

Literature reviews. The physical training for musicians. Systematic review. Vol. 5, Issue 3; p. 532-561, september 2019. A Coruña. Spain ISSN 2386-8333.

## **The physical training for musicians. Systematic review**

## **La preparación física del músico. Revisión sistemática**

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### **Abstract**

During the past few years, interest on musician's health is increasing, because with time, the demand level is higher. 76% of the musicians suffer or have suffered physical problems that prevent them from performing at their usual level and 84% of the musicians have had injuries which interfered with their practice. A bibliographic systematic search of the last 10 years has been carried out on intervention studies with physical activity in musicians in primary sources (MPPA magazine) and secondary sources (Music Thesis in Spain, PubMed, WOS, and SciElo), to learn, identify and reflect on the applications that physical activity has in musicians. 2 doctoral thesis and 9 research articles have been systematically analyzed, and subsequently classified according to the sample, the group or instrument, the methodology of the exercise program, and the duration. Physical activity interventions have positive effects on pain, body posture, musical performance and physical condition. In addition, it promotes awareness about the benefits of exercise for prevention. Improving body awareness, incorporating new habits of physical activity, introducing breaks, and making a correct physical and musical programming is decisive for the prevention of musculoskeletal injuries common in this group.

### **Keywords**

Exercise; musicians; prevention; healthy habits.

### **Resumen**

En los últimos años, está creciendo el interés por la salud de los músicos, ya que cada vez el nivel de exigencia es mayor. Las investigaciones muestran que alrededor del 76% sufren o han sufrido problemas físicos que les impide realizar su actividad con normalidad, y el 84% ha tenido lesiones que habrían interferido en su práctica. Se ha realizado una búsqueda bibliográfica sistemática de los últimos 10 años sobre estudios de intervención con actividad física en músicos en fuentes primarias (revista MPPA) y secundarias (Tesis de música en España, PubMed, WOS, y SciElo), para conocer, identificar y reflexionar las aplicaciones que tiene la actividad física en los músicos. Un total de 2 tesis doctorales y 9 artículos de investigación han sido analizados sistemáticamente, y clasificados posteriormente en función de la muestra, el colectivo o instrumento, la metodología del programa de ejercicios, y la duración. Las intervenciones con actividad física tienen efectos positivos sobre el dolor, la postura corporal, el rendimiento musical y la condición física. Además, favorece la conciencia sobre los beneficios del ejercicio para la prevención. Mejorar el conocimiento del cuerpo, incorporar nuevos hábitos de actividad física, introducir descansos, y hacer una correcta programación tanto física como musical será determinante para la prevención de lesiones músculo-esqueléticas comunes en este colectivo.

### **Palabras clave**

Ejercicio; músicos; prevención; hábitos saludables.

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## **Introduction**

According to the World Health Organization the concept of health is defined as a “state of complete physical, mental and social well-being” and not only the absence of illnesses or diseases”. Taking into account the global concept of health when making this review, it will only set forth the part related with physical well-being and the benefits to musicians of physical activity, as pointed out by Martin (2015), the musician’s physical efforts have been underrated by part of their own collective group and the main consequence in the appearance of injuries is the lack of attention to body health.

When we see a person playing a musical instrument with certain dexterity, it transmits ease and apparent normality in its execution, externalizing total control and dominion, barely without effort (Betancor, 2011).

Viaño, Díaz & Martinez (2010) defined musical interpretation as a physical activity where a musical instrument intervenes and requires a muscular demand of the upper extremity to execute different movements with ability and precision, together with adequate postural control.

The work of Chesky, Devroop, & Ford (2002) highlights that the most frequent injuries for musicians that are ending their careers are: hearing loss, overload syndrome, neuropathic entrapment, hands and lips focal dystonia, and others of musculoskeletal and / or neuromuscular origin. These last ones are the most common, present in 64% of orchestra musicians. 20% suffer peripheral nerve problems and 8% focal dystonia as mentioned (Lederman, 2003).

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Table 1 obtained from Betancor (2011) classifies the most frequent pathologies for this profession, taking into account different authors.

Table 1.  
Most frequent Pathologies for instrumentalists.

<i>Musculoskeletal system disorders</i>	<i>Nerve Entrapment</i>
<ul style="list-style-type: none"> <li>- Epicondylitis</li> <li>- Tendonitis</li> <li>- Tenosynovitis</li> <li>- Bursitis</li> <li>- Arthritis</li> <li>- Osteoarthritis</li> <li>- Contractures</li> <li>- Temporomandibular Disorders</li> </ul>	<ul style="list-style-type: none"> <li>- Carpal tunnel syndrome</li> <li>- Upper thoracic outlet syndrome</li> <li>- Radial tunnel syndrome</li> <li>- Ulnar nerve compression syndrome</li> <li>- Ulnar tunnel syndrome</li> <li>- Cervical radiculopathies</li> <li>- Lumbar radiculopathies</li> </ul>
<i>Hearing Loss</i>	<i>Focal Dystonia</i>
	<i>Hypermobility</i>

These types of lesions could even lead to occupational inability. It is because of this that in the past few years, interest in musician's health is increasing, because every time the demand level is greater with higher injury indexes, being at times between 32% and 90% (Abréu & Micheo, 2007; Kochem & Silva, 2017; Paarup, Baelum, Holm, Manniche, & Wedderkopp, 2011). This variation will depend on factors such as type of instrument, the population being studied, etc.

The bibliographical review carried out by Almonacid, Gil, López & Bolancé (2013) obtained as a result a prevalence of 25.5%-86% for musculoskeletal disorders derived from playing an instrument, and indicated that the main areas where they are localized were neck, back and arm.

In this sense, the research of Roset, Rosinés, & Saló (2000) in Cataluña, using 1730 musicians, showed that 77.9% has suffered some ailment along their life, 85.7% being musculoskeletal, emphasizing that the majority of injuries that musicians have are

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localized in the upper extremities (arms and hands) and thorax's dorsal side (Cantó, 2008; Joubrel, Robineau, Pétrilli, & Gallien, 2001).

The majority of scientific studies have been centered in the epidemiology, which has facilitated knowing musician's specific injuries, specifying by instrument family, and even by specific instruments (Bragge, Bialocerkowski, & McMeeken, 2006; Moraes & Antunes, 2012; Paarup et al., 2011)

The principal causes that favor the appearance of injuries in this group are those presented below:

- Physiological factors (sex and age): women that play an instrument have a greater probability of suffering injuries than men; also, due to precocious training that normally begins starting at 4 or 5 years old, it facilitates their occurrence (Fishbein, Middlestadt, Ottati, Straus, & Ellis, 1988; Viaño, 2004).
- The instrument: depending on their characteristic (size, shape and weight) and study time, the physical requirements are different, causing fatigue or other ailment (Sardá, 2003). For example, the inherent position for the clarinet requires to support the entire weight of the instrument with the right hand thumb, and at the same time, perform a large quantity of movements with the rest of the fingers of both hands at a considerable speed (Thrasher & Chesky, 1998).
- Instrumental technique: bad technique provokes rigidity, adopting injurious positions, excessive pressure of the finger movements over the instrument, that together with long practice periods without rest or not performing a previous warm-up, cause pain in different areas of wrists, hands, neck and even shoulders (Wynn, 2004).
- Musical requirements: the interpretive difficulty of a musical piece, in many occasions demands speed, intensity and movement repetition generating

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mechanical stress (Bejjani, Kaye, & Benham, 1996; Mark, Gary, & Miles, 2003).

- Corporal asymmetry: in the same manner that an athlete in unilateral modalities, to avoid muscular decompensation, works both sides, musician encounter the same situation, since they perform their movements with specific groups without giving importance to the rest, producing tonic or phasic imbalance as the case may be (Ackermann, Adams, & Marshall, 2002).
  
- Lack of physical condition: good physical condition is necessary to maintain the position to play an instrument for prolonged periods, which in occasions is not a natural position, or to be able to respond to the increase in study hours (Sardá, 2003). Muscular weakness produced by prolonged seating should be treated through healthy physical activity habits. With that it will be achieved, on the one hand, to elongate the shortened musculature and in the other hand, to activate the muscles that present inactivity, having positive effects on prevention (Frabretti & Gomide, 2010).

But it is important once the information is obtained; to search for the principal factors that provoked their appearance and solutions through experimental research with different types of interventions, adapted to the individual needs presented by the musicians.

For this reason, the proposed objectives for the bibliographic review are shown below:

- Know the applications that physical activity has on musicians through a specific bibliographic search.
  
- Identify relevant research of interventions with physical activity on musicians to prevent specific injuries on this group.

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- Reflect over the most adequate recommendations for musicians in relation to their physical training and its programming, with the purpose of influencing on the general physical condition and prevent future musculo-articular injuries.

## Method

### *Search procedure and strategy.*

To perform a systematic bibliographic review, primary sources have been searched, specifically, in the only medical journal specialized in the etiology, diagnosis and treatment of medical and psychological disorders related with the scenic arts, called *Medical Problems of Performing Artists*.

The secondary sources consulted consisted on electronic support databases. The search was mainly done in databases for music thesis in Spain:

(<http://www.tesisdemusica.es/database.html>), MEDLINE (PubMed)  
(<https://www.ncbi.nlm.nih.gov/pubmed/>), Web of Science (WOS)  
(<https://www.recursoscientificos.fecyt.es>)

And the virtual library of Spanish scientific journals in health science called SciELO (<http://scielo.isciii.es/scielo.php>).

The basic search criteria have been established as years (2008-2018), the languages (English/ Spanish) and the key words (musicians, exercise, preventions, injuries and health).

### *Selection Criteria*

To filter the search, it was established as a premise to obtain the most updated results. Thus, different inclusion and exclusion criteria were determined, which allowed looking at those interventions carried out with musicians that included physical exercise during the last 10 years.

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### Inclusion criteria

- Years: 2008-2018
- Languages: Spanish / English
- Interventions with physical activity
- Sample: musicians (symphony orchestra/band)

### Exclusion criteria

- Therapeutic interventions (treatments other than exercise)
- Articles with insufficient information

Also during the search boolean operators were used (AND, OR, “”) and filters for language, dates and key words, depending on the existing possibilities of the sources consulted, so that later, a systematic review of the information found could be done.

### **Results**

The initial search obtained a total of 3024 documents found. Of all of them, 48 have been categorized as relevant and valid because they complied with the criteria previously established, of those, 37 were repeated references and have been excluded. Finally, 9 articles and 2 doctoral thesis have been selected.

As shown on Table 2, the results obtained in the search of articles related with physical activity and musicians, in *Medical Problems of Performing Artists* magazines are according to the different search strategies used as indicated below

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**Table 2.**

**Results of the search in *Medical Problems of Performing Artists* magazines**

MAGAZINE: <i>Medical Problems of Performing Artists</i>		
SEARCH STRATEGY	Nº OF REFERENCES OBTAINED	Nº OF VALID REFERENCES
Title Word: exercise	5	3
Abstract words: musicians and exercise	31	
Abstract words: musicians and exercise Years 2008-2018	18	3 (R)+ 3
Abstract words: musicians, exercise, health	7	2 (R)
Abstract words: musicians, exercise, health Years: 2008-2018	4	2 (R)
Abstract words: musicians, exercise, injuries	7	2(R)
Abstract words: musicians, exercise, injuries Years: 2008-2018	6	2 (R)
Abstract words: prevention, exercise, musicians	8	1(R)
Abstract words: prevention, exercise, musicians Years: 2008-2018	4	1 (R)
TOTAL VALID REFERENCES		19
REPEATED REFERENCES		13
TOTAL VALID ARTICLES		6

Note: (R) References repeated in previous searches.

The database music thesis in Spain, updated on January 6, 2019, has a total of 2262 doctoral thesis related to music. Between the years 2008-2018 there are 1633 published, of which, 1493 are in English or Spanish.

Below are the number of valid references obtained that can be consulted relating to this study subject following the search strategies mentioned, as seen on Table 3.

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**Table 3.**  
**Results of the bibliographical search of musical thesis in Spain.**

DATABASE: MUSICAL THESIS IN SPAIN		
SEARCH STRATEGY	Nº OF REFERENCES OBTAINED	Nº OF VALID REFERENCES
Year (2008-2018) & Language (English / Spanish) and Scope (medicine / health)	40	1
Year (2008-2018) & Language (English / Spanish) and title "ejercicio"	3	1
Year (2008-2018) & Language (English / Spanish) and title "lesiones"	2	0
Year (2008-2018) & Language (English / Spanish) and title "prevención"	1	0
Year (2008-2018) & Language (English / Spanish) and title "salud"	4	0
Year (2008-2018) & Language (English / Spanish) and title "exercise"	0	0
Year (2008-2018) & Language (English / Spanish) and title "injury"	0	0
Year (2008-2018) & Language (English / Spanish) and title "health"	0	0
Year (2008-2018) & Language (English / Spanish) and title "prevention"	0	0
TOTAL VALID THESIS		2

For bibliographical searches in PubMed there were 1964 articles corresponding to the time period established (2008-2018), using the search words *musicians* OR *musician* OR *musician's*.

The PubMed database is the one from which more valid references were obtained, but many of them were repeated from previous searches (Table 4).

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**Table 4.**  
**Results for the PubMed database search**

DATABASE: PubMed		
SEARCH STRATEGY	Nº OF REFERENCES OBTAINED	Nº OF VALID REFERENCES
((musicians[All Fields] OR musician[All Fields] OR musician's[All Fields]) AND ("pain"[MeSH Terms] OR "pain"[All Fields])) AND ("2008"[PDAT] : "2018"[PDAT])	145	
((musicians[All Fields] OR musician[All Fields] OR musician's[All Fields]) AND ("exercise"[MeSH Terms] OR "exercise"[All Fields])) AND ("2008"[PDAT] : "2018"[PDAT])	72	6 (R)+ 3
((musicians[All Fields] AND ("exercise"[MeSH Terms] OR "exercise"[All Fields])) AND ("injuries"[Subheading] OR "injuries"[All Fields] OR "wounds and injuries"[MeSH Terms] OR ("wounds"[All Fields] AND "injuries"[All Fields]) OR "wounds and injuries"[All Fields])) AND ("2008"[PDAT] : "2018"[PDAT])	6	4 (R)
((musicians) AND exercise) AND health) AND ("2008"[Date - Publication] : "2018"[Date - Publication])	24	10 (R)
TOTAL VALID REFERENCES		23
REPEATED REFERENCES		20
TOTAL VALID ARTICLES		3

**Note: (R) References repeated in previous searches.**

As shown in Table 5, the database Web of Science (WOS) obtained a total of 2574 results in which the Word *musicians* appeared in the title in the past 10 years, but when the search was filtered for *musicians* AND *exercise*, these have been reduced to 14 references, and of those, 4 complied with the inclusion criteria, but they were repeated investigations from previous searches.

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**Table 5**

**Results for database search in Web Of Science**

Resultados de la búsqueda en la base de datos Web Of Science

DATABASE: Web Of Science		
SEARCH STRATEGY	Nº OF REFERENCES OBTAINED	Nº OF VALID REFERENCES
Timespan: 2008-2018. Databases: WOS, CCC, DIIDW, KJD, MEDLINE, RSCI, SCIELO. TITLE:(musicians)	2574	
Timespan: 2008-2018. Databases: WOS, CCC, DIIDW, KJD, MEDLINE, RSCI, SCIELO. TITLE:(musicians) AND TITLE: (pain)	44	
Timespan: 2008-2018. Databases: WOS, CCC, DIIDW, KJD, MEDLINE, RSCI, SCIELO. TITLE:(musicians) AND TITLE: (exercise)	14	4 (R)
Timespan: 2008-2018. Databases: WOS, CCC, DIIDW, KJD, MEDLINE, RSCI, SCIELO. TITLE:(musician) AND TITLE: (exercise) AND TITLE: (health)	2	0
Timespan: 2008-2018. Databases: WOS, CCC, DIIDW, KJD, MEDLINE, RSCI, SCIELO. TITLE:(musicians) AND TITLE: (exercise) AND TITLE: (injuries)	1	0
TOTAL VALID REFERENCES		4
REPEATED REFERENCES		4
TOTAL VALID ARTICLES		0

As far as the SciELO database, it is the one that had the least amount of information during the bibliographic search as shown in Table 6

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**Table 6.**

**Results for SciELO search**

Resultados de la búsqueda en SciELO

DATABASE: SciELO		
SEARCH STRATEGY	Nº OF REFERENCES OBTAINED	Nº OF VALID REFERENCES
exercise [Summary] and musicians [All indexes]	1	0
prevention [All indexes] and musicians [All indexes]	1	0
TOTAL VALID REFERENCES		0
REPEATED REFERENCES		0
TOTAL VALID ARTICLES		0

Of all the studies selected, information on the authors, year published, number of participants, sample characteristics, type of instrument and intervention, duration and number of sessions was extracted.

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**Table 7.**

**Systematized results**

N	Study	N	Musician	Instrument	Face to Face	Duration	Sessions
1	<i>Cámara (2017)</i>	G.experimental <i>n</i> =4 G.control <i>n</i> =2	Professional	Flute	Not face to face	12 weeks	3 per week
2	<i>Gallego (2017)</i>	Pilot <i>N</i> =19 Experimental <i>N</i> =29	Student	Clarinet/Oboe	Not face to face	Pilot=9 weeks Experimental= 6 weeks	2 per week
3	<i>Gallego, Martín, Ros &amp; Ruiz (2018)</i>	<i>N</i> =10	Student Professional	Clarinet	Not face to face	6 weeks	3 per week
4	<i>Roos &amp; Roy (2018)</i>	<i>N</i> =30 Experimental: <i>n</i> =15 Control <i>n</i> =15	Student Professional	Orchestra (general)	Semi face to face	-	14 sessions
5	<i>Árnason, Briem &amp; Árnason (2018)</i>	<i>N</i> =23 Experimental <i>n</i> =13 Control <i>n</i> =10	Student	Various	Face to face	-	Total 20 sessions
6	<i>Lundborg &amp; Grooten (2018)</i>	<i>N</i> =24	Professional	Strings	-	11 weeks	2 per week
7	<i>Andersen, Mann, Kristensen &amp; Sogaard (2017)</i>	<i>N</i> =23	Professional	Orchestra (general)	Face to face	9 weeks	3 per week

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8	Chan, Driscoll, & Ackermann (2014a)	N=85 Final N=53 Experimental n=30 Control n=23	Professional	Orchestra (general)	Supervised by physiotherapist	9-12 weeks	Total 16 sessions
9	Chan, Driscoll, & Ackermann (2014b)	N=144 Final Sample N=50	Professional	Orchestra (general)	Not Face to face	12 weeks	2-4 per week
10	Chan, Driscoll, & Ackermann (2013)	N=13	Professional	Strings	Supervised by physiotherapist	8 weeks	2 per week
11	Lee, Carey, Dubey & Matz (2012)	N=15	Student	Orchestra (general)	Not Face to face	8 weeks	-

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## Summary of the main studies

### a) *Thesis*

#### *Cámara (2017)*

This thesis poses as its principal objective to assess in an experimental manner the effect produced by a physical exercise program over the performance and skills of musicians, specifically flutists. To achieve this, an intervention was done with 6 flutists (2 as control group and 4 as experimental group) with one desertion. For this, a Non face-to-face training plan was designed during 3 days / week with a 12 weeks total duration. The sessions followed a structure (warm-up, main part and back to rest), which included aerobic exercises (walk / run / stairs) and strength (abdominals, lumbar, neck and shoulders, arms, pectorals, dorsal and trapezium). For the intervention they used questionnaires (PAR-Q/IPAQ/POMS), physical condition tests (spirometry / abdominal strength / Course-Navette) and flute performance tests (FC and a specific pulmonary capacity test while performing a piece, also developed a table that allowed to evaluate the interpretation, and conducted open interviews. Depending on the initial physical level 3 training levels were established with 20 to 60 minutes duration. The results showed an improvement in physical and also interpretative performance of the experimental group. The author concluded that the specific training plan should contain aerobic exercises of moderate intensity, toning exercises for the involved musculature (except hands and mouth), warm-up exercises and final stretching.

#### *Gallego (2017)*

This investigation applied a specific autonomous exercise program designed for clarinetists and oboists using an e-learning tool to facilitate the program's content. It had as a purpose to improve the general physical condition and corporal posture. The participant established their own intensity criteria taking an effort perception scale as reference. The exercise program establishes 3 progressive difficulty phases. The first, adaptation phase, with low intensity exercises (mobility, postural exercises, toning upper extremities and spine. The second level, development and improvement phase (increases the intensity, circuit training,

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coordination, higher resistance bands). Third level, physical condition maintenance phase, (similar intensity, higher coordinative difficulty exercises and global muscular implication, higher resistance elastic bands). All sessions had postural educational exercises with the instrument.

To know the changes produced several questionnaires and scales were used that allowed to follow the participants online. For the physical evaluation tests selected predictive evaluations formulas of 1RM for the trapezium and the dorsal, polar fitness test, Rockport test, Langlade test for corporal posture and an adaptation of this test for the clarinet. Exercises to assess joint range of the upper extremities and spine: (chest rotation and inclination / shoulder range).

A pilot first intervention was done with  $N=19$  and 9 weeks duration (18 sessions) and later a second experimental intervention with  $N=29$  and 6 weeks (12 sessions). The most outstanding results in the second intervention showed that the physical activity program increased the strength for the trapezium ( $p = .003$ ) and the dorsal ( $p = .008$ ), highlighting with predictive analysis, the possible changes in strength for the dorsal after the first 6 sessions ( $p = .006$ ). In relation to corporal posture, positive changes occurred. The author concluded that, the practice of specific physical exercise in music professional teaching, prepare the participants for the requirements of musical interpretation.

#### *b) Articles*

*Gallego, Martín, Ros & Ruiz (2018)*

The participants in this study ( $N=10$ ) were clarinetists that presented muscular pain when playing the instrument. The investigation proposed an intervention with autonomous exercises for 6 weeks (3 sessions / week), with proposals for joint mobility, postural musculature strengthening, scapular zone and mainly the upper extremities, with elastic bands and flexibility exercises. It evaluated corporal posture and pain perception. The results showed a perceived decrease of pain ( $p < .001$ ) and changes in the dorsal zone ( $p < .001$ ). It

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concluded that a regular program of physical activity produces visible postural changes and a reduction of perceived pain.

*Roos & Roy (2018)*

Performed a study with 30 orchestra students and professional musicians without injuries. The sample was composed by an experimental group  $n=15$  and a control group  $n=15$ . The intervention with physical activity was semi- face-to-face (11 sessions non face-to-face and 3 face-to-face). It was based on the investigation of Chan, Driscoll & Ackermann (2013). The exercises were supplied through videos in a USB. The proposed exercises were warm-up, back to rest, strength and resistance exercises for the postural muscular groups. The progression of the basic activation exercises to dynamic and with resistance, as well as heavy motor movements. They concentrated, specifically at the neck, shoulders, abdominals, back and hip areas. Each series included six exercises of increasing difficulty. To measure the intensity of the symptoms and functional limitations an MPIQM questionnaire was used, and to evaluate the prevalence and frequency of the symptoms, an NMQ questionnaire. The results pointed out a significant decrease of pain intensity ( $p = .01$ ) and pain limitation ( $p = .006$ ), concluding that this program is feasible and effective to reduce the intensity and functional impact of symptoms in musicians. However, it does not highlight any data related to the frequency or medium term prevalence.

*Árnason, Briem & Árnason (2018)*

The authors developed a face-to-face theoretical-practical course for a sample  $n=23$  (experimental group  $n=13$  and control group  $n=10$ ). The profile of the participants was: students of different specialties (6 singers, 6 flutists, 4 guitarists, 3 pianists, 1 cello, 1 saxophone, 1 clarinet and 1 saxhorn). It consisted in carrying out a course about education and prevention, working with corporal conscience and attitude towards health and prevention. 4 theoretical and 16 practical sessions were performed. The sessions consisted in proposals of general physical activity, empirically raise awareness about the importance of alignment through exercises. Also specific exercises were provided to strengthen and

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mobilize the back, shoulders and warm-up routines. The evaluation instruments were questionnaires about corporal consciousness in daily activities and touching on the importance of health. The results obtained demonstrated that after the course, the participants increased the time dedicated to previous warm-up ( $p = .036$ ). Also their corporal consciousness improved while they were playing ( $p = .026$ ) and their daily activities ( $p = .004$ ). Therefore, this type of intervention benefits musicians because they improve their corporal perception and attitude toward prevention.

#### *Lundborg & Grooten (2018)*

The intervention was made with 24 professional string musicians. It lasted 11 weeks with a frequency of 2 sessions / week. The sessions presented warm-up exercises for 5-10 minutes with proposals such as dead weight without dumbbells, scapular control, and spinal column mobility exercises. For the sessions main part it was proposed a progression of 4 series of 9 to 12 repetitions, with exercises for the upper extremities, amongst them shoulder presses with dumbbells, wrists flexion, rowing exercises, flexion with bands, etc. For the lower extremities (different squats exercises) and global exercises (lumbar, strides with weights, burpees, bird-dog, push-ups, etc). To measure the changes produced a hand dynamometer was used to do the Biering-Sorensen test. Also, a questionnaire was used to evaluate the perceived performance playing the instrument, the mobility, the incidence and intensity of pain. The most outstanding results were the increase of isometric neck pain from 11% TO 19% and 25% for the back extensors ( $p < 0.05$ ). The authors impact the necessity to perform controlled and random studies to be able to confirm the results obtained.

#### *Andersen, Mann, Kristensen & Sogaard (2017)*

A total of 23 professional orchestra musicians participated in this investigation. 2 groups were formed, applying 2 different face-to-face trainings, lasting 9 weeks, 3 days per week. The first group followed specific strength training  $n=12$  and the second group, global training  $n=11$ . The specific strength training included supervised high intensity exercises and exercises centered on the neck and shoulders. The maximum number of repetitions was 15

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at 70% maximum intensity and the load was progressively increased reducing the repetitions (8-12 repetitions) and increasing the load between 75-85% of maximum intensity.

For this, I.M.C. was calculated, and other instruments were used such as a visual pain scale, a hand dynamometer (strength), Aastrand sub-maximum test (aerobic capacity), and Stroyer's questionnaire to know their physical aptitude.

The most outstanding results showed a significant reduction in pain ( $26.3 \pm 22.5$  to  $11.4 \pm 15.2$  mm) amongst the participants for the specific strength plan group. However, the global training group also showed pain reduction, but in this case, not significant ( $19.7 \pm 24.0$  to  $13.5 \pm 26.0$  mm). Unlike these results, the aerobic capacity significantly increased ( $34.1 \pm 7.9$  mL / min / kg to  $40.0 \pm 13.6$  mL / min / kg) and perceived muscular strength improved for the participants ( $5.7 \pm 1.3$  to  $6.5 \pm 1.8$ ).

The conclusions reached by the authors was that exercise could improve the musician's labor situation, and that future programs should include aerobic and strength exercises designed to cover the needs for this group, together with relevant educational actions.

*Chan, Driscoll, & Ackermann (2014a)*

Initially, the study counted with a sample of professional musicians  $N=85$ . The participants were divided into an experimental group where an exercise proposal was applied (ending  $N=30$ ) and a control group  $N=23$ . The intervention lasted 9-12 weeks with a total of 16 sessions of 35 minutes each. The participants received a document with exercise photographs and suggestions (execution, load, rest, etc.). The general recommendation was 3 series of 12 repetitions centered at neck, shoulder, abdominal, spine and hip zones. The load progression was gradual, with initial activation exercises, and later more complex exercises with proprioception, ending with functional exercises with resistance. This was the structure of a typical session. For follow-up, each participant documented his/her progress (series, repetitions, difficulties). The investigation collected perception data of effort playing

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the instrument in different situations (private, practicing and concert). Also information was gathered to know the frequency and severity of PRMDs and the posture, ease of movement, concentration stress, confidence, energy levels, techniques and muscle strengthening. The results after the intervention revealed a reduction in the severity and frequency ( $p < .05$ ) of the musculoskeletal disorders after the exercise program, but not 6 months after it ended. Also, the effort perception significantly improved only during private practice. This intervention was rated by the participants as effective to strengthen the musculature used to play the instrument, and to become acquainted with learning techniques for practices and posture.

Therefore, the investigators considered that the specific exercise program for musician was effective in the reduction of the frequency and severity of PRMDs.

*Chan, Driscoll, & Ackermann (2014b)*

This intervention proposal had a final sample of  $n=50$  professional orchestra musicians. The intervention with exercises for 12 weeks delivered through a DVD, in which there were also explanations of the musculature involved and their execution which should be done 2-4 times per week. To learn about the program results, they used an analog visual scale for frequency and severity of musculoskeletal disorders, perception scales for effort playing the instrument (private, rehearsal, concert). Likert scale to rate the experience of using a DVD. Previously, some of the participants had taken a face-to-face program with a time difference of 6-12 months, to compare the difference between the two methods.

The results showed a significant reduction of frequency and severity of PRMDs ( $p < .01$ ). Highlight that the effort perception during practice was maintained. Finally, 78% rated the use of the DVD as good or excellent, because of its detailed explanations. The most relevant conclusion of this study has been that the musicians recognized the importance to strengthen the muscles involved for playing an instrument and the need to reduce the risk of developing PRMDs, improving the awareness of exercise importance for the longevity of professional careers.

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*Chan, Driscoll, & Ackermann (2013)*

After a first phase of bibliographic review, an exercise proposal was designed based on the articles found. The proposal performed by experienced physiotherapist consisted in 5 progressive intensity exercises for the neck, shoulders, back, abdominals and buttocks since they were the most selected in the majority of investigations obtained during the review. The basis exercises worked the deep neck flexor, activation of the middle and inferior trapezium, abdominal stabilization, and activation of the external hip rotator. The intervention lasted 8 weeks, with a frequency of 2 times / week. The participants filled out a registry and tracing sheet so that the physiotherapist could have control of the participants. At the end, semi-structured interviews were done whose comments referred to the difficulty of some exercises and the framework. The investigation has served as a pilot study for other of greater importance, which has allowed the creation of an exercise program based on scientific evidences.

*Lee, Carey, Dubey & Matz (2012)*

15 student musicians participated in an intervention lasting 8 weeks in which for 4 weeks they performed respiratory exercises and the other 4 strengthening and flexibility for a 20 minutes interval. The evaluation test used was an injury and pain survey, and another evaluation of efficacy on physical and musical performance. On the other hand, in an isolated way, the kinematic movements of a cellist and a flutist were evaluated. The results showed that students have a low physical condition, but their musical efficacy lever is high. Also, the movement analysis after the intervention permitted to observe an increase in range of movement of the shoulder during the interpretation and the flutist changed corporal weight after the intervention. The authors related these changes to the physical efficacy provided by the program which had given greater mobility for musical expression.

## **Discussion**

After the bibliographic review, in the last decade a total of 11 investigations have done interventions with physical exercise. For the design and programming of this type of

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investigation, the key is to have as a base, the causes mentioned in the introduction. Thus, in the results, the types of musicians and instruments for the sample have been analyzed.

In relation to the type of musicians in which the interventions have been applied, 6 have centered only on professional musicians (Andersen et al., 2017; Cámara, 2017; C Chan, Driscoll, and Ackermann, 2014a; Chan et al., 2013; Chan, Driscoll, & Ackermann, 2014b; Lundborg & Grooten, 2018), 3 on music students (Árnason et al., 2018; Gallego Cerveró, 2017; Lee et al., 2012), and in 2 of them, professional and student musicians have participated at the same time (Gallego et al., 2018; Roos & Roy, 2018).

Physiological factors are found among the causes of injuries mentioned (Fishbein et al., 1988; Paarup et al., 2011), and musical requirements (Bejjani et al., 1996; Mark et al., 2003). The physical and interpretive needs of a music student are not going to be the same as those of an adult professional musician, as well as their possible ailments and manner to intervene before professional ailments. Thus, the programs have to be according to age and musical demands, individualizing as much as possible the exercise program. Another factor is the type of instrument, since each one of them presents a different technique. The instruments on which the majority of interventions have been centered were made in a generic manner with orchestra musicians (Andersen et al., 2017; Árnason et al., 2018; Chan et al., 2014a; Chan et al., 2014b; Lee et al., 2012; Roos & Roy, 2018), others concentrating by family of instruments (Chan et al., 2013; Lundborg & Grooten, 2018), random instruments (Árnason et al., 2018), and specific instruments such as clarinet or flute (Cámara, 2017; Gallego, 2017; Gallego et al., 2018).

The specificity for the type of instrument is important for the design because the lesions and the physical demands are not equal for wind, percussion or string. Also, each musical instrument has a physical demand and different corporal position.

Physical condition should be adequate, as stated by Lee et al. (2012), musicians have low physical condition but a high musical efficacy, so it is important to improve the physical efficacy. For this, after analyzing the investigations presented, all point out the importance

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of aerobic exercises, to maintain good general physical condition that allows to improve musical performance (Cámara, 2017).

On the other hand, exercises to strengthen the neck, shoulders, back, abdominals and buttocks zones have to be included (Cámara, 2017; Chan et al., 2013, 2014b; Roos & Roy, 2018),, but also, exercises related with corporal posture and mobility (Árnason et al., 2018; Gallego, 2017; Gallego et al., 2018; Roos & Roy, 2018).

Both recommendations make sense since the instruments, in many occasions, are not ergonomic (transverse flute, violin, etc.), because they have been created independently of the physical health of the musicians, and the human being is the one that has to adapt to their form, size and weight, creating abnormal adaptations on their musculoskeletal system that produce medium term alterations such as scoliosis, hyperlordosis or hyper kyphosis that are related with the superior or inferior crossed syndrome or both, (Barczyk-Pawelec, Sipko, Demczuk-Włodarczyk, & Boczar, 2012).

Lastly, to include flexibility exercises to improve the joint mobility range. All of it, following a session structure type (warm-up, principal part and back to rest).

For wind instruments, the investigations of Cámara (2017), Gallego (2017) and Gallego, Martín, Ros & Ruiz (2018), highlight the previous aerobic recommendations, as well as, those related to corporal posture, as they have a direct relationship over lung capacity and the respiratory system. In relation with strength exercises it was pointed out the importance of targeting on the dorsal area and upper extremities. Lastly, in relation with flexibility exercises, to follow the recommendations to stretch the pectoral, superior trapezium and levator scapulae to avoid the superior crossed syndrome.

For string instrument, there are different studies but many of those written utilize a sample of general orchestra musicians and therefore, it is more difficult to be able to establish common guidelines for strings, since they could be differentiated in high and low strings, whose corporal positions are different. In relation to aerobic exercises, they would not have much influence over the interpretation since they do not involve the respiratory to play the instrument. However, it is important to point that they should work on their aerobic capacity

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for been optimally fit. In so far as more specific exercise, the majority of investigations were centered on one hand in strengthening exercises for the neck, shoulder, abdomen, spine and buttocks zones (Andersen et al., 2017; Chan et al., 2013; Chan et al., 2014a; Lundborg & Grooten, 2018; Roos & Roy, 2018) and on the other, mobility exercises for the back and shoulders (Árnason et al., 2018; Lundborg & Grooten, 2018).

Independently of the instrument family and the recommendations pointed out in the investigations, it is important to point out that any time that a physical activity program is proposed to musicians, it should take into consideration their individual needs.

Beside these recommendations of physical prescription, education and awareness are important in the subject of injury prevention (Andersen et al., 2017; Árnason et al., 2018; Chan et al., 2014a; Chan et al., 2014b), showing the benefits of physical exercise for musicians in relation to pain (Andersen et al., 2017; Chan et al., 2014b; Gallego et al., 2018; Roos & Roy, 2018) and the importance of including physical habits in musician's routine such as specific warm-up and stretching (Rosset & Fàbregas, 2005).

In as much as program accessibility, the majority have been proposed as a non-face-to-face manner or with a very low face-to-face component, always under the supervision or recommendation to correctly execute the exercises. Tools such as DVD (Chan et al., 2014b), web pages designed for these type of programs (Gallego, 2017; Gallego et al., 2018), or to supply the exercises in a USB (Roos & Roy, 2018), make it possible for professional musicians to carry them out anywhere, facilitating access to them at the most suitable time, and even result motivational by using new technologies. Even though the use of remote tools could be beneficial, it should be taken into account that one of the main problems of sedentary or physically inactive persons is their adherence to an exercise program. In this sense, it has to be taken into account the level of sedentary lifestyle because, in this case, it could be more interesting to propose face-to-face alternatives to improve their medium and long term adherence.

## Conclusions

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For the making of this review limitations related with access to information, the characteristics of the sample and the type of study have been encountered.

Many of the articles related with musician's physical problems found in *Medical Problems of Performing Artists* magazine were closed to access. In relation to the sample, the number of participants was reduced, which does not allow generalizing the results to the population studied. The group format was heterogeneous, and it is not possible to know the needs for the type of instrument. The types of investigations are not longitudinal or the sample had injured musicians, and did not allowed to know about the effect of prevention of injuries. Nonetheless, the bibliographic search has permitted to reflect the need of continuing research in this field. In the searches done, only a total of 11 valid references have been found for the past 10 years. In the other hand, putting into practice a physical activity program should be designed, having as premise the risk factors that a musician has to suffer an injury (physiological, instrument, instrumental technique, musical difficulty, corporal asymmetry and low physical condition). The search for the individualization principle and the analysis of the needs of each instrumentalist is essential to minimize the existing risks for the professional musician. The majority of investigations found was generic and did not focus on a particular instrument. On the other hand, the results obtain have allowed to see the most adequate recommendations for an adequate exercise program. Improve the knowledge of the human body, incorporate new physical activity habits, introduce breaks, and perform the correct physical and musical programming will be a determinant for the prevention of some common injuries for this group.

Thus, this field should be studied by all health related professionals from a preventive point of view and in the early stages, in more specific researches and larger samples, that will allow to see in a quantitative manner, the improvements of including physical activity on the day to day and the transfer that it can have on musical activity.

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