study met the provisions of the Declaration of Helsinki (1975, rev. 2013).[30] Ethical approval for the study and methods was obtained from the Catholic University of Valencia (UCV2015-2016-37-V.3).

Objectives

Gender was considered in the objectives set for this investigation. The overall goals were to:

1. Identify the most common bad habits in clarinetists with a pre-activity test to determine a suitable battery of exercises to correct it.
2. Evaluate the incidence of a specific exercise program for clarinetists by non-invasive assessment and control tests to detect the aerobic and muscle-joint changes that may occur.

Secondary goals were to:

1.1 Select tools to understand their body alignment and detect muscle imbalances.
2.1 Select specific exercises to improve the participants' postural alignment and to help them in managing their development and improvement during the process.

TABLE 1. Perceived Differences in Pain and Exertion by Gender

Variable	Women		Men	
	Average	*p*	Average	*p*
Initial muscle pain	5.67±0.816	0.042*	6.50±0.577	0.006*
Final muscle pain	4.83±0.753		4.75±0.500	
Initial perception of exertion	4.50±0.837	0.415	5.67±1.155	0.184
Final perception of exertion	4.00±0.894		5.00±1.000	

*Significant at $p<0.05$.

TABLE 2. Starting and Ending Related Samples Test

Variable	Average	*p*-Value
L-1. Vertex of the head and neck stays horizontal		
Initial	1.80±0.789	0.015
Final	1.30±0.483	
L-3. Acromion must be aligned with the earlobe and center of the greater trochanter		
Initial	2.40±0.516	0.000
Final	1.50±0.527	
L-11. Shoulder blades must touch their vertebral border and the inferior angle must be connected to the rib cage		
Initial	2.10±0.738	0.000
Final	1.30±0.483	

2.2 Estimate the changes in their perception of pain and exertion after application of the exercise program.

Measurements

Different Google Inc. tools were used to create online questionnaires in order to assess the participants' physical fitness[23] and musculoskeletal pathologies[6] in order to select the sample. The first questionnaire was administered pre-activity to obtain information about sociodemographics, physical fitness,[24] and musculoskeletal pathologies in clarinetists[6] in order to assess them for inclusion or exclusion from the sample. The second questionnaire, used during the exercise program, included the OMNI ratings of perceived exertion scale (rated 1–10)[25] and a self-report faces pain scale (rated 1–10).[26]

To assess physiological indicators (weight and height), a Seca 813 scale (Seca GmbH & Co., Germany) and the Langlade postural test were used[27] (Appendix 1, online). Although the postural evaluation tool is old, the tools that are used nowadays follow the same alignment criteria as the one described by Daza.[28] During the exercise program the participants used TheraBand® medium-strength green and red elastic bands equivalent to 2 and 3 kg.[29]

Protocol

To determine the effect of physical activity on pain in injuries caused by clarinet performance, a quasi-experimental intervention design was performed by modifying the physical condition. It was based on a 2-month-long specific exercise program (Appendix 2, online) that was performed 3 days/week, individually and autonomously, and prioritizing the upper body. A webpage was designed where the study and the exercises were explained (http://adaptasport.wixsite.com/clarinetes-muestra). This webpage was provided to different musical societies in the province of Valencia.

The intervention group received an initial assessment (pre-test) of the Langlade postural test[27] to visually observe the spine alignment. Once the intervention ended, the test was repeated (post-test). These evaluations were done face-to-face.

During the 9-week trial, program progression was monitored by the researcher via emails, and documentation regarding the tasks to be performed was submitted at the end of each exercise session. The exercises in the program were aimed at improving joint mobility, aerobic conditioning, and muscle tone the areas involved in a proper postural hygiene.

The intervention lasted 9 weeks. Every 3 weeks, the complexity of the task was increased. The program was divided into three phases: 1) adaptation to exercise with simple exercises of low intensity; 2) skills development, with an increased number of series and repetitions; and 3) functional development, with global exercises.

Each session was structured in three parts: warm-up, main activity, and cool-down. After each session, the subjects completed an online questionnaire to register their perception of pain[26] and exertion.[25]

Statistical Analysis

SPSS ver. 20 software for Mac (SPSS Inc., Chicago, IL, USA) was used to perform the following statistical treatments: 1) Kolmogorov-Smirnov normality test to check for the normal distribution of the subjects; 2) *t*-tests to compare initial and final values on the pain scale, perception of exertion scale, and Langlade test; and 3) bivariate correlations were done between muscle pain scale, Langlade, and Pearson correlation coefficient. In all cases, a confidence level of 95% and a significance level of $p<0.05$ were applied.

RESULTS

Analysis of the participants' perceptions of pain and exertion showed that the effort when playing the clarinet did not undergo notable changes, but muscle pain decreased from 6±0.816 to 4.8±0.632 points, with significance of 0.001 to <0.05. Results were similar by gender, with the significance levels in muscle pain of 0.042 and 0.006 in women and men, respectively (Table 1).

Considering the physiological values assessed, the horizontal alignment of the vertex between the head and neck,

TABLE 3. Muscle Pain and Langlade Correlations, for Women and Men

Variable*	Women		Men	
	R	*p*	*R*	*p*
Finals DOMS and final Langlade (L-1)			0.577	0.423
Final DOMS and final Langlade (L-3)			0.577	0.423
Final DOMS and final Langlade (L-11)	0.686	0.132	0.333	0.667

*L-1, the vertex of the head and neck stay horizontal; L-3, the acromion must be aligned with the earlobe and the center of the greater trochanter; L-11, the shoulder blades must touch their vertebral border and the inferior angle must be connected to the rib cage. DOMS, delayed-onset muscle soreness.

proper alignment of the acromion with the earlobe and greater trochanter, and appropriate closeness of the shoulder blades to the rib cage underwent changes with $p<0.05$ (Table 2).

Correlations of Physiological and Perceptual Values

A correlation analysis was performed to understand the relationship between perceptual and physiological values. There was a moderate relationship between the changes in the shoulder girdle and the pain scale with a correlation value of 0.582. The relationship was higher in women than in men. Men have more incidence in the alignment between the head-neck vertex and the acromion with the ear and greater trochanter (Table 3).

DISCUSSION

According to the literature reviewed for this article, the most common ailments found in clarinetists are those in the muscles and joints due to muscle overuse,[7] tendinitis and spine pain caused by poor positioning when playing an instrument, the clarinet's weight,[6] and the amount of time playing,[5] together with a lack of fitness.[18] After developing an exercise program specifically designed for clarinetists, and completing the program individually and independently, improvements in the clarinetists' postural alignment and a decrease in their pain perception were observed. Therefore, the implementation of an exercise program in this population can be crucial to lessen the pain of the most common injuries when playing this instrument, since there are significant variations between the initial and final changes in their pain perception (initial mean of 6 vs final of 4.8), decreasing from intense to moderate pain. There were also moderate relationships between the correlations of muscle pain and Langlade since correlation values of 0.582 were found with regard to the item concerning the shoulder blades position with their attachment to the rib cage. It is important to consider that muscle compensation and postural hygiene exercises must be included in the daily routine of a professional musician to prevent the most common injuries.

The aim of this pilot study was to stress the importance of specific exercise programs by kind of instrumentalist and thus, moving forward with future research lines in which the impact of exercise on other instrumentalists is considered. Longitudinal research can be proposed to observe the importance of these programs in schools and professional orchestras for possible improvements in the quality of life of this population. Ultimately, specific training for teachers can be raised so they can learn to promote healthy habits in their students.

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APPENDIX 1. Langlade Test

Name _____

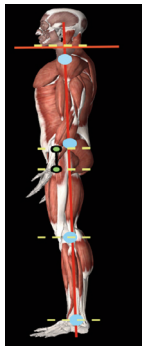
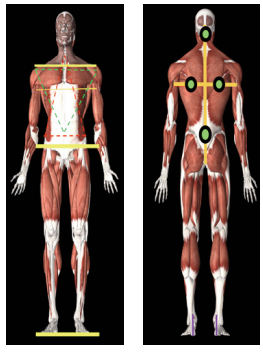
Subject nº _____

Age _____ Gender _____

Weight _____ Height _____

Instrument and grade _____

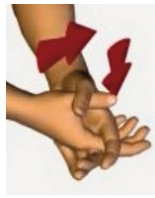
Years of experience _____

	Initial		Final	
	Yes	No	Yes	No
Sagittal Plane				
L-1. The vertex of the head and the neck stay horizontal. L-2. The chin stays slightly tucked in. L-3. The acromion must be aligned with the earlobe and the center of the greater trochanter. L-4. The anterior superior iliac spine and the pubic symphysis are aligned. L-5. The kneecaps face forward and are in the same vertical plane that passes through the heel and the forefoot. L-6. The feet have a normal arch. 				
Coronal Plane				
L-7. The shoulder line, the nipple line, and the iliac spine line must be parallel. L-8. The shoulders are down and parallel to the support surface in humans. L-9. The shoulders and the hips form two symmetric triangles with the center of the trunk. L-10. The iliac crests are parallel to the support plane. L-11. The shoulder blades must touch their vertebral border and the inferior angle must be connected to the rib cage. L-12. The C7 and the superior part of the intergluteal fold must be aligned with the plumb line. L-13. The spinous processes throughout the spine must coincide with the plumb line. L-14. The Achilles tendon forms a vertical line. 				

APPENDIX 2. Example Session Exercise

SESSION 1

OBJECTIVES: Developing joint mobility of the upper limb and rachis. Strengthen the phasic musculature of the upper limb.

Name	Description	Series	Repetition	Break	Image
Cat-cammel	From a quadruped position with neutral rachis. A flexo-extension of the spine is performed with increasing amplitude and moderate pace while holding the elbow extension.	1	10	No	
Torso rotation	In bipedal standing position, rotation of the torso to both sides at a moderate pace.	2	10	15″	
Torso inclination	In bipedal standing position, with the forearms in pronation touching the exterior part of the leg. Lateral inclination of the torso to both sides.	2	10	15″	
Wall slide	In bipedal standing position, flexion of the shoulder and elbow on a vertical surface, holding the rachis aligned.	2	15″	15″	
Wrists mobility	Holding hands, make internal and external rotation movements.	1	15″		
Arm abduction with bands	In bipedal standing position, perform shoulder abduction in pronation to 90°.	2	10	20″	
Brachial biceps	In bipedal standing position, perform flexo-extension of the elbow alternating with forearm supination.	2	10	20″	

Name	Description	Series	Repetition	Break	Image
Rowing	In bipedal standing position with the shoulders flexed, perform retropulsion of the shoulder with forearm in pronation and then perform a shoulder abduction to 90º with flexion of the elbow and hold hands in neutral position.	1	3 min		
Planch	In quadruped position with the hip forward. Support with elbow flexion, arms in antepulsion and knee flexion, on a horizontal surface holding the alignment of the spine.	2	15″	30″	
Walking	Walking for the time and intensity indicated with arm and leg movements, performing dynamic movements coordinated with the lower member.	1	25 min		
Shoulder mobility	In bipedal standing position, perform circular movements with the shoulder, leaving the elbows relaxed.	1	15″		
Chest stretching	In bipedal standing position, retropulsion of the shoulder with supination and support of the hand on the wall.	1	15″		
Stretching	On the knees, flex the torso, hip, knee, shoulder antepulsion, and forearm pronation. Hold a static position.	1	15″		
Stretching	In bipedal standing position, perform shoulder antepulsion with forearm pronation and palmar extension.	1	15″		

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