

**Hearing loss, earplug use and attitudes to hearing protection
amongst non-orchestral ensemble musicians**

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Abstract

Music-induced hearing loss and its prevention amongst professional musicians has been researched extensively, but there has been less attention on musicians playing in non-orchestral ensembles. This study's aim was to survey musicians from brass, pipe, concert or wind, and jazz big bands regarding their perceived risk of music-induced hearing damage, rates of self-reported hearing loss, and use of earplugs and acoustic screens while playing in ensemble. A questionnaire was administered to 257 Australian band musicians and the data were compared to responses obtained previously from 367 orchestral musicians. The results showed that band and orchestral musicians had similar rates of self-reported hearing loss, but band musicians were significantly less likely to perceive risk or use protective equipment when compared to orchestral musicians. Amongst the band types, pipe band musicians had the highest incidence of hearing loss, greatest awareness of risk, and highest rates of earplug and screen use. In contrast, brass band musicians demonstrated poor risk awareness and a reluctance to use protective equipment. These results suggest that a band-specific approach to hearing conservation is needed to develop appropriate and effective strategies that account for the widely differing cultures and work practices of the various non-orchestral ensembles.

INTRODUCTION

Hearing loss and its prevention amongst musicians has been the subject of intensive research over the last few decades, with reports on rates of hearing loss, exposure levels and exposure management published across the world [1-3]. While the bulk of this research has been directed towards the professional orchestral community, musicians who play in amplified ensembles and bands have also been scrutinized as to their risks, hearing health and conservation practices [4, 5]. In response to this research, evidence is now emerging of effective techniques and technologies aimed at protecting the hearing of musicians without negatively impacting on their abilities to make music, particularly in ensemble situations [6, 7].

A critical aspect of this field of study is the attitudes and behaviors of the musicians. Simply put, research and development will count for little without the willing and active participation of the artists themselves, and an understanding of this will enable better targeted and more effective strategies to be developed. Again, the orchestral community is well represented in this aspect of the research, with several European studies identifying awareness and understanding of the issue coupled with poor uptake of specifically designed hearing protectors [8, 9]. These findings have led to more sophisticated approaches to exposure management [7, 10] and improvements in technology for this group of musicians, including improved absorptive personal and diffusive sectional acoustic screens [6, 11] and level-dependent musicians' earplugs [12].

In contrast to these developments in knowledge and understanding for the orchestral genre, less is known about the approaches and attitudes to hearing conservation in

ensembles such as brass bands, pipe bands, concert or wind bands, and jazz big bands.

Although several recent studies have examined hearing conservation practices in student bands [13-15], adult band musicians have received little attention despite the likelihood that they may experience similar or even greater sound exposure levels than their orchestral colleagues.

The aim of the current study was to gauge whether musicians from brass, pipe, concert or wind, and jazz big bands (collectively referred to as “band musicians”) perceived themselves to be at risk of music-induced hearing damage; believed they have a hearing loss; and to ascertain whether they routinely practiced conservation behaviors such as wearing musicians’ earplugs or using acoustic screens while playing in ensemble. A secondary aim was to determine how these band musicians differed from professional orchestral musicians in their perception of risk, rates of self-reported hearing loss, and their use of protective equipment.

METHODS

In order to provide comparative data, a questionnaire, which had previously been distributed to musicians in eight of Australia’s professional orchestras [16], was distributed to a sample of band musicians across Australia.

Two hundred and fifty-seven musicians from pipe, brass, concert, wind, jazz and big bands responded to the survey. A further four respondents who were members of professional orchestras were excluded (as this was the subject of the previous investigation) and a single

chorister was also excluded. Table 1 shows the number of respondents, the mean age, age range, and gender distribution for each band type.

Responses from the band musicians were compared to survey responses from 367 musicians playing in professional orchestras. The orchestral musicians have been described previously [16], but for comparative purposes, their demographic details are also shown in Table 1. The band and orchestral musicians had similar levels of musical experience: 54% of band musicians and 55% of orchestral musicians had more than 20 years' experience. In terms of age, the orchestral musicians were slightly younger on average, and there were more females in the orchestral sample (48%) compared to the band sample (35%).

	Band Type				Total	Orchestra [16]
	Pipe	Brass	Wind/ Concert	Jazz/ Big		
n	56	116	72	13	257	367
Males	45	73	38	10	166	178
Age range	17-78	15-78	18-80	18-68	15-80	22-70
Mean age	45.1	45.6	41.4	46.7	44.5	42.7

Table 1. Age and gender characteristics of band and orchestral musicians

The questionnaire was produced in two formats: a web-based online survey and a one-page survey document. The document and the link to the online survey were sent to band

musicians residing in Australia, and participants were offered the choice of completing the survey online or they could opt to print the survey document, fill it in and return via mail, fax or email. Band members were reached via emails to band leaders and administrators identified from the authors' personal contacts, web searches and social media. Of the 257 surveys in the final sample, 240 were completed online and 17 were completed in writing.

The questionnaire (shown in Appendix 1) asked about self-perceived hearing health; risk of hearing damage while playing; the use of acoustic screens and earplugs; as well as attitudes to, and difficulties typically associated with, earplug use while playing music, such as difficulty hearing themselves, hearing other musicians, intonation and balance issues.

Data Analysis

Band members were allocated to one of three groups according to their main ensemble.

Because the number of jazz/big band musicians was so small ($n=13$), these musicians were combined with wind/concert band musicians to form a single group: Wind/Concert/Jazz.

The other two groups were Pipe and Brass. Pearson chi-square and two-proportion z-tests were used to test the significance of the observed differences between the three band groups and between the combined band musicians versus the orchestral musicians.

To determine which factors were most influential for earplug use, we combined data from the band and orchestral musicians and performed a logistic regression with earplug usage as the dependent variable. Age, gender, self-perceived hearing loss, instrument type, ensemble type and perceived risk during ensemble playing were the predictor factors.

RESULTS

Reported Hearing Problems

Self-reported hearing loss (in response to the question: Do you think you have a hearing loss?), was most common amongst pipe band musicians (57%). For brass band musicians, 45% reported a loss, and 43% of concert/wind/jazz band players, which was similar to the rate of self-reported loss amongst orchestral musicians, 43% of whom reported a loss. See Figure 1. A Pearson chi-square test showed no difference in incidence of self-reported HL between orchestral players (43%) and all band musicians combined (47%; $\chi^2 = 4.45$, $p = .22$), but pipe band musicians' incidence of self-reported hearing loss (57%) was significantly higher than the orchestral players (43%; $z = 1.97$, $p < .05$).

The survey also asked about tinnitus (i.e., the presence of temporary or permanent ringing or buzzing in the ears - a pathology closely associated with noise-induced hearing loss [17]): Do you have a ringing or buzzing in one or both ears? Figure 1 shows the incidence of reported tinnitus at least sometimes across the band types. Fifteen percent of band players reported tinnitus all the time and 29% sometimes (compared to 9% and 42% of orchestral players respectively). Tinnitus was closely associated with hearing loss. Eighty-four percent of those with tinnitus all the time self-reported a hearing loss, whereas only 30% of those without tinnitus reported a hearing loss. A Pearson chi-square analysis showed no significant difference in incidence of tinnitus (at least sometimes) between the band types ($\chi^2 = 11.2$, $p = .08$), or between orchestral players and all band musicians combined ($\chi^2 = 3.2$, $p = .07$), with a similar proportion of orchestral players (51%) and band musicians (45%) reporting tinnitus at least sometimes.

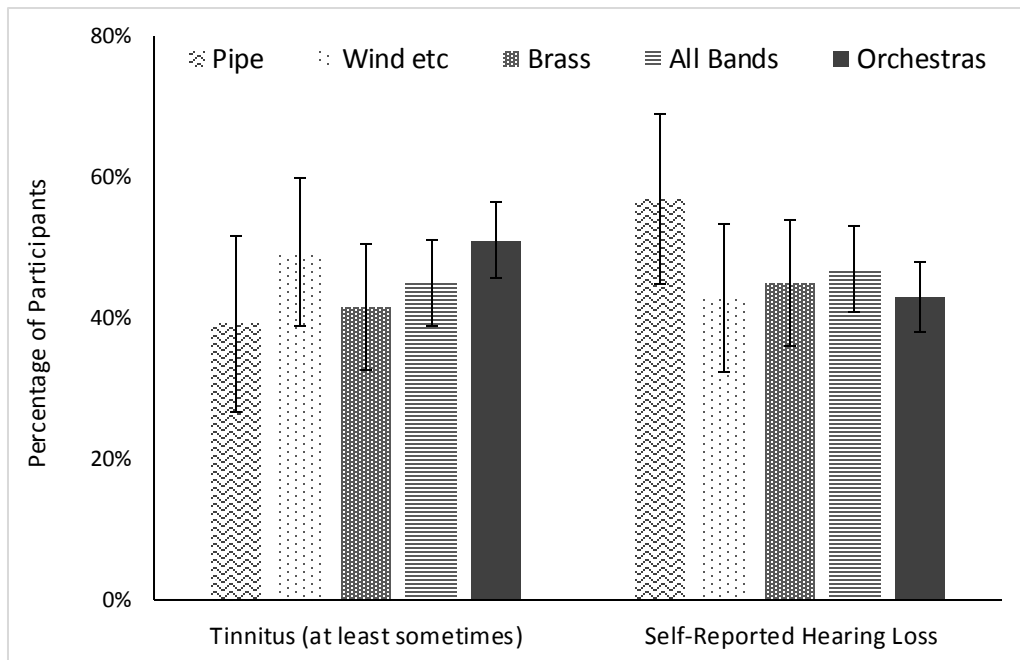


Figure 1. Incidence of tinnitus and self-reported hearing loss in bands and orchestras. Error bars = 95% confidence intervals.

Perception of risk

The proportion of band musicians who reported feeling that they were exposed to potentially damaging sound levels during ensemble playing varied significantly according to band type, with pipe band musicians perceiving more risk than musicians from other band types: 73% pipe, 64% concert/wind/jazz, 46% brass ($\chi^2 = 18.1$, $p < .01$). Fewer band musicians believed they were at risk of harmful noise exposure during solitary practice, with pipe band musicians again perceiving greater risk than the other band types: 52% pipe, 14% concert/wind/jazz, 5% brass. A Pearson chi-square analysis showed a significant difference in perceived risk perception during ensemble playing with orchestral players more likely than band musicians to report a risk when playing as a group (80% vs 58%, $\chi^2 = 43.9$, $p < .001$). There was no difference in perceived risk during solo practice for orchestral players compared to all band musicians combined (20% vs 18%, $\chi^2 = 2.3$, $p = .53$).

Earplug use

Amongst band musicians 24% of respondents reported at least some earplug use. Usage varied according to band type with pipe band musicians significantly more likely to use earplugs than members of other band types: 54% pipe, 28% concert/wind/jazz, 7% brass ($\chi^2 = 63.6$, $p < .001$). The most popular style were the custom-molded musicians' earplugs, with 62% of earplug wearers using these at least some of the time (51% used them exclusively), 30% using one-size-fits-all musicians' filtered earplugs (20% exclusively) and 25% using disposable foam earplugs (18% exclusively). Although overall earplug usage was significantly lower in bands than in professional orchestras (24% vs 64%, $\chi^2 = 99.7$, $p < .001$) the pattern of usage across earplug types was similar as shown in Table 2. The reluctance of brass

players to use earplugs is consistent across both bands and professional orchestras, with brass players reporting the lowest earplug usage rates in both groups.

	Professional orchestras	Bands
	%	%
Use of Protective Devices		
Earplugs	64	24
Screens	62	16
Earplug types used		
Custom	62	60
Filtered Generic	39	30
Foam	39	25
Motivation of earplug users		
To protect hearing	90	90
Discomfort	26	43
Advice from audiologist etc	18	44
Noticed decline in hearing	15	20
To hear more clearly	3	26
Directed by employer	5	n/a
Issues with earplug use		
Hearing others	79	52
Hearing self	72	37
Intonation	57	40
Balance	50	41
Comfort	24	25
Insertion/removal	17	9

Table 2 Comparative data on earplug usage for bands (combined results of current study) and orchestral musicians (results from previous study [16]).

The main motivation for earplug use amongst band musicians who wore them was to 'protect hearing' (90%). Just under half wore earplugs in response to discomfort or pain (44%), and a similar number wore them in response to a directive from an audiologist/occupational health and safety adviser/band management/other. As shown in Table 2, this pattern of results bore some similarities to the pattern found for orchestral players: Both groups' main motivation was to protect hearing, and few were motivated by a decline in hearing. Interestingly, however, 44% of band musicians were acting on advice of an audiologist or other professional but only 18% of orchestral players nominated this reason ($z = 4.4, p < .001$). More band musicians suggested that clarity was a motivating factor (26%) compared to orchestral musicians (3%; $z = 5.8, p < .001$), and responding to discomfort or pain was also a bigger factor for band musicians (43%) than for orchestral musicians (26%; $z = 2.5, p < .05$).

When asked to describe playing when wearing earplugs, there were differences according to band type: 61% of pipe musicians reported only mild or no problems compared to 15% of brass musicians ($z = 6.2, p < .001$), half of whom found playing with earplugs difficult or impossible. When asked to nominate the specific problems they had with wearing earplugs, band musicians reported that hearing others (52%), balancing with other players (41%), intonation (40%), and hearing themselves (37%) were the most common problems. Less important were practical issues relating to insertion, removal and comfort. These responses were quite similar to those of orchestral musicians (see Table 2), although orchestral musicians were more likely to report multiple issues with earplugs than band musicians –

84% of orchestral musicians reported more than one issue or problem with wearing earplugs, compared with 56% of band musicians.

Acoustic Screens

Use of acoustic screens was uncommon amongst band musicians, with only 16% of respondents reporting use of them. Again usage was highest amongst pipe band members (32%), followed by concert/wind/jazz (17%) and brass band members (7.5%). Screen usage was significantly lower when compared to orchestral musicians, 62% of whom used screens at least some of the time ($z = 11.2, p < .001$).

Factors affecting uptake of earplugs

Logistic regression was used to determine the factors which influenced the uptake of earplugs. The data for the band and orchestral musicians were combined into a single dataset. The dependent variable was earplug usage at least sometimes. The predictor factors were age, gender, self-perceived hearing loss, perceived risk during ensemble playing, instrument type (brass or non-brass) and ensemble type (orchestra or band).

Predictor Factor	Odds Ratio	95% Confidence Interval	p
Gender	1.28	0.84-1.95	.25
Age	0.99	0.84-1.16	.89
Self-Reported HL	1.34	0.88-2.05	.17
Risk Ensemble *	5.09	3.13-8.29	.000
Instrument Type *	3.98	2.51-6.31	.000
Ensemble Type *	4.14	2.72-6.29	.000

Table 3 Results of logistic regression analysis. Significant results are marked with an asterisk (*)

As shown in Table 3, perceived risk during ensemble playing was a significant predictor – the odds of wearing earplugs for musicians who perceived they were at risk during ensemble playing was around 5 times higher than for those who did not perceive the risk. Similarly, the odds of orchestral players using earplugs was around 4 times higher than for band musicians, and the odds of non-brass players wearing earplugs was also around 4 times higher than for brass players.

DISCUSSION

This study aimed to determine rates of self-reported hearing loss, hearing conservation practices and motivating factors amongst musicians in brass bands, pipe bands, concert or wind bands and jazz big bands, and to compare this with similar reports in professional orchestras.

Results showed self-perceived hearing loss is highly prevalent in this population, yet there is little acknowledgement of risk and use of protective equipment is poor compared to orchestral musicians, and particularly in brass bands. With 47% of all respondents reporting a hearing loss, and only 24% using protective equipment, it is clear that hearing conservation among these musicians is an issue requiring further attention, particularly amongst players in pipe bands, who were most likely to report a hearing loss.

Hearing conservation practices varied widely according to band type, with particularly notable differences between pipe and brass musicians. Although pipe band musicians had the highest incidence of hearing loss, they also demonstrated by far the greatest awareness of risk, both in ensemble and individual practice. Commensurate with this, pipe band musicians reported the highest rates of earplug and acoustic screen use and the majority reported mild or no problems with using earplugs. Players in brass bands on the other hand, despite also exhibiting high rates of hearing loss, were least likely to perceive any risk either in ensemble or in individual practice. Earplug and screen usage rates among this group were also extremely low (7% and 7.5% respectively) and almost half reported significant problems with using earplugs.

The contrasting findings for pipe and brass band musicians suggest that pipe and brass musicians differ in their approach to hearing conservation. For pipe musicians, it seems that their high incidence of hearing loss, which has previously been noted elsewhere [18], serves to underline the personal risk of the occupation, resulting in greater awareness and acceptance of the risk and a greater willingness to adopt hearing conservation behaviors such as earplugs and screens.

Most pipe musicians recognized not only the risks involved in ensemble playing, but also the risk from their own instrument - more than any other musicians (both band and orchestral). This probably arises from the widely acknowledged very high sound levels emitted by the bagpipe. Bagpipes are invariably described as 'loud' and were historically used outdoors for pastoral, social, and later military purposes [19]. Audible over vast distances, the bagpipe

emits sound levels of 105 dB at the piper's ear [20], so perhaps it is not surprising that the inherent risk associated with bagpipes is recognized and acted upon by its proponents.

In contrast to the pipe musicians, brass musicians showed a lack of risk awareness and nearly negligible hearing conservation practices. It is often reported that brass players experience difficulties with earplugs related to occlusion, or the predominance of the musicians' own buzzing and articulation noises produced while playing due to the covering of the ear canal [21, 22]. Indeed both the orchestral and band-based brass players in this study reported difficulty with earplugs and poor uptake, providing yet further evidence of the problems faced by brass players. Brass musicians' difficulties seem relatively consistent across bands and orchestras, and therefore it is likely that successful earplug use and fitting techniques will be applicable across all ensemble types. This includes the making of deeply fitting custom-moulded earplugs as discussed and demonstrated by Killion and Chasin [22, 23], which significantly reduces the impact of this problem for brass players. Like their orchestral counterparts, brass musicians playing in bands will need to combine well-fitting earplugs with dedicated practice to develop the skill of playing with earplugs [21].

A further factor influencing the low uptake of earplugs amongst brass bands may be poor levels of education or training and an entrenched cultural resistance to hearing conservation. The more widespread hearing conservation practices within pipe bands and orchestras suggest there is a greater degree of cultural acceptance in these ensembles. In the case of orchestras at least, this cultural acceptance is likely to have been supported and sustained by the establishment of workplace hearing conservation strategies, and more

frequent or effective education and training activities for these professional musicians and their support personnel [e.g., 10].

Although education, cultural issues, and difficulties with using earplugs all undoubtedly contribute to the low rates of protective behaviors observed amongst brass musicians, the logistic regression analysis confirmed that risk awareness is the main factor influencing use of earplugs for both bands and orchestras. Making the risk 'real' and 'personal' for brass players and others yet to undertake protective hearing behaviors will be an essential first step before they can be expected to approach the levels of risk awareness necessary to consider taking protective action.

A particularly interesting difference between band and orchestral musicians was the finding that band musicians were more likely than their orchestral counterparts to act on the advice of an audiologist or other professional when deciding to wear earplugs. This willingness to take advice and direction from others suggests that band members may be open to learning lessons from professional orchestral musicians. By drawing on the successes experienced in the professional sphere, orchestral musicians could pass on practical advice regarding when and how to protect hearing, and more band musicians could be helped to recognize the risk associated with their music making.

Of course, any attempt to improve the uptake of hearing conservation practices in bands should take into account that orchestras and bands – while all engaged in making music - have very different work patterns, exposure patterns, and widely differing cultures. These differences suggest that a variety of approaches to hearing conservation will be required,

and that while band musicians may be receptive to advice from others, not all hearing conservation strategies used in professional orchestras will be appropriate or effective in bands of various types.

Consideration should also be given to the fact that the results presented here were the result of voluntary responses to an online survey invitation, and those with a particular attitude to earplug usage (positive or negative) may have been more likely to respond to the survey than those less engaged with the topic. As a result, the findings may not be representative of the views of band musicians in general.

Conclusions

The diverse results for the various ensemble types reported in this study strongly suggest that a broad-based approach to hearing conservation in non-orchestral bands is unlikely to be effective. Each band type requires further investigation and understanding to facilitate effective strategy development. In particular, an understanding of the typical exposure levels, rates of hearing pathology and the cultural differences between the groups is needed. This will enable targeted, band-specific interventions that acknowledge and - where necessary - challenge the entrenched views of the musicians in each group. Further to this, the education of band musicians and hearing care providers regarding available earplug technology and effective manufacturing techniques, as well as continued development of musicians' earplugs is vital to overcome ongoing issues with the use of these devices. In time, there is no reason why practical and artistically sensitive noise reduction strategies such as those now emerging in some professional orchestras should not also be available for non-orchestral musicians whether they play in pipe, jazz, concert, wind, or brass bands.

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