Contributing Factors, Prevention, and Management of Playing-Related Musculoskeletal Disorders Among Flute Players Internationally

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Major studies have shown that flutists report playing-related pain in the neck, middle/upper back, shoulders, wrists, and hands. The current survey was designed to establish the injury concerns of flute players and teachers of all backgrounds, as well as their knowledge and awareness of injury prevention and management. Questions addressed a range of issues including education, history of injuries, preventative and management strategies, lifestyle factors, and teaching methods. At the time of the survey, 20.7% of all respondents were suffering from flute playing-related discomfort or pain; 49.7% had experienced flute playing-related discomfort or pain that was severe enough to distract while performing and 25.8% had taken an extended period of time off playing because of discomfort or pain. Consistent with earlier studies, the most common pain sites were the fingers, hands, arms, neck, middle/upper back, and shoulders. Further research is needed to establish possible links between sex, instrument types, and ergonomic set up. Further investigation is recommended to ascertain whether certain types of physical training, education, and practice approaches may be more suitable than current methods. A longitudinal study researching the relationship between early education, playing position, ergonomic set-up, and prevalence of injury is recommended. Med Probl Perform Art 2014, 29(3):155–162.

The flute playing position is essentially static, with the instrument being held unilaterally, against gravity, often for extended durations. Several studies of flute populations have documented the prevalence of playing-related musculoskeletal disorders (PRMDs), and a comparison of these has shown that flutists report pain typically in the neck, middle/upper back, shoulders, wrists, and hands. 1-5 Many contributing factors may lead to PRMDs and include postural flaws, physical and psychological characteristics, incorrect technique, fatigue, intensity and type of practice, discrepancies between instrument size and physical stature, stress, lack of conditioning, and lifestyle choices. 6-8 Some studies indicate that playing in an asymmetrical and/or elevated arm position may be more likely to cause upper body musculoskeletal symptoms. 9,10

Due to limited data on the rate of injuries in the flute community and a paucity of data from outside the United States, new research was necessary to highlight areas of concern to the flute community. This article focuses on a 2007–2008 study that characterized these problems more clearly. The survey described was part of a doctoral dissertation completed in 2011.11

LITERATURE REVIEW

Survey Findings

In the 1991 National Flute Association (NFA) survey (n=420),9 the largest number of pain complaints was in the neck and upper back regions, but other problematic sites were the fingers, wrists, and shoulders. Spence in 2004 compared the responses of the University of North Texas (UNT) Musician Health Survey (n=329 flutists) with the 1999 NFA Flute Health Survey (n=40). Flutists reported problems in several anatomical sites, including the hands, wrists, forearms, elbows, shoulders, and neck, as well as the upper and middle back. Thompson, in a 2008 doctoral dissertation,5 surveyed high school and college age flutists (n=30), reporting that common pain sites were the hands, wrists, neck, shoulder, and forearms. Pain, in a 2009 doctoral dissertation,1 reported that over half of 181 flutists surveyed either sometimes or always experienced pain while playing, typically in the neck, shoulders, left upper back, right upper back, and wrists.

A limitation of previous major surveys on flute-playing populations1,2,9 has been that they were all undertaken in the U.S. The current survey included respondents from 25 countries.

Previous flute survey findings provided little information about the playing background and experience of respondents. Some focused exclusively on a comparatively small group of high school and/or college students.5,12

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Other studies or surveys reported exclusively on the injuries of specific demographic groups such as children,\textsuperscript{13} orchestral musicians,\textsuperscript{14-17} music schools,\textsuperscript{18} students,\textsuperscript{19-21} music teachers,\textsuperscript{10} and military band musicians.\textsuperscript{22} Some studies included a significant number of musicians, but only a small sample of flutists (such as Bengston and Schutt\textsuperscript{23}).

The grouping of all of the woodwinds together in other major studies such as the one by Fry\textsuperscript{18} means that key physical challenges involved in maintaining the flute playing position and their potential consequences have not been explored to any extent in the reporting of survey results. One of the few instrument-specific studies undertaken on the rate of musician injuries was conducted by Cayea and Manchester,\textsuperscript{24} who found that playing the flute (compared with other instruments) was associated with a medium level of injury among university students.

While the PRMDs of musicians have been well documented since the 1980s, this is not generally reflected in the flute literature. Some flute pedagogues and authors\textsuperscript{25-27} provide information about positioning, especially the need to be comfortable and relaxed, but there is little mention of the physical ramifications of playing with incorrect posture. Posture and hand position are often discussed\textsuperscript{28,29} due to their impact on flute technique, sound, and intonation, but not, however, on physical well-being. Two notable exceptions are Debost\textsuperscript{30} and Edmund-Davies,\textsuperscript{31} who refer specifically to the difficulties associated with the flute playing position and the potential for injury.

\section*{Flute Playing Position}

Issues pertaining to flutists are different to those of the other wind instruments and warrant specific attention. Firstly, the playing position of the flute is asymmetrical, while the positioning of other wind instruments such as the oboe and clarinet are closer to the midline of the body. Secondly, the flute is not a reed instrument and, by nature, requires less lip pressure and generally much greater airflow. Finally, the flute is not only held against gravity, but unlike other wind instruments in which the hands are positioned at trunk level, such as the oboe and clarinet, flute players are exposed to a greater load due to the higher elevation of the arms (Fig. 1).

The awkward flute playing position and associated postural and musculoskeletal problems have also been noted in the performing arts medicine literature.\textsuperscript{32-34} There is much valuable general advice on prevention and management of PRMDs in several publications on musicians' health\textsuperscript{35-37}; however, for flutists searching for flute-specific advice on positioning, pedagogy, posture, or technique, there is little to be found in this literature.

\section*{Relationship Between the Sex of the Player and Type of Flute Played}

Although there exist some data on who plays the flute and therefore some evidence of gender-specific differences, the amount of epidemiological data is relatively small when it comes to understanding the factors that contribute to flutists' health. A study of musculoskeletal pain in student instrumentalists compared to a general student population by Roach et al.\textsuperscript{30} found that female musicians were more likely than men to report upper-body joint pain and upper back and shoulder pain. The authors compared this finding with women in the general student population (non-musicians) who "were 70% less likely to report shoulder pain than were the men." Of particular interest was that 78% of the violinists in the study were women and 88% of the percussionists were men.\textsuperscript{30}\textsuperscript{126} This is relevant because the "women who played the violin had 23 times the odds of upper-body joint pain and 14 times the odds of shoulder pain than did the men who played the violin."\textsuperscript{25}\textsuperscript{128} While there were no flutists in the study, the playing position of the violin is, like the flute, held against gravity and asymmetrically, whereas percussion playing is generally much more dynamic, using a greater range of movement, and more symmetrical.

Nyman et al.\textsuperscript{2} found that "orchestra musicians working in an elevated arm position (e.g., violinists, violists, flutists, and trumpet players) had a higher prevalence of neck-shoulder pain than those working in a more neutral position, even with an exposure of <2 hours of active playing time per workday. The duration of active playing time per workday did not affect the prevalence of neck-shoulder pain among the subjects playing in a more neutral arm position."\textsuperscript{36,37} Wahltrom Edling and Fjellman-Wiklund\textsuperscript{30} found that female music teachers who played in asymmetric postures "reported significantly more symptoms in the neck, shoulders, and upper back than male teachers." In the same study, teachers who played with an asymmetric posture "had significantly more musculoskeletal disorders than music teachers with a symmetric playing posture."\textsuperscript{30,113} These results contrast with Cayea and Manchester's\textsuperscript{24} finding that females playing flute experienced a lower rate of injury than other instrumentalists, despite the overall combined group of males and females experiencing a medium rate of injury.

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The sex of a musician may become an issue when playing particular instruments, and this is not necessarily able to be determined when flutists are grouped together with other woodwinds in previous studies. Of potential significance to flutists is that the instrumentalists in Roach's study20 who were not currently suffering from upper-body pain spent "an average of 9 hours a week in some type of physical activity." They also concluded that the "lesser upper-body mass of women as compared with men" may be influencing the higher rate of pain in female violinists, and that this could, therefore, be managed and prevented by appropriate physical training programs to improve strength and endurance in the upper body.22(10)

Aims

Due to limited data on the specific musculoskeletal disorders of flutists, and a paucity of data from outside the U.S., a new study was needed to more definitively establish the extent of PRMDs in flutists internationally. The study was designed to fill gaps in existing knowledge and to contextualize the findings within those of previous relevant surveys. The current survey provides insight into how practice habits, education, lifestyle, positioning, gender, and playing background impact on the prevalence of PRMDs in flutists.

METHODS

Using online survey templates on SurveyMonkey (http://www.surveymonkey.com), survey questions covered a range of factors not previously addressed including flute education, history of playing injuries, preventative and management strategies, lifestyle factors, and teaching methods.

The Griffith University Human Research Ethics Committee granted ethical approval for the survey. The survey was promoted through online flute discussion groups, flute societies, university music faculties, flute-related websites, and flute teachers internationally. Data were first collected on the SurveyMonkey website, then entered into SPSS Version 18.0 for Mac (SPSS-IBM, Armonk, NY). Investigations of the relationship between pain and other variables such as sex and age were analyzed using the Pearson chi-square test (or Fisher's exact test, if the assumptions were not met). Otherwise, an in-depth statistical analysis was not attempted beyond the reporting of response frequencies.

RESULTS

Demographic Data

Participants

The survey drew responses from 421 respondents, and 408 of those were able to be included. The responses from 13 participants were excluded due to answering so few questions that there was no comparative data beyond basic demographic information. Flutists and teachers from all backgrounds and standards of playing participated, including school and university students, amateurs, semi-professionals, professionals, school teachers, private teachers, university teachers, as well as musicians representing various styles of music. The level of playing experience ranged from beginners to very advanced players.

The majority of respondents (81.9%) were female, consistent with earlier flute surveys.23-25 The majority of respondents resided in Australia (36%) and the U.S. (39.2%), as well as Africa, Asia/Pacific, Canada, Europe, and South America.

Most respondents (90.1%) considered flute to be their main instrument, and the remainder played other instruments as their major, such as piano, clarinet, oboe, and saxophone. Flute is an important doubling instrument for reed players in styles such as jazz and musical theatre, hence the inclusion of this question in the survey. Respondents performed with a wide range of ensembles, including orchestras, flute choirs, bands, chamber groups, church ensembles, and others.

Level and Type of Playing Activities

Professional performers made up 22.3% of the total group, and there were a similar number of semi-professional performers (22.5%) and adult amateur players (23.3%). Participants included flute educators such as private flute teachers (38.7%), multi-instrumental teachers (13.5%), school flute teachers (15.2%), and university flute professors or teachers (8.8%). There were also upper primary school and high school students (17.6%), as well as undergraduate students enrolled in music degrees (13.2%) and postgraduate music students (7.6%). As evidenced by the percentages for each group of players, there was cross-representation in these groups. It is common for many professional and semi-professional performers as well as university students to teach flute in addition to their other musical activities.

Only 10.8% of the total group had played the flute for <5 years, while 44.2% had played for 6 to 20 years and 44.9% for >20 years. Only one participant had played flute for less than a year, so while few beginner players responded to the survey, there was a good representation from a range of other players.

Respondents took part in a range of ensemble activities, such as playing in orchestras (58.8%), as pit musicians (31.5%), and in flute choirs (41.3%), concert or symphonic bands (41.5%), flute recitals (53.8%), chamber music (46.5%), gigs such as weddings, functions and restaurants (33.8%), and as church musicians (29.9%). This is evidence that respondents were active performers whether playing professionally or as amateurs or students.

Half of the total group of participants (50.4%) had attained a formal music qualification, whether a university degree or a performance diploma (associate, licentiate, or fellowship) from bodies such as the Australian Music...
Examinations Board or Trinity College London. Half of the total group of respondents could therefore be considered advanced players. Performance diplomas such as associate, licentiate, and fellowship qualifications include advanced repertoire pieces that are commonly programmed in recitals by professional flutists internationally.

Age and Sex

Each respondent was required to indicate which age range they belonged to, rather than their specific age, as well as their sex. A combination of information such as exact age, sex, country of residence, as well as performing and teaching status together could have easily identified certain high profile performers. Providing an age range rather than an exact age was one way of ethically ensuring that such performers and teachers felt secure in sharing their honest views. Age categories ranged from 11 to 71+, though there were no responses from anyone aged 11 and under. The age categories were designed to correspond with primary and middle school (11 years and under), high school (12–18 years), and university or college (19–25 years). The remaining categories were 26–30, continuing thereafter in 10-year increments from age 31–40 up to 71 and over.

Type of Flutes Played

The type of flutes played indicated that most respondents were experienced players, with 99% using a concert flute with a standard (straight) head joint. Curved head joints were mainly used by flutists who played alto flute (42.1%) or who played bass flute (91.9%). Only a small group of respondents played on fully silver plated flutes (6.3%), while 60.5% played on full sterling silver instruments. Full sterling silver flutes are rarely played by beginners, because of their weight and expensive cost, and they are usually played by intermediate, advanced, and professional players. A further 5.1% played other professional flutes such as those made of gold or aurumite (fused gold and silver).

Similarly B-foot were played more commonly (66.9%) than C-foot joints. The B-foot extends the flute’s range from middle C to the B immediately below, which necessitates having an additional key, and therefore it makes the flute slightly longer and heavier. Most respondents (81.1%) played on open hole flutes, which are commonly played by flutists at intermediate level and above. Most respondents played offset G mechanism concert flutes (67.2%), which many flutists consider more comfortable to play because it reduces the distance that the fourth finger of the left hand is required to reach the G-key.

PRMD Findings

Prevalence of Pain

The findings from the survey are consistent with earlier studies showing that PRMDs are common in the flute community. At the time of the survey, 26.7% of respondents were suffering from flute playing-related discomfort or pain. The sex of respondents was not a significant factor across the total sample of those who were currently suffering from discomfort or pain. It is important to note, however, that the majority of respondents (81.9%) were female, and so without equal representation of males and females in the sample, this statistic may not be meaningful. On the other hand, previous flute surveys included a similar percentage of female players (85–90%), and therefore the ratio of male to female players in this survey may be representative of the modern flute-playing community.

Of the total group of respondents, half (49.7%) had experienced flute playing-related discomfort or pain that was severe enough to distract them while performing at some time. Over a quarter of the total respondents (25.8%) reported that they had taken an extended period of time off playing because of flute playing-related discomfort or pain. Exactly half of the respondents (50.0%) stated that the level of discomfort, pain, or tension experienced tended to dictate the length of their practice sessions. Over a quarter of the total respondents (27.2%) stated that they had made specific changes to their flute playing position on the recommendation of a medical or health practitioner for the purpose of avoiding injuries. One in five of the respondents (19.8%) reported hypermobility of the fingers, wrists, or elbows, a known contributor to musculoskeletal conditions.

Contributing Factors to Pain

Factors reported by the flutists as contributing to the development of PRMDs were tiredness/fatigue (54.5%), not taking sufficient breaks (46.5%), stress/worry (41.5%), poor posture in non-playing activities including computing (39.7%), not stretching (36.0%), playing in cold rooms/spaces (30.2%), lack of exercise/fitness (28.3%), neck positioned to the side (26.2%), shoulders rolling forward (25.2%), and performance anxiety (24.6%). These factors are consistent with those stated in the performing arts medicine literature.

Playing Experience and the Relationship Between Formal Qualifications and Reports of Pain

The majority of respondents who were in pain at the time of completing the survey had been playing the flute for at least 11 years (82/103 or 79.6%), therefore very experienced players. The group of respondents not suffering from playing-related discomfort or pain at the time of the survey were more likely to have no formal music qualifications (30/103 or 29.1%) than the group that reported discomfort or pain. Those suffering from playing-related discomfort or pain at the time of the survey were significantly more likely to possess music performance degrees, such as bachelor or master of music or Doctor of Musical Arts degrees, or other diplomas such as associate, licentiate, or
fellowship diplomas. This result is consistent with the performing arts medicine literature, which reports that playing intensity, load, and overuse are important contributing factors to playing-related injury.

**Medical Conditions, Medication and Treatment**

Respondents reported a number of medical conditions that affected their flute playing at some time, including anxiety (16.0%), carpal tunnel syndrome (8.6%), depression (17.9%), hypermobility (9.3%), tendinitis (16.0%), scoliosis (8.3%), and temporomandibular joint syndrome (11.4%).

Almost half of the total group of respondents (48.6%) had never used any type of medication to alleviate flute playing-related pain, whereas 46.2% had used over-the-counter painkillers and one in five had used non-steroidal anti-inflammatory medications (19.5%). Other types of medications reported by participants included anti-anxiety and antidepressant medications, oral steroids, steroid injections, muscle relaxant drugs, anaesthetic injections, narcotic analgesics, beta-blockers, arthritis cream, as well as naturopathic or herbal treatments.

While 43.5% of respondents had not consulted any of the listed health and medical practitioners about playing-related discomfort or pain, the remaining flutists most commonly consulted with massage therapists (25.5%), physiotherapists (25.2%), and medical doctors including specialists (24.4%). Almost one fifth (18.0%) had consulted with a chiropractor. These results are consistent with those of Pain and Fortune who reported that flutists commonly consulted with health care professionals about playing-related physical problems.

**Prevention and Management**

The majority of respondents who reported being free of discomfort or pain at least some of the time (65.2%) attributed good or improved playing position as a contributor to staying free of discomfort or pain. They also attributed the following factors to staying free of discomfort or pain: rest (30.5%), freedom of movement while playing (39.6%), the ability to relax or deal with stress (38.7%), being fit or exercising (38.0%), feeling happy/satisfied/positive/confident (32.6%), good posture in non-flute playing activities (31.6%), and good teaching (30.7%).

Respondents reported a range of strategies that were most beneficial in preventing or managing playing-related discomfort or pain, including massage (45.9%), stretching (45.4%), general exercise and fitness (36.1%), Alexander technique (26.2%), use of a heat pack (26.2%), and various types of strength training (19.1%). Each of these strategies is also recommended in the performing arts medicine literature. Fortune also reported that flutists found that stretching, rest, Alexander technique, and massage to be the most effective strategies for treating flute PRMDs. Factors that worsened PRMDs were fatigue, insufficient breaks from playing, stress or worry, poor posture in non-playing activities such as computing, not stretching, playing in cold environments, lack of exercise, poor playing postures, and performance anxiety.

**Practice Habits**

More than half of the respondents (52.9%) reported they took breaks whenever they needed to. Only 11.1% stated that they rarely or never took breaks. Of the group who rarely or never took breaks, 40.5% were under age 25, 19% were professional players, 19% were school students, and 28.6% were adult amateur players. Of the group of respondents who rarely or never took breaks, 40/42 (95.3%) played flute for at least 6 years, and five of those (12%) played typically for at least 5 hours per day.

**Lifestyle Factors**

Most respondents were nonsmokers (92.2%), with only 3.4% describing themselves as regular or heavy smokers. The majority of respondents (82.7%) rarely or never drank alcohol or were social/occasional drinkers.

Whether a flutist was involved in weekly aerobic activities such as walking, running, cycling, and swimming was not a significant factor in current discomfort or pain. Of those who were in pain, only 20/103 or 19.4% were not involved in aerobic activity at least once or twice per week. This was a similar result to the group who were not currently suffering from discomfort or pain (49/280, 17.5%). Those not suffering from discomfort or pain were only slightly more likely to do strength or resistance training at least once per week (141/267, 53.1%) than those in discomfort or pain (45/96, 47.0%). Whether a flutist undertook strength or resistance training was not a significant factor in terms of whether they were in pain or not. Resistance training includes a range of variables, such as the number of repetitions and the level of resistance.

This statistic relied upon self-reporting of activity, so to gain a better understanding of the benefits of strength or resistance training for flutists, more controlled scientific testing would be necessary. Roach et al. suggested that having greater upper body strength may be useful for female violin players at a higher risk of musculoskeletal pain in areas such as the upper back and shoulder. Similar to the violin, the flute is asymmetrically played, with the hands held at a distance from the body. Future studies could investigate the relationship between upper body strength in flute players and playing-related pain.

**Emphasis on Posture by Teachers**

Respondents expressed concern about the lack of emphasis that their teachers placed on posture during their studies. Flutists were more likely to have received "much emphasis" on posture by either their first private flute teachers (30.9%) or university flute professors (49.3%) than school band program teachers (18.6%). This is concerning...
as band teachers work with school-age children, including beginners, and it is during the early years of study where playing habits, whether good or bad, are formed. These statistics are supported by respondent comments, such as:

"My marching band teacher didn't teach 'good' posture or playing position. It was emphasized that the flute should be parallel to the ground to create the right militaristic 'look' for band competitions."

"Information imparted was lacking any underlying science or integrity."

"Posture and playing position were not addressed in any way until I developed tendinitis during my first year of university instruction."

It is common in countries such as the United States and Australia for school-age flute students to commence learning their instrument within primary school or high school band programs, whereby a band director or multi-instrumental teacher provides instruction on the instrument, based on the material in a band method book. Instruction often takes place entirely within small and large group settings, rather than one-to-one lessons with specialist teachers. The teachers training the band may or may not have extensive training in playing flute and may have to teach a full range of band instruments. This type of teaching is challenging, due to the broad range of knowledge required about wind, brass, and percussion instruments. The responses from participants in this study highlight the need for band teachers to place greater emphasis on posture in their lessons and rehearsals, one way of helping young flute players to develop good playing habits.

Playing Position

Almost half of the respondents (43.1%) reported that they had a tendency toward gripping the flute too tightly, either in normal situations or after becoming fatigued. Playing with excessive physical tension is discouraged in both the flute and performing arts medicine literature. Other tendencies toward poor playing positions included slumping in a chair (26.5%), standing with one hip pushed to the side (25.4%), raising the shoulders (23.5%), shoulders rolled forward or inward (22.5%), the neck positioned to the side (23.0%), or pressing the flute too hard against the chin (22.0%).

Teachers' Definitions of Good Posture

Flute teachers surveyed typically used a number of general terms to describe good posture, such as "natural," "relaxed" or "relaxation," "free of tension," or "without tension," "straight" back/trunk/spine, and "balance" or "balancing" (i.e., the flute or head). One teacher described good posture as: "Relaxed and comfortable with as natural a body position as is possible with the flute." Other respondents gave similar definitions. Llober and Odom present an alternate opinion, that a comfortable position is not necessarily the most appropriate one, stressing the importance of the need for efficiency of joint movement, balance, symmetry, as well as even distribution of weight. The flute playing position presents challenges in this respect, as the left arm must reach across to the right side of the body to touch the keys, so symmetry is not possible using a standard flute. Vertically played flutes which allow players to work in a symmetrical position are available on the market, although few professional flutists perform on these instruments.

Band Seating

Band seating was an area in which flutists expressed concern, particularly in relation to the lack of emphasis on posture and positioning in teaching and band directing. The vast majority of teachers (200/210 or 95.2%) had observed flute players sitting too close together, which resulted in poor playing postures. Several teachers commented:

"Band directors do not understand that flutists need more room between chairs. I have to explain this often. I urge them to have no more than two students sharing a stand, and preferably to give each student her/his own stand and music."

"Sitting postures in bands and orchestras is mostly very poor, even in professional ensembles. There is rarely enough space for chairs to be pushed back allowing players to sit right at the front. Also, lateral space is often not enough to allow for the correct rotation of the body to the right."

"I am forever complaining in community bands about the seating being too close together. Nothing is ever done about it and I think everyone regards me as a crank."

Further Training

Support for further training in injury prevention and management was strong, with most respondents (78.3%) agreeing that knowledge of basic anatomy is useful in the prevention and management of flute playing injuries. An overwhelming majority (91%) believed that all flute teachers should receive training in injury prevention and management. Similarly, most respondents (89.9%) agreed that all flute players should receive training in injury prevention and management. Qualitative analysis of the comments provided in this section of the survey confirmed these findings and showed, for example, that some flutists learn about injury prevention and management strategies from medical and health practitioners, or advanced teachers, instead of during their initial flute education and training. Many respondents (70.8%) felt that during their flute studies, they did not receive sufficient information or advice on injury prevention and management, consistent with Fain's findings. Comments indicated that this was of grave concern to some members of the flute community and needs to be addressed.

DISCUSSION

The findings of this study are consistent with those of several earlier studies of flute populations which found
that common sites for flutists' pain are the neck, middle and upper back, shoulders, arms, fingers, and hands. As in other studies of flute players, the majority of respondents were female. Today's flute community is a very different one to the group of players that the flute was initially designed for. The modern flute was invented in the mid-1800s by the German flutist and flute-maker Theobald Boehm, at a time when it was not considered to be an appropriate instrument for women to play. Many traditional pedagogical materials still used by flute educators were written by male players and intended for an exclusively male market. It is interesting that these materials do not focus much on the physical problems associated with flute playing. Despite numerous studies indicating that playing-related pain is common among flute players, the contemporary flute pedagogical literature includes only some references to the physical problems associated with flute playing.

Despite the lack of information about injury prevention in the flute pedagogy literature, survey respondents showed a strong interest in further information about injury prevention and management strategies. This finding indicates that although there is much general information available in the performing arts medicine literature about what causes injuries and how to prevent them from occurring, this knowledge is not necessarily being passed onto music educators in their training. The results from this survey indicate that there is a willingness to receive the training necessary to prevent injuries.

Flutists were concerned about the lack of emphasis on posture and positioning in teaching, particularly by band teachers. Flute teachers showed particular concern about band seating, reporting that many conductors and band directors apparently ignore poor postural tendencies in the flute section. Teachers were also divided on what defines good posture and playing position.

Various studies have shown a concerning rate of PRMDs in the flute community, yet there are a number of simple strategies drawn from the performing arts medicine literature that flutists and their teachers could put in place to address these problems, such as taking more frequent breaks, optimizing the playing position by using more efficient technique, as well as improving ensemble seating and posture. Ensuring that there is sufficient space between the chairs in an ensemble is an easy change that can be made by teachers and band directors, so that flutists can play in a position that is optimal for their physical well-being. In addition to a band teacher's usual responsibilities, it seems reasonable to suggest that monitoring the posture of the players in their ensembles and addressing any obvious weaknesses are tasks that could easily be included in their normal rehearsal schedule. Band directors and teachers need to be aware of the risk factors associated with playing in poor positions and create ergonomically sound playing conditions, which ensure that flute players are not subject to unnecessary loading during rehearsals.

Similarly, taking more frequent rest breaks is a strategy that is relatively simple to implement, especially in an individual's practice routine. Some respondents commented that this approach has assisted them in preventing pain. One respondent stated, "I find that taking breaks whenever I need to helps with concentration and leads to less pain." Another reported, "I need to play for 3 hours as a time. I've learned that frequent breaks not only help my health but also help me to focus better. I now learn more repertoire in much less practice time as a result of my frequent breaks."

**Limitations of the Study**

The recruitment of volunteers for this study was primarily undertaken online, through email lists, and flute website notifications. While the survey link was emailed to many institutions and organizations, there could be many reasons why potential responders could not participate, including that the emails may have been caught in spam filters. The online format of the survey may have discouraged less computer-literate flutists. Another disadvantage to using an online survey program is that computer or internet connection failures could result in a participant not completing the survey.

This study involved self-reporting of contributing factors and management by participants, and therefore the interpretation of the data is limited without being able to compare the same responses with a control group. This was a descriptive study and so a control group was not appropriate. However, respondent bias was possible due to self-selection by individuals interested in or reporting pain rather than individuals without problems.

The survey was written in the English language, and therefore, it may not have been accessible to non-English speakers. Future surveys of flute playing populations who are native speakers of other languages are recommended.

**CONCLUSIONS**

Further research is needed to establish possible links between sex, instrument types, and ergonomic set-up. Further investigation is recommended in order to ascertain whether certain types of physical training, educational approaches, and practice methods may be more suitable than current methods to better prepare flutists for the physical requirements of flute playing. Studies investigating the relationship between upper body strength and flute playing-related pain are recommended. Additionally, as little is known about the relationship between early flute education, playing position, ergonomic set-up, and prevalence of injury, a longitudinal study focusing on these areas is recommended.

Flute teachers and band directors are advised to adopt simple injury prevention strategies into their lessons and rehearsals, such as setting up the flute section in ergonomically sound seating positions, with sufficient lateral room between the chairs. Similarly, while the flute playing position is somewhat awkward and asymmetrical, it is possible to avoid unnecessary movements such as raising the shoul-
ders, positioning the head to the side, or bending the wrists. Other simple prevention strategies include taking sufficient rest breaks, as well as reassessing and optimizing technique.

The findings of this international survey have helped to characterize the playing-related problems of flutists more clearly than previous surveys, providing a greater insight into the playing and teaching lives of the broader flute community. The survey has also given a deeper understanding of the ways that flutists approach preventing and managing PRMDs.

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REFERENCES

1. Pain S. An application of the principles of anatomy, physiology, and neurology to the balancing and playing of the flute [dissertation]. Norman, OK: University of Oklahoma; 2009.


