Pain and posture of children and adolescents who learn the accordion as compared with non-instrumentalist learners

<H1> Abstract

Objectives: This study aims at assessing the impacts of practicing the accordion on pain and posture of children and adolescent students.

Methods: Pain and posture (forward head posture, scapular posture and lumbar lordosis) were compared between two groups of preparatory and secondary school students, matched for age and sex: those who have accordion lessons, hence accordionists (n=16) and those who never have studied a musical instrument, hence non-instrumentalists (n=16).

Results: Students having accordion lessons reported significantly more pain in the shoulder, wrist/hand and thoracic regions ($p<0.05$), showed a significantly more forward head posture (accordionists (median±IQ distance) = 35.6º ± 7.8º, non-instrumentalists (median±IQ distance) = 45.3º±10.8º; $p <0.05$), and a significantly increased lumbar lordosis (accordionists (median±IQ distance) = 55.5º ± 30.6º, non-musicians (median±IQ distance)= 39.0º ± 3.9º, $p <0.05$). No significant differences were found for scapular posture between groups.

Conclusions: This study suggests that children and adolescents who play the accordion have an increased forward head posture and lumbar lordosis and a tendency to report more pain than children and adolescents who do no play any musical instrument.

Key words: children, adolescent, posture, pain, accordion lessons

<H1> Introduction

Learning a musical instrument requires long hours of systematic practice, if the musician is to acquire high performance level skills [1]. However, prolonged and repetitive non-planned and non-structured practice has been associated with an increased risk of pain and injury prevalence. Such risk is even higher when adding long hours of static and asymmetric postures, repeating the same movements and/or using continued force to play [2]. The weight, size and transportation of the instrument have also been pinpointed as additional risk factors for pain and injury development in instrumental musicians [1]. Lifetime prevalence of pain affecting playing capacity among musicians can be as high as 85%, affecting mainly the low back (up to 66.7%) and the neck regions (up to 48.5%) [3]. Furthermore, a study on playing-related musculoskeletal problems in child instrumentalists (mean age±SD=12.7±2.0 years old) reported a lifetime prevalence of 67% in this age group [4]. Diminishing all potential risk factors should thus be a major concern to all who care of the musician.

Among all musical instruments, the accordion is one of the largest and heaviest instruments that musicians have to carry and play. Its weight might vary between 10 and 14 Kg and its length while open might reach 50 to 65 cm. These characteristics per se might put accordionists at high risk of developing pain and injury, especially if coping strategies are not taken into consideration. This is of particular concern for children and adolescents, as the magnitude and direction of load they carry might affect normal growth and development, impacting, for example, on bone growth and postural habits [5]. The accordion is back transported, just as school bags are. The latter have been shown to be associated with increased pain and postural changes in children [6]. Furthermore, carrying a loaded backpack significantly compresses lumbar disc height in children [7]. The accordion can be played in a sitting or standing position. The sound is produced by opening and closing the bellows with the upper limbs and different sounds depend on the precision with which the bellows are manipulated. The accordion has bellows on one side only (usually the left side), which transforms this apparently symmetrical instrument into an asymmetrical one. The opening/closing of the bellow requires more movement and effort from the left arm than from the

right arm. Thus, the size, weight and performance of the accordion make it a highly demanding instrument [8].

The cervical, shoulders and lumbar regions are the regions where musicians tend to report pain most frequently [3]. However, studies investigating pain or posture in accordionists are scarce. The present study thus constitutes an attempt to characterise pain of children and adolescents who recently have started their accordion lessons. Furthermore, it aims at comparing the posture of these students with the one who never played any musical instrument.

<H1> Ethics

Ethical approval to carry out this study was obtained from the xxxx University Ethics Committee (process number 1/2013). Participants and their legal guardians gave their written informed consents prior to data collection.

<H1> Methods

This is a small matched case-control study comparing pain and posture between children and adolescents who play accordion and those who do not play any instrument.

<H2> Participants:

The case group were children and adolescents aged between 10 and 17 years old who played accordion. They were required to have a minimum of one year of instrumental formal lessons and were recruited from the same music school and were matched in age (± 1 year) and sex to equal number of students who did not played any musical instrument (control group).

<H2> Procedures

All accordionist students from one music school aged between 10 and 18 years old (n=22) were invited to participate; a total of 16 (72.7%) accepted. A convenience sample of 16 non-musician students was recruited among the general local population of preparatory and secondary students. Participants were personally invited by one of the study authors (LA).

A questionnaire developed for the purpose of this study gathering information on demographics (age and sex), frequency of sports practice, time spent using computers and pain characteristics (presence and location), was filled in by all participants. Sports practice and time spent using computers were included as these factors have been shown to be associated with increased pain prevalence in adolescents [9–11]. Additional collected information involved participant's height and weight and posture (i.e. forward head posture, scapular posture and lumbar lordosis). Physical activity and time spent at the computer were also enquired, the first by asking participants frequency of physical activity (e.g. once a month, twice a month, once a

week or more than three times a week); and the second by an open question asking time spent per week in front of a computer. Pain presence and location during the last three months were assessed using the Portuguese version of the Standardised Nordic Musculoskeletal Questionnaire [12]. For the accordionist group only, one of the authors (LA) measured the weight of the accordion of each participant using a bathroom scale.

Regarding posture measurements, forward head posture was characterized through the measurement of the angle between the seventh cervical vertebra (C7), the tragus of the ear and the horizontal. This angle was measured using a universal goniometer and a bubble level (Figure 1). It gives the position of the head relative to the trunk, when the gaze is horizontal, with decreasing values indicative of a more forward head posture [13]. This method was chosen because it was shown to be valid when compared with radiographic measurements [14]. Participants stood in their stocking feet in a position they felt “natural” for them and were instructed to have a similar distribution of body weight in each foot, to place their feet slightly apart and to keep both arms by their sides. The spinous process of C7 was identified by palpation according to Hickey et al. [15] and marked. To facilitate the natural head posture that was sought, participants were asked to tilt their head forward and backwards with decreasing amplitude until they felt that a natural head posture was reached [13]. Once settled, measurements were taken and the procedures were repeated twice.

Scapular posture was assessed using the validated Lennie’s method [16]. First, the anatomical reference points of interest were identified and marked, namely the upper and lower angles of the scapula, the root of the spine of the scapula and the thoracic spinous processes. Secondly, the perpendicular distance between the scapular anatomical landmarks and a line crossing the thoracic spinous processes was measured, resulting in three measurements for each scapulae: i) perpendicular distance between the superior angle of the scapulae and the thoracic line; ii) perpendicular distance between the root of the spine of the scapulae and the thoracic line and iii) perpendicular distance between the inferior angle of the scapulae and the thoracic line (Figure 2). As authors intended to characterize the symmetry between both scapulae, the right values were subtracted the left values and a final value indicating the

symmetry/asymmetry of both scapulae was used for later statistical analysis. Finally, the elevation of one scapulae in relation to the other was measured, taken as the distance between the point in the thoracic line representing the alignment of the lower angle of the right scapulae and the point representing the alignment of the left scapulae. Measurements were collected twice.

Lumbar lordosis was measured using a flexible ruler, which has been shown to be reliable and valid, in line with Rajabi *et al*. [17]. The anatomical landmarks of T12 and S2 were identified and marked. To identify T12, the iliac spines were palpated and assumed to be aligned either with the spinous process of L3 or with the intervertebral space L3-L4 [18], depending on whether the person performing the measurements felt a spinous process or a space, respectively. For S2, we palpated the posterior iliac spines (which are believed to be aligned with S2) [19]. Posteriorly, a 60 cm flexible rule was moulded to the contour of the lumbar spine and transposed to graph paper. Once the contour of the lumbar spine was transposed to the paper, the distance between the ends of the lumbar spine (L) and the perpendicular distance between this line and the deepest point of the curvature (H) were measured (Figures 3). These values were used in the following equation to calculate the value for the lumbar lordosis: [theta] = 4 X [arctan(2H/L)], where [theta] represents the magnitude of the lumbar lordosis in radians. Values were posteriorly converted to degrees.

All posture measurements were performed by one of the authors (AGS), who is a physiotherapist.

<H2> Data analysis

Statistical analysis was performed using SPSS version 22. Comparisons of pain prevalence per body region between groups were investigated using a Chi-square test. Comparisons of head and shoulder posture, lumbar lordosis, weight, height, time in front of a computer and physical activity between groups were made by means of a Mann Whitney U test, as data did not follow a normal distribution (tested by the Shapiro-Wilk test; $p<0.05$). Significance was set at $p<0.05$.

<H1> Results

A total of 32 children and adolescents entered the study: 16 children and adolescents who played the accordion and 16 children and adolescents who did not play any musical instrument, matched for sex and age (seven males and nine females in each group; mean±sd age= 13.4 ± 2.5 years old) to the accordionists group (Table 1).

Considering height, weight, reported physical activity and time spent at the computer, no significant differences between groups were found ($p>0.05$).

Participants in the accordion group belonged to different instrumental grades, ranging from the 2nd grade to the 7th grade (Table 1). The mean (±sd) weight of the accordion participants played at home was 9.8±2.3 Kg. For all participants except one, the weight of the accordion represented more than 10% of body weight. This percentage varied between 12% and 25%. Participants spent 4.8±2.8 hours practicing accordion per week.

<H2> Pain presence and location

All participants in both groups reported to feel pain in at least one body site in the last 3 months previous to data collection (Table 1). The number of participants reporting pain per body region was significantly higher in the group who played the accordion for shoulder ($X^{2\ (1,\ n=32)}=5.24$, $p=0.03$), wrist/hand ($X^{2\ (1,\ n=32)}=11.22$, $p=0.001$) and thoracic regions ($X^{2\ (1,\ n=32)}=4.57$, $p=0.04$). No significant differences were found for the remaining body regions ($X^{2\ (1,\ n=32)}\leq 3.24$, $p>0.05$).

<H2> Posture

Children and adolescents who played accordion had significantly more forward head posture than adolescents who did not play any musical instrument (angle C7, tragus, horizontal (median ± IQ): accordionists = 35.6º ± 7.8º; non-musicians = 45.3º±10.8º; $p<0.05$), (Table 2). Additionally, children and adolescents who played the accordion also had a significantly higher

lumbar lordosis (accordionists (median± IQ) = 55.5º ± 30.6º, non-musicians (median± IQ) = 39.9º ± 3.9º; $p < 0.05$). No significant differences were found for the remaining measurements related to scapular posture ($p > 0.05$).

<H1> Discussion:

The present study aimed at investigating if children and adolescents who play the accordion report more pain and postural deviations when compared with a similar group of children and adolescents who do not play any musical instrument. The results suggest that accordionist learners seem to complain more of pain, to have a more forward head posture and an increased lumbar lordosis. A cause-effect relationship cannot be established with a comparative observational study design. Nevertheless, these study results raise a few questions that could be investigated in future studies with larger sample sizes. For example, the results suggest that playing the accordion might predispose children to higher pain prevalence (at least in some body regions) when compared to children who do not play the accordion. Thus, it is possible that playing the accordion may contribute to unhealthy spine posture, which may lead to pain either at short or at long term. Possible explanations for this results that corroborate the need for further studies are related to a concomitant number of risk factors, such as the weight and size of the accordion, the asymmetrical posture required to play, and practicing habits [2,15]. Importantly, the presence of pain in this age group can influence adult life, especially of those who decided to become professional instrumentalists, as developing pain at younger ages increases the risk of having pain in adulthood [21, 22].

With regard to posture, and in line with our study findings, Bittner-Czapińska and Janiszewski [8] reported a more frequent incidence of faulty posture and lateral curvature of the spine in accordionists. Furthermore, Durmala *et al.* [23] demonstrated that normal lumbar lordosis values (median values) in teenagers aged 10 to 16 years old might vary between 30º and 38º depending on age and sex. The median value found in the present study for the lumbar lordosis of adolescents who did not play accordion is slightly higher (39.0º). This could be due to the small size of our sample or to differences in measurement procedures between our study

and Durmala's et al. study. In the present study, accordionists showed significantly higher values for the lumbar lordosis when compared with non-musicians. This difference might have a negative and long term impact on the health and wellbeing of accordionists, as a positive correlation between changes in lumbar curvature and the presence of degenerative changes and pain has been reported in the literature [24, 25]. Similarly, adolescents who played the accordion showed a more forward head posture; this, in turn, has been shown to be associated with neck pain in both adolescents [26] and adults [13]. The practice of the accordion requires stronger force applied by the left arm, as compared to the right, due to the management of the bellows. Thus, differences in the left and right scapulae posture were expected. Nevertheless, no significant differences for scapulae posture between student groups could be found,

The accordion, as mentioned above, is an instrument with a considerable weight and structure. The average weight of the accordion was 9.8 ± 2.3 Kg and the mean weight of students was 56.1 ± 13.2 kg. According to the literature, the adolescent should not transport loads that represent more than 10% of their own body weight [27]. When calculating the percentage of load of the accordion in relation to participants own body weight, it represented more than 10% for most accordionists reaching values as high as 25%. Moreover, in addition to transporting the accordion, these students have to simultaneously carry their schoolbags. Studies on the impact of school bags have shown that the weights of students' backpacks are directly proportional to the likelihood of back pain [28]. Furthermore, carrying bags at 10%, 20%, and 30% of body weight might occlude skin blood flow [29], are associated with postural changes, in particular increased forward head posture and spinal curvatures [30, 31], and increased pain complaints after a 6-minute walk [6]. Therefore, it is conceivable that the mechanical overload potentially imposed by the accordion to body structures might well lead to postural changes and pain.

One may argue that the results here presented highlight the need for investigating the impacts of implementing preventive strategies within music educational curricula, aiming at reducing the risk factors that instrumentalist students are exposed to as young students.

For example, music teachers could consider planning their teaching class taking into account practical aspects such as breaks, beginning the classes with easier repertoire, practice highly demanding repertoire for short periods or use easier repertoire or motor imagery in between to minimise the excessive demands of playing the accordion on the neuro-musculoskeletal system [32], probably minimizing pain and postural changes. Furthermore, music schools could consider having specialized advice, such as from a physiotherapist, who can help implement general preventive strategies as well as personalized interventions targeting the individual needs of students. A previous exercise programme for professional orchestra musicians [33], seems appropriate for adolescents who played the accordion as it covers the body regions where adolescents in the present study reported more pain and where postural changes were identified (neck, the shoulders and the thoracic and lumbar spine), and so could be considered to be implemented with this musician's population. Motor imagery is a mental process by which an individual rehearses or simulates a given action (e.g. mentally rehearsing the movements of playing the accordion for a specific piece of music) and has been suggested as a strategy to facilitate motor planning efficiency and biomechanical economy in voluntary action [34]. Conceivably, these strategies can minimise the impact of playing the accordion on spine posture and pain. Nevertheless, their effectiveness needs to be investigated.

<H2> Methodological considerations

It is worth mention that time of the day at which measurements were taken can influence measurements of biological variables. Although this consideration was not taken into account previous to the beginning of data collection, all study measurements were taken during the afternoon. The small size of the sample could constitute an additional limitation to this study; however, this study added important considerations to a scarcely literature focused on the impacts of accordion playing on pain and posture of children and adolescents.

This study used a limited number of static measurements which may be insufficient to adequately capture accordionists' posture. Future studies might investigate dynamic postures while playing the accordion and how they relate to static postures. Furthermore, future studies

could considerer investigating potential associations between the posture of different body segments and composite pain measurements taken over time (e.g. days, weeks or months) as well as include measurements of other body parts such as the wrists/hands and the thoracic spine.

Despite the above methodological considerations, the present study contributed to the field of musician's health and wellbeing. Generally speaking, it revealed that children and adolescents who play the accordion tend to report more pain and to have a more forward head posture and lumbar lordosis than children and adolescents who do no play any musical instrument. In a fast rate growing body, such as for the case of this age group, such modifications might greatly impact on a healthy development and on later options regarding a career as a professional instrumentalist.

<H1> References

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352 Tables

353 Table 1 – Sample characteristics.

Sample Characterization		Accordionists n=16 (%)	Non – Musicians n= 16(%)	p value
Sex	Male	7 (43.8%)	7 (43.8%)	
	Female	9 (56. 2%)	9 (56. 2%)	1.00
Age (average±SD)		13.7±2.6	13.4±2.5	1.00
Weight (average±SD)		61.2±14.2	56.1±13.2	0.724
Height (average±SD)		165.1±10.2	160.2±11.6	0.72
Chronic pain (pain for 3 months or longer)				
	Neck	9 (56.3)	4 (25.0)	0.074
	Shoulders	8 (50.1)	2 (12.6)	0.027
	elbow	0	0	
	Wrists/hands	10 (62.6)	1(6.3)	0.001
	Thoracic Region	6 (37.5)	1 (6.3)	0.041
	Lumbar Region	6 (37.5)	2 (12.5)	0.11
	Hips /Thighs	5 (31.3)	1 (6.3)	0.086
	Knees	2 (12.5)	4 (25.0)	0.327
	Ankles/Feet	2 (12.5)	3 (18.8)	0.5
Practice of Exercise	No exercise		1 (6.3%)	Unable to calculate
	Practice very little		-	
	Practice little		-	
	Practice often	10 (62.5%)	4 (25%)	
	Practice very often	6 (37.5%)	8 (50%)	
	Missing		3 (18.7%)	
Average time spent in front of a computer (minutes per day)		60.9±32.2	58.8±30.3	0.88
Accordion's level of practice				
	2nd grade	7 (43.75%)		
	3rd grade	1 (6.25%)		
	4th grade	5 (31.25%)		
	7th grade	2 (12.50%)		
	8th grade	1 (6.25%)		
Time spent playing accordion (hours per week)		4.8±2.8		
Mean weight of accordion (kg)		9.8±2.3		
Accordion weight/body weight (mean±sd in percentage)		16.8±4.8		
Accordion weight in relation to body weight<10% (number of participants)		1		

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Table 2 - Posture assessment results for the accordion players and non-players.

Posture	Accordionists Median (IQ*)	Non-musicians Median (IQ*)	p value
Forward head posture (º)	35.6 (7.8)	45.3 (10.8)	<0.001*
Superior angle of the scapulae-thoracic column (cm)	1.0 (0.9)	0.6 (0.9)	0.539
Root of the scapulae-thoracic column (cm)	0.8 (0.9)	0.5 (0.5)	0.210
Inferior angle of the scapulae-thoracic column (cm) (cm)	0.6 (0.9)	0.9 (0.9)	0.224
⊥distance between inferior angles of both scapulae (cm)	0.3 (0.2)	0.8 (0.2)	0.956
Lumbar lordosis (º)	55.5 (30.6)	39.0 (3.9)	0.002

Note: Posture measurements were taken while participants were barefoot in static standing and before accordion classes for the accordionist group; IQ – interquartile distance, calculated as percentile 75 minus percentile 25.

Figure Legends

Fig1 – Measurement of forward head posture.

Fig 2 – Measurement of scapular posture.

Fig 3 – Measurement of the lumbar lordosis.

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