
Article:
Greasley, AE orcid.org/0000-0001-6262-2655, Fulford, RJ, Pickard, M et al. (1 more author) (2020) Help Musicians UK hearing survey: Musicians' hearing and hearing protection. Psychology of Music, 48 (4). pp. 529-546. ISSN 0305-7356

https://doi.org/10.1177/0305735618812238

Help Musicians UK Hearing Survey: Musicians' hearing and hearing protection

The prevalence of hearing loss in Western industrialised societies is steadily increasing, largely owing to ageing populations (AoHL, 2011, WHO, 2018). In addition, noise-induced hearing loss (NIHL) in younger populations is rising due to music listening on smartphones, iPods and other personal devices through headphones (Jiang, Zhao, Guderley & Manchaiah, 2016). NIHL caused by exposure to loud music over time has been termed 'Music-induced hearing loss'[1] (MIHL) and has received increased media attention. Famous musicians including Phil Collins, Ozzy Osbourne, and Brian Johnson have attributed hearing issues to their work, and a growing body of research has explored hearing problems among professional musicians. In 2014, Help Musicians UK[2] (HMUK) conducted a national survey as part of their Health and Well-being Strategy[3] which explored factors affecting musicians' health and well-being, obtaining data from 552 musicians. Results highlighted a variety of issues including anti-social working hours, work instability, illness and physical problems, and mental health issues. However, an unanticipated finding was that 47% of the sample reported experiencing hearing problems (HMUK, 2014). A more recent study by Gembris, Heye and Seifert (2018) exploring health problems of orchestral musicians found that 34% (of N=2,536) reported some type of hearing disorder (e.g. hearing loss, tinnitus), and worryingly, around 20% of musicians under 30 years old had already been diagnosed with a hearing disorder. It is estimated that around 15% of the world's population (approximately 1

[1] The term 'music-induced hearing loss' occurs in the literature to indicate that the cause of sound is wanted as opposed to unwanted. Using standard Pure Tone Audiometry alone, it remains difficult to distinguish hearing loss due to loud music from that caused by any other loud sound (cf Chasin, 2018). In this paper therefore, the term NIHL will encompass any loss caused by, or attributed to, musical sounds or sounds in musical contexts.
[2] Help Musicians UK (est. 1921) is a leading charity for professional musicians of all genres, providing advice, guidance and financial and emotional support throughout their careers
[3] HMUK HWB strategy: "to be at the centre of shaping a national network of services that support the health and wellbeing of musicians, and the obvious place to come to when musicians need help or when they want to access that network"

billion people) have some degree of hearing loss (Lancet, 2016), and while the higher prevalence of hearing problems reported among musicians may be due to reports of tinnitus as well as hearing loss, the incidence of hearing problems appear to be higher for musicians and further exploration is therefore needed.

The duration of exposure to music for musicians varies on a daily basis and according to physical and environmental factors including spatial location relative to the ensemble, repertoire, ensemble size, and room acoustics (Behar, Wong & Kunov, 2006). Therefore causal links between sound measurement data and evidence of NIHL from pure tone audiometry (PTA) from the clinic cannot easily be made (Behar et al. 2006; Zhao, Manchaiah, French & Price, 2010). Despite these challenges, speculation about the existence of MIHL, as distinct from NIHL, has fueled attempts to characterise the audiometric 'notch' (localised increases in the threshold of hearing observed on a standard audiogram) due to loud music. Phillips, Henrich, and Mace (2010) found that NIHL notches were present in 44% of a sample of classical music students (n=329) and occurred most frequently at 6kHz, contrasting with NIHL observed in industrial workers where notches are typically found at 4kHz. They also explored evidence that bilateral notches (affecting both ears), being 'steady' in prevalence in comparison to unilateral notches (affecting one ear), may not increase as a function of noise exposure, but rather may have a genetic basis. Their findings support evidence that lateral variances in thresholds may be due to environmental factors, such as the asymmetrical playing positions of some musical instruments like the violin (Emmerich, Rudel, & Richter, 2008; Royster, Royster, & Killion, 1991). However, another audiometric sample of 162 orchestral music students revealed a notch in the left ear at 6kHz regardless of instrument played suggesting that environmental factors may not explain all lateral threshold variance (Backus & Williamon 2009). This is supported by self-report data revealing no

significant differences in the likelihood of diagnosed hearing disorders according to instrument group or ensemble size (Gembris et al., 2018).

Another line of enquiry has been to compare prevalence in musicians with non-musical populations. Schmidt, Verschuure and Brocaar (1994) found notches consistent with general NIHL in student musicians but found similar hearing loss patterns in a control group of medical students, drawing no firm conclusions. The largest controlled comparison study of NIHL prevalence was conducted by Schink, Kreutz, Busch, Pigeot and Ahrens (2014) in Germany using social insurance data for over 3 million people over four years. Musicians were found to have a 3.51-fold higher incidence rate of NIHL and a 1.45 higher incidence rate of tinnitus than in the general population (Schink et al., 2014, p. 3), although these data do not account for the diversity of instrument types, performing contexts and sound exposure durations among professional musicians.

Acoustical research has verified that music can exceed safe levels in both classical and popular music contexts (Opperman, Reifman, Schlauch & Levine, 2006; Potier et al., 2009; Yassi, Pollock, Tran & Cheang, 1993). Using microphones mounted on the ears of orchestral musicians measuring binaural sound exposure, Schmidt et al. (2011) found that the majority of unamplified, classical musicians were exposed to more than 8 hours of sound at 85dB and highlighted instrument-specific differences; brass players averaged between 86-98dB, string players up to 98dB in the left ear, and percussionists experienced peaks of greater than 115dB. However, a review of studies published between 1992 and 2005 concluded that the level of sound to which orchestral musicians are exposed in their work is of ‘no significant hazard’ to the musician (see Table 2, Behar et al., 2006, p. 166), though research shows that the risk for amplified music is greater. Using dosimeters, Yassi et al. (1993) found that sound levels at a rock concert were more than double the safe daily exposure, with peak levels reaching 139.5dB, a level risking irreparable damage to the ear.

In sum, the literature reveals a mixed picture. If MIHL exists as distinct from NIHL, its biological bases are, as yet, unsubstantiated. The number of uncontrollable variables in acoustical studies and the variety of measurements adopted present methodological challenges and often preclude the drawing of firm conclusions. The detection of MIHL may require more sensitive measures than standard PTA (Zhao et al., 2010, p. 62) such as those used in the identification of cochlear synaptopathy (Liberman et al., 2016). Nonetheless, there remains compelling evidence that working musicians do indeed have a higher risk of NIHL than the general population due to exposure over time (Zhao et al., 2010).

Uptake of hearing protection

Evidence of exposure to high sound levels and subsequent NIHL for musicians provides a rationale for examining the provision and uptake of hearing protection by musicians which evidence suggests is low (Niquette, 2006; Patel, 2008). A survey of professional orchestral musicians in Denmark showed that, with the exception of those already experiencing a hearing disorder, most musicians were reluctant to wear hearing protection, with only 15% wearing it regularly (Laitinen & Poulsen, 2008). The attenuation of musical sound levels feels counterintuitive for performers who require the ability to monitor not only the timbre, pitch and dynamic of their playing but also their co-performers. Other studies have shown that orchestral musicians choose not to use hearing protectors when practising or performing, or may use them incorrectly (Niquette, 2006; Sliwinska-Kowlaska & Davis, 2012; Zander, Spahn & Richter, 2008). A study with 19 professional musicians carried out by Patel (2008) found that the main reasons provided for not wearing hearing protection were because it hindered their own performance by affecting the sound quality, made it difficult to hear other musicians, and that the sensation of wearing protection was unpleasant. Musicians also reported problems with fit (e.g. difficulties inserting earplugs, lack of comfort) and

interference with communication in rehearsals. Whilst some believed that hearing protection was not needed, others did not use protection because they did not want to be seen as having 'weak' hearing (Patel, 2008, p. 21). To the positive, Jamieson (2015) found high levels of hearing protection use among individuals working in the sound and music industries, with 82% reporting wearing hearing protection at least sometimes.

A series of publications by Chasin (1996, 2009, 2010) have explored issues with the use of hearing protection associated with different instruments (e.g. occlusion, loss of high frequency sounds) and offer instrument-specific hearing protection guidance for musicians. For example, ER-15 earplugs are advised for players of smaller stringed instruments (e.g. violin, viola) as they provide a uniform attenuation across the frequency range, while the optimal ear protection for percussionists is the ER-25 plug which provides enough protection to avoid hearing loss but not so much as would prompt overcompensation and associated injuries to the wrist or arm (Chasin, 2010). However, the extent to which musicians are aware of, and use, advice provided by clinical specialists is not known.

In sum, the literature suggests that the study of NIHL in musical contexts and the uptake of hearing protection by musicians are complex issues; whilst there is awareness among musicians of the risks of hearing damage, the uptake of hearing protection is low. These factors highlight a need to examine further the current state of musicians' hearing and use of hearing protection. This survey study aimed to explore 1) professional musicians' awareness of, and perceptions surrounding, their hearing heath, and 2) associated help-seeking behaviour including attitudes towards hearing protection. Whilst the survey was exploratory in nature and did not seek to support or disconfirm a priori hypotheses, based on prior research it was anticipated that at least a third of musicians would report experiencing a hearing problem, and that uptake of hearing protection would be low. The study also aimed to explore instrument-specific variations, building on research suggesting that certain

instrumental groups, notably brass and percussion, may differ in regards to their hearing health and associated help-seeking behaviour.

Method

HMUK Hearing Survey 2015

Following on from their survey on musicians' general health (HMUK, 2014), HMUK devised a new survey to explore specifically musicians' hearing problems and related help-seeking behaviour. The survey was designed by employees at HMUK (third and fourth authors) in 2015. It was guided by a steering committee which included professional musicians, an audiologist, a music psychologist, and representatives from Musicians' Union and the British Tinnitus Association, who advised on survey content areas, question types and response formats. A pilot exercise was conducted to review the data collection method resulting in the development of a 40-item survey, with sections covering 1) the prevalence and type of hearing problems, 2) awareness and concern about noise at work, 3) hearing testing, 4) perceptions and awareness about hearing protection and 5) preferences for advice and resources[4]. In a final survey section, respondents were asked to provide demographic details (e.g. age, gender, main instrument). Acknowledging that musicians might not want to disclose their hearing loss, no names were collected. Please see Appendix A for a full list of survey questions. The survey was hosted online by SurveyMonkey and was live between 18th March and 23rd April 2015.

Recruitment

A multi-channel recruitment campaign was launched at Help Musicians UK in March 2015 distributing the survey via e-newsletters, the HMUK website, Facebook and Twitter. The survey link was also distributed by email to key stakeholders at musician specialist

[4] The present paper does not report data from Section 5.

organisations (including Incorporated Society of Musicians, Musicians' Union, PRS Foundation, Musicians' Hearing Loss Services, British Association of Performing Arts Medicine), all professional UK orchestras (including the City of Birmingham Symphony Orchestra, London Philharmonic Orchestra, Hallé Orchestra; Royal Scottish National Orchestra, Welsh National Opera), non-classical ensembles (including the English Folk Dance and Song Society, The Nest Collective), music labels (including the British Phonographic Industry, Universal, Sony), music magazine websites (including Music Week, Classical Music, Norman Le Brecht's blog), and general hearing loss charities (including Action on Hearing Loss, British Tinnitus Association). HMUK also distributed the survey link to all musicians on their mailing list who had engaged with the charity's services in the previous three years.

Analysis

An initial analysis was undertaken at HMUK. Data were spooled from Survey Monkey to MS Excel where a descriptive breakdown of responses and visual summaries were created. These descriptive data were used to report and publicise initial findings on the HMUK website (HMUK, 2015). Quantitative data were transferred to SPSS by the research team (first and second authors) and a more detailed analysis performed using both descriptive and inferential statistics. Inferential statistics were used to explore the nature of associations emerging between fixed choice variables using Chi Square statistic. Bonferroni corrections were applied where necessary to reduce the likelihood of false positives. Qualitative data were transferred to QSR Nvivo v10 and analysed using thematic analysis (TA), a method deemed appropriate for summarising large numbers of open-ended responses. Themes were not mutually exclusive and thus some responses resulted in higher coding densities than others.

Participants

A total of 693 professional musicians completed the survey. Demographic data was provided by 435 participants (237 men, 55%; 198 women, 45%). Figure 1 summarises the spread of participants across age categories, the majority of whom were aged 25- 34 years old. Of the 435 musicians who reported their geographical location, most (41.1%) were based in Greater London, followed by South East England (14.7%). Figure 1 also displays musicians' career lengths and shows that 75% had been working as a musician for over five years. Durations were bimodal in distribution; whilst the majority had been working for fewer than 5 years, the next most populous group of musicians had been working for over 30 years.

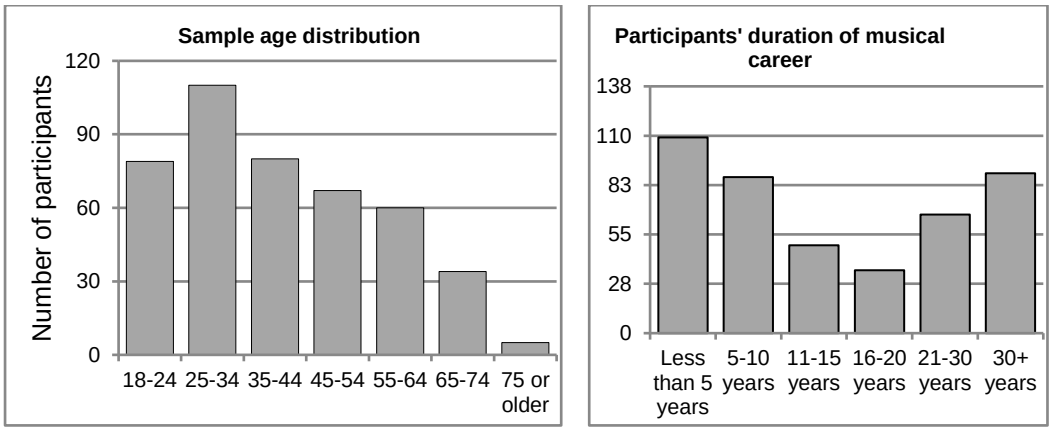


Figure 1: Age distribution, and number of years working as a professional musician

Participants were asked 'How best would you describe your work?', both as a fixed choice response about musical genre (maximum three choices), and as a free-fill field about their work role. A total of 420 respondents chose from a list of 16 categories and the modal response was two genres per participant. The majority (268) described their work as 'Classical' representing 63.8% followed by 'Jazz' (96), 'Opera' (72) 'Musical Theatre' (69) and Pop (69). A total of 407 participants responded to the free-fill question about work role and these were coded by the research team into eight categories shown in Table 1. Where

multiple responses were given, the first was taken as the primary role and coded as such. Of these, the groups ‘Orchestral’, ‘Singers’, ‘Teachers’ and ‘Band’ were prioritised for analysis being largely homogenous (the second most populous group, ‘Instrumental’ was less so, including participants describing their work as ‘freelance’, ‘musician’, ‘performer’, ‘pianist’). Responses by 431 participants to the question ‘What is your main instrument?’ were grouped into eight categories (see Table 2), with ‘Brass’, ‘Winds’, ‘Piano’, ‘Strings’ and ‘Percussion’ being most homogenous (all prioritized groups in **bold**).

Table 1. Categorised responses to ‘How best would you describe your work?’ (n=407)

	Frequency	Percentage
Orchestral musician	**125**	**30.7%**
Instrumental (incl. 'freelance', 'musician', 'performer')	**90**	**22.1%**
Singers (incl. opera singers)	**66**	**16.2%**
Teachers	**41**	**10.1%**
Band (incl. jazz, session, drummer)	**39**	**9.6%**
Composers	21	5.2%
Producer/DJ (incl. sound engineers)	19	4.7%
Other	6	1.5%

Table 2. Categorised responses to ‘What is your main instrument?’ (n=431)

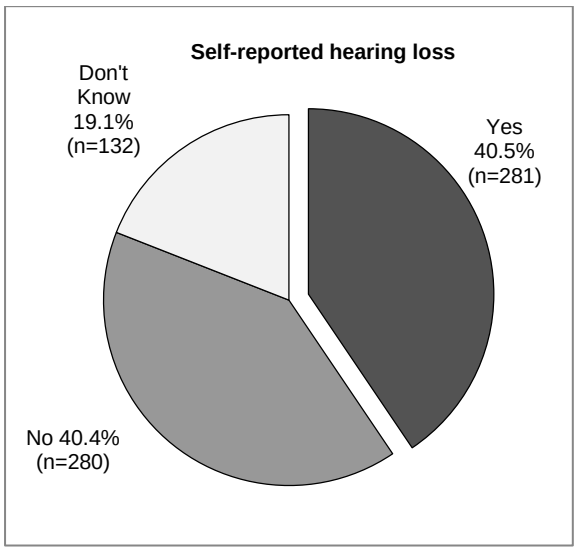
	Frequency	Percentage
Strings incl. Harp	**95**	**22.0%**
Winds incl. Sax	**69**	**16.0%**
Piano incl. Keyboard and Organ	**62**	**14.4%**
Voice	61	14.2%
Guitar	60	13.9%
Brass	**39**	**9.0%**
Percussion incl. Kit	**28**	**6.5%**
Other	17	3.9%

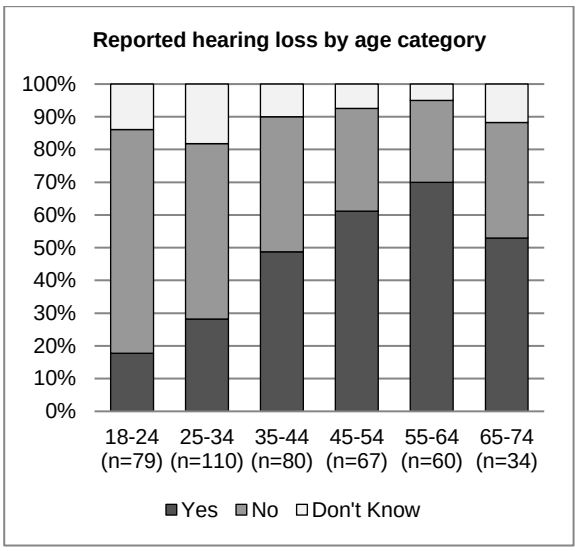
Results

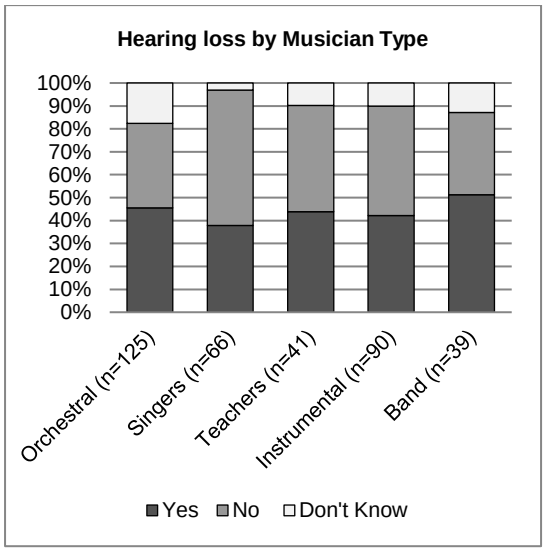
Awareness and attributions of hearing health

In response to the question ‘Have you experienced a hearing loss?’, 40.5% selected ‘Yes’ and 40.4% selected ‘No’ (see Figure 2). A further 19.1% selected ‘Don’t know’ (excluded from

inferential tests). Figure 2 shows an increasing proportion of the sample reporting having experienced a hearing loss across age brackets up to '55-64'. Excluding the 75+ category from analysis, as there were only five respondents, older musicians were more likely to report having experienced HL (χ^2 (5) = 52.998, p < .001), also significant with α = 0.008 Bonferroni correction. Band musicians reported the highest percentage of HL (59%) and Singers the lowest (39%) but no significant association was found. There was an association between main Instrument and HL such that Guitarists (62%), Brass (59%) and Percussion (58%), reported a greater incidence of HL than Winds and Piano players (both 37%) (χ^2 (6) = 15.609, p = .016), however this was not significant with α = 0.007.







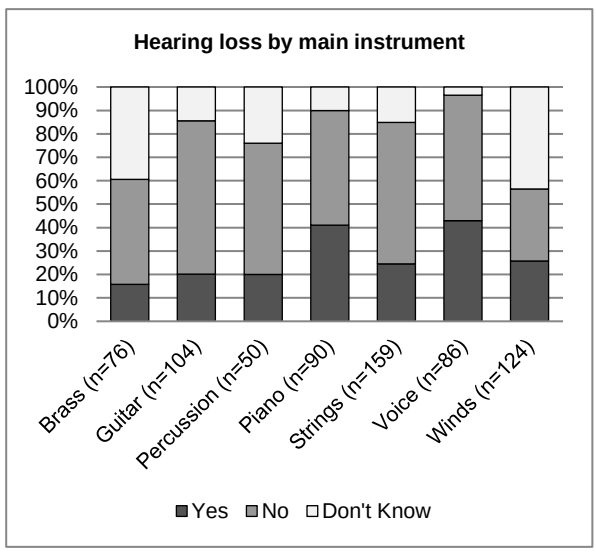


Figure 2. Reported HL with breakdowns by age, musician type and main instrument

Those who responded 'Yes' or 'Don't know' to having experienced a hearing loss were asked 'What type of hearing problem do you have? (tick all that apply)'. 296 participants made 529 selections (including 'Don't know' and 'Other'). The most commonly cited problem was Tinnitus, followed by HL in both ears and HL in one ear (see Figure 3). Tinnitus was reported more frequently by younger participants whilst hyperacusis was reported more frequently by older participants. Hearing loss in both ears was reported more frequently in older age categories while hearing loss in one ear did not appear to vary as a function of age. Band musicians reported the lowest proportion of hyperacusis but the highest proportions of bilateral HL and tinnitus. Orchestral musicians and singers reported the highest proportions of unilateral hearing loss. Guitarists reported the highest proportion of Tinnitus and also the smallest proportion of hyperacusis. There were too few data points across sub-groups of age, instrument type and musician type to perform inferential statistics.

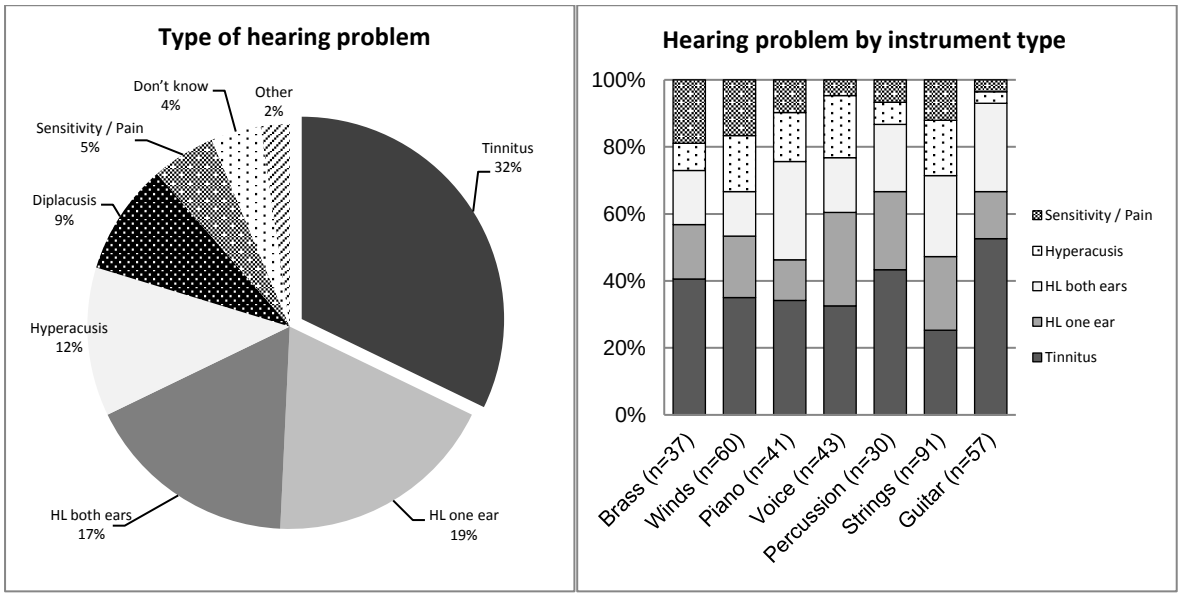


Figure 3: Types of hearing problem: all participants, and by main instrument type

Of 512 participants responding to 'Are you worried about noise levels at work?' exactly half were, and were not, worried about noise exposure at work. Orchestral musicians were proportionally more worried than all other groups (72.6%), with fewer Singers and Instrumentalists worried than expected (χ^2 (4) = 31.770, p < .001, also significant when Bonferroni correction applied, $\alpha = 0.01$). By main instrument, Brass were the most worried about noise level (71.8%) followed by Strings (62.8%) and Percussion (57.1%), with the Piano players proportionally (33.3%) the least worried about noise levels (χ^2 (6) = 24.505, p < .001) (Figure 4). For those who were worried about noise at work, significantly more than would be expected by chance reported already having a hearing loss (χ^2 (1) = 8.83, p = .003) and attributing their hearing loss to the working environment (χ^2 (1) = 7.57, p = .006).

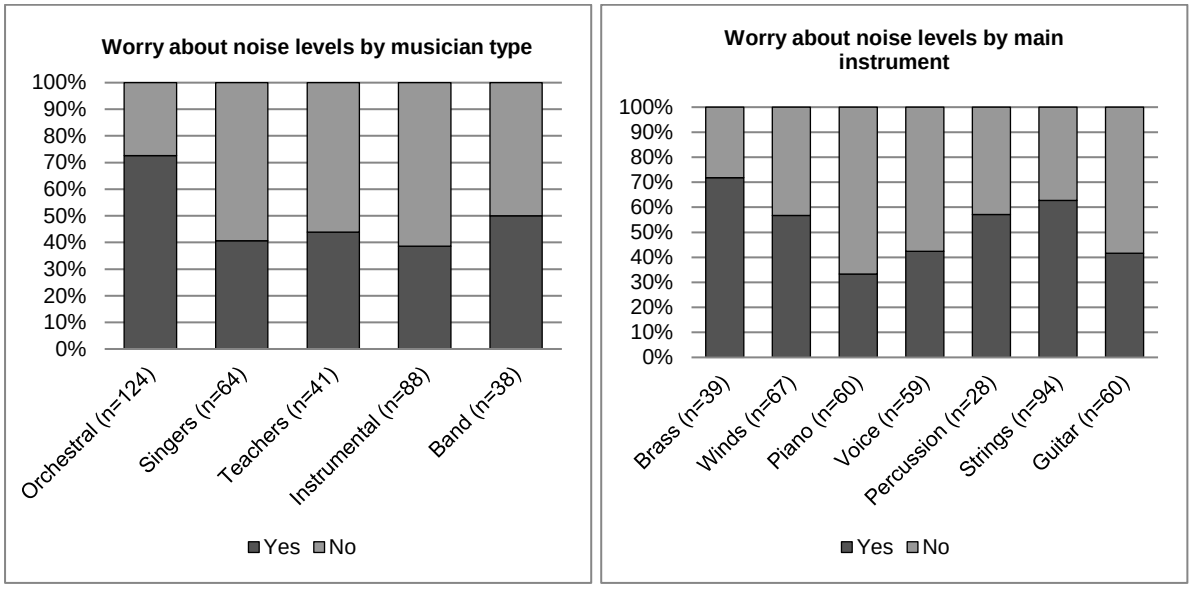


Figure 4. Worry about noise at work by musician type and main instrument

Participants were asked whether they felt that working as a musician was the main contributory factor to their HL to which 57.8% selected 'Yes', 23.2% said 'No' and 18.9% 'Don't know' (Figure 5). There was an association between attributing HL to being a musician and instrument type (χ^2 (6) = 15.900, p = .013); brass players were 3.37 times more

likely to attribute their HL to their work and 15 out of 18 of the percussionists (more than expected due to chance) attributed their HL to their work (the other 3 reported 'Don't know'). However, the overall association was not significant with Bonferroni correction at α=0.007.

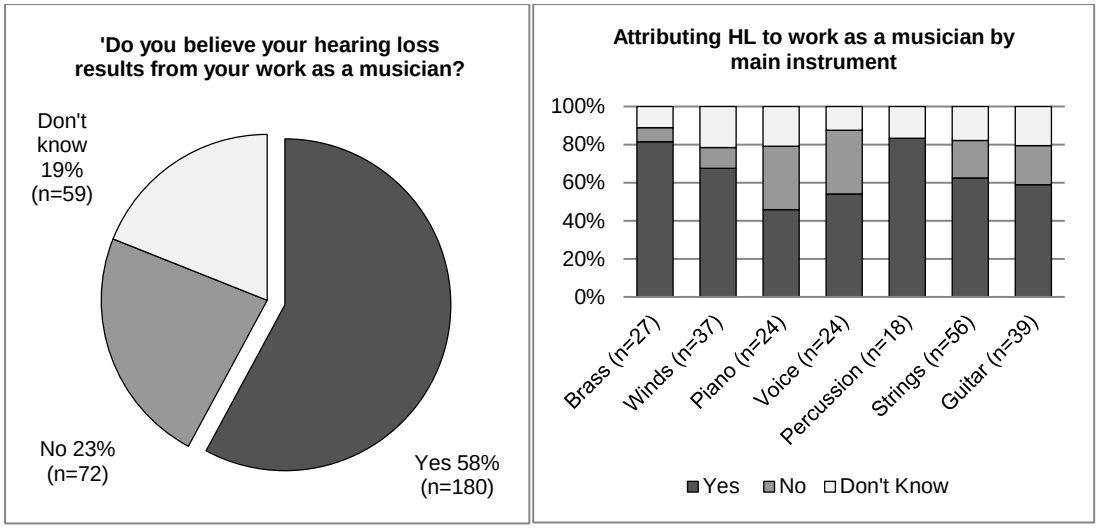


Figure 5: Attributing HL to work as a musician by musician type and instrument

In response to the question 'What factors do you feel have contributed to your hearing loss?', most reported musical, rather than general environmental, contributing factors (see Table 3), and this was also reflected in the thematic analysis (TA) of free-fill responses (n=127). Frequently coded themes included: Music-induced HL (120), Percussion/drums (24), Brass (24), Rock band (23), Feedback monitors (16), Hearing protection not worn (13), Spatial location over time (13), Bad acoustics (11), and Piccolo (11).

Table 3. Responses to "What factors do you feel have contributed to your hearing loss?" (n = 313 selecting 641 responses (including those who 'Don't Know' about their hearing loss)

	Frequency of responses	Percentage of responses
Working as a musician	246	38.3%
Listening to music	100	15.6%
Age-related hearing loss	92	14.3%
General environmental noise	66	10.3%
Illness	48	7.5%
Other	47	7.3%
Travel	20	3.1%
Operating machinery	14	2.2%

Help-seeking behaviour

Of those who reported 'Yes' or 'Don't know' to having hearing loss, 305 musicians responded to the question 'Have you sought professional help for your hearing loss?'. Of these, roughly half had sought help (49.8%) and half had not (50.2%). A greater proportion of those in the older age categories had sought help and this association was significant (χ^2 (5) = 19.709, p <.001) and remains so when Bonferroni correction is applied (α=0.008). By main instrument, Singers (66.7%) followed by Piano (56.0%) and Strings (53.6%) were most likely to seek help (see Figure 6). Conversely, only 25.9% of Brass had sought help. The association between help seeking and instrument type approached statistical significance (χ^2 (6) = 11.116, p = .085). Those who had sought help were more likely to attribute their HL to music (χ^2 (1) = 6.80, p =.009). The vast majority of respondents, 80.9%, would be 'very likely' to seek help if they experienced hearing loss in the future.

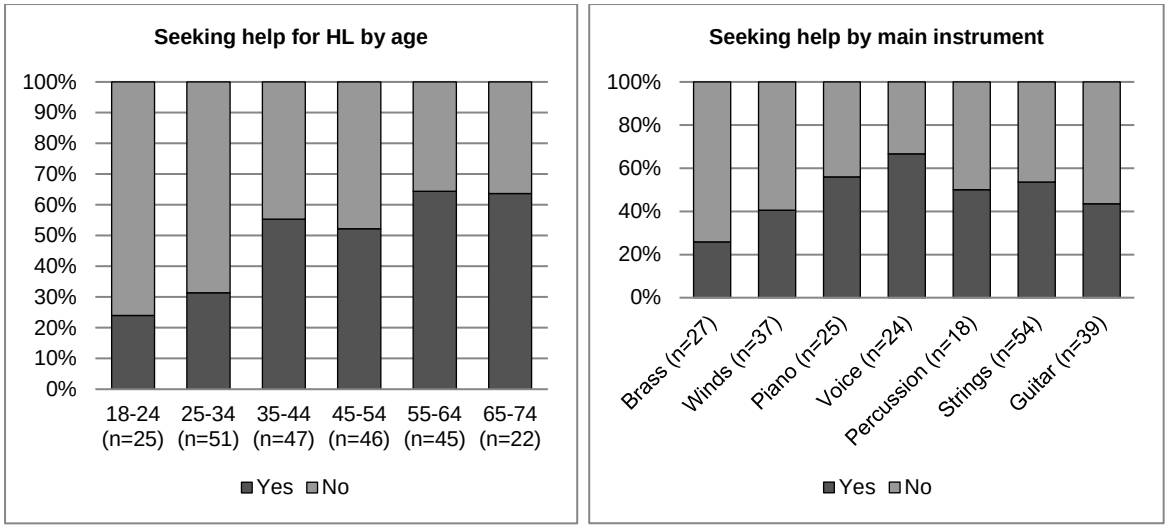


Figure 6: Seeking help for hearing loss by age and main instrument

110 participants responded to the question 'Please tell us a little more about the professional help you sought and how effective you found it'. The most prevalent themes were: National Health Service or public sector (19 occurrences), Negative experiences or outcomes (11), Positive experiences or outcomes (11) revealing a mixed picture of help-seeking experiences:

> *"Saw* an ENT [Ear, Nose and Throat] consultant then was fitted with a hearing aid. While it has its limitations it has *helped"*
>
> *"*MU [Musicians' Union] services mainly gave me personalised ear plugs which I use a lot, and they help to avoid even more hearing *loss"*
>
> *"They* diagnosed the problem after the test but there is no treatment to improve the situation. The damage is *done."*

Across all participants, 32.5% had had a hearing test, whilst a larger proportion of 67.5% had not. 139 participants responded to the free-fill question 'Why did you have a hearing test' and the most prevalent themes were: Work or University Provided Test (38 occurrences), Check for Level or Damage (23), Symptoms Prompted Test (19), and Tinnitus Prompted Test (19),

revealing that a hearing test was most often prompted by experiencing symptoms of hearing loss or tinnitus, or by the convenience of tests being offered or provided by employers:

> *"*It was a free test at Specsavers Hearing and, as I suffer with Tinnitus, I thought I'd try out the hearing *test"*
>
> *"I* attend my own audiologist regularly, have also had test provided as standard by RSNO [Royal Scottish National Orchestra]*"*
>
> *"I* wanted to know if I had sustained hearing loss, and because I am exposed to loud music every day as a classical *musician"*
>
> *"I* have regular tests for my own peace of mind, it's important to monitor your own hearing as a recording producer and *engineer"*

Participants who had not sought help (n=153) were asked to select reasons why this might be from a list of predetermined responses. The most frequent responses demonstrated a lack of concern or indifference: 'I believe my hearing loss is unavoidable' (54 selections), 'My hearing loss doesn't affect my life' (46), and 'My hearing loss doesn't affect my career' (39). Other frequent responses indicate a desire to act but having insufficient knowledge or awareness of options: 'It hadn't occurred to me that there was a solution' (42) and 'I don't know where to go' (36). By contrast, others had already sought a solution: 'I have taken protective action myself' (41). The TA of 43 open-ended responses reflected these diverse attitudes. When participants were asked why they had not had a hearing test, the most frequent responses were 'I haven't experienced a hearing loss' (173) and 'I don't know where to go for a test' (105). Again, the TA reflected these selections revealing neutral attitudes alongside more negative beliefs about the potential outcomes of getting a test:

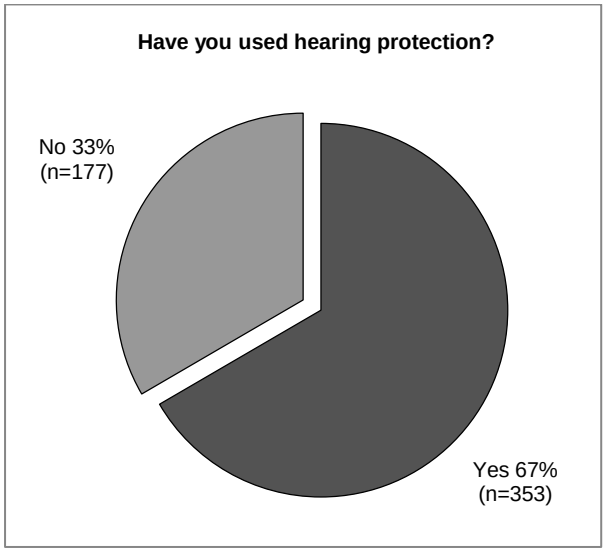
> *"Haven't* got round to it as it is something that hasn't affected my *work"*
>
> *"It* doesn't trouble me *sufficiently"*
>
> *"I* feel it would be a waste of doctors' *time"*

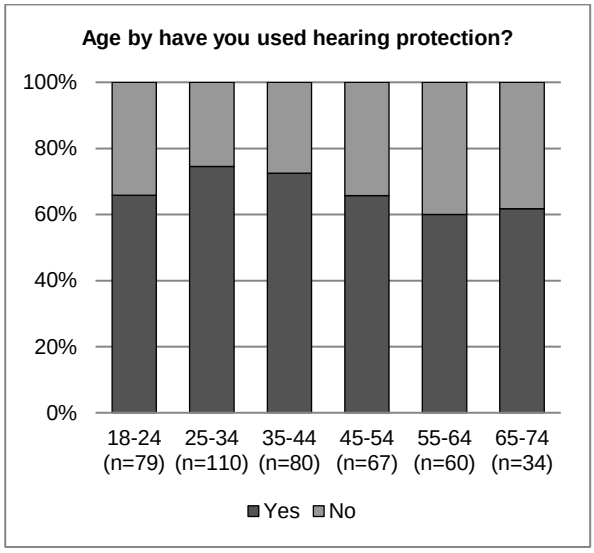
"I would hate to find out I had any hearing *loss"*

"To my knowledge there is no treatment, so a diagnosis would seem useless to *me"*

Use of and attitudes towards hearing protection

Reassuringly, two thirds of the 530 respondents reported they had used protection (66.5%). Whilst no association was found with age, Orchestral and Band musicians were more likely to report using protection that Singers and Teachers (χ^2 (4) = 19.518, p = .001, also significant at $\alpha = 0.01$). Percussionists and Brass players (85.7% and 84.6%) were most likely to have used hearing protection, whilst Singers and Pianists (45.9% and 41.9% respectively) were least likely to have worn protection (χ^2 (6) = 48.081, p < .001) (Figure 7). For those reporting having used hearing protection, more participants than expected also reported experiencing a hearing loss (χ^2 (1) = 13.20, p < .001), attributed their hearing loss to noise at work (χ^2 (1) = 7.49, p = .006), reported having had a hearing test in the last 3 years (χ^2 (1) = 6.93, p = .008) and were worried about noise at work (χ^2 (1) = 41.68, p < .001).





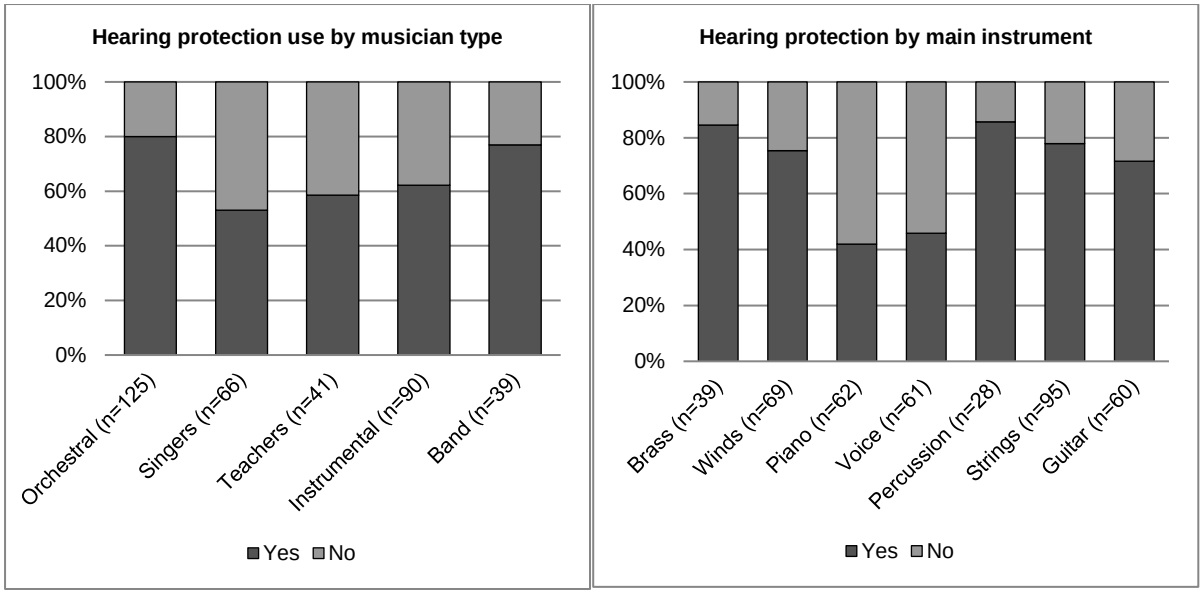


Figure 7. Use of hearing protection by age, musician type and main instrument

321 participants provided information about the situations in which they use their hearing protection, selecting from a given list. The most frequently selected responses were 'When I feel the sound is above a level I consider to be safe' (18.3%), 'When I am performing in a loud concert / gig' (16.1%), 'When I am attending a loud concert/gig' (13.3%) and 'In certain venues' (10.4%). The TA of 192 free-fill responses revealed that the main motivations for using hearing protection were Loud Music prompts Protection (75 occurrences), Tinnitus prompts Protection (48), and Brass, Percussion or Piccolo prompts Protection (30). Other common motivations were Advice or Awareness from Job or University (28), Pain or Hyperacusis prompts Protection (22), Fear, Worry, Concern prompts Protection (16), Prevent further Damage (16), Bad Acoustic, Pit or Location (14) and Work or University provided Protection (13).

All participants were asked to state their opinion on whether musicians should use hearing protection. Of 476 responses, 81.9% thought that hearing protection should be worn, 14.1%

were unsure, and, reassuringly, only 4.0% believed that they should not wear protection. A total of 305 musicians provided written responses to the question 'Should musicians use hearing protection?' of which the most frequently occurring themes were 'Yes, but only if loud' (66 occurrences) and 'Sometimes, Not Always, Depends (60) and 'Yes, Especially Musicians' (40), reflecting the importance of subjective assessments of loudness and the role of diverse musical contexts, such as repertoire and venue:

> *"Yes,* but only when being exposed to noise that is too loud for a long period of *time"*
>
> *"I* think it depends on what is being *played"*
>
> *"In* certain circumstances and for specific musicians. For example rock bands, drummers, musicians that site themselves directly in front or very close to their *amplification"*
>
> *"Only* if necessary. For example, I would assume that brass players in orchestra pits should use some sort of protection but a pianist can simply regulate the dynamic levels and length of p*ractice"*

Other frequently coded themes related to the desire to protect hearing or prevent further hearing loss: 'Yes, to Prevent Hearing Loss' (51) and 'Yes, to Protect your Ears' (47):

> *"I* think it is vital - especially for working musicians who are more likely to be consistently exposed to it rather than on one off *occasions."*
>
> *"Prevention* is better than cure, you don't realise you are experiencing *damage"*
>
> *"I* didn't start wearing protection until it was too *late."*

A common theme related to the way in which hearing protection can negatively affect the perception of music and performance: 'Yes, But Affects Sound / Performance' (38) and a further eight themes began 'Yes, but…' followed by a caveat about wearing protection only in certain situations for certain types of musicians. Taken together, these themes reveal that

the most prevalent attitude towards the use of hearing protection is that it should ideally worn, but not in every situation:

> *"Yes,* but have not yet encountered any which are sufficiently advanced not to impact upon the ability to perceive *detail"*
>
> *"It* would be nice if something was developed which did not remove the immediacy of sensation, i.e. you hear everything just *quieter"*
>
> *"If* necessary for orchestral musicians, however as a professional opera singer, it is unadvisable to wear forms of hearing protection as it alters the singers*'* sense of the sound they *produce."*

In sum, musicians' opinions about whether hearing protection should be used in musical contexts revealed a strong tension between a concern and desire to protect one's hearing from the damaging effects of loud sounds, and the potentially undesirable effects of using hearing protection on the perception of one's own, and other musicians' sound.

Discussion

The current study provided a much-needed exploration of the initial finding by HMUK in 2015 that 47% of a sample of musicians in the UK experience some form of hearing problem. In the present sample, 40% self-reported as having experienced a hearing loss with a further 19% reporting that they were 'not sure'; although the present study had a slightly higher proportion of popular musicians, the samples were otherwise demographically similar. This prevalence figure is higher than in Gembris et al. (2018) who found an incidence of 34% of hearing problems reported by professional orchestral musicians, which may in part be due to the presence of popular/band (amplified) musicians in the current sample. It should be acknowledged that, without audiometric data, self-report data on hearing loss is subject to bias. Nonetheless, with 32.5% of the sample reporting having had a recent test, and a

significant association between this and reporting hearing loss, we may infer that the majority of these musicians had gained professional verification of their hearing loss from the clinic.

The survey results showed an increased prevalence of hearing loss with age in this sample of professional musicians, replicating the finding by Gembris et al. (2018). This is likely explained by the incidence of presbycusis (age-related hearing loss) in general populations which affects 1 in 3 people over 65 years old (AoHL, 2011). Nonetheless, the survey also highlighted issues specific to musical populations. Whilst Gembris et al. (2018) found no differences in reported hearing problems according to instrument group, the present data suggest that brass, guitar and percussion players may be more at risk of NIHL, supporting prior studies (Behar et al., 2006; Schmidt et al., 2011). Data showed that Brass and Percussion players were more likely to attribute their HL to their work as a musician. They were also proportionally more worried about noise at work, and more likely to use hearing protection. Furthermore, Brass players and Band musicians were more likely to be worried about noise at work, but were less likely to have sought help for their hearing loss, despite the high reported use of protection. It may be that these musicians have already identified solutions, do not perceive a need for further support, and therefore were less likely to report seeking help. It would be beneficial to conduct more in-depth qualitative research into the experiences of musicians in these high-risk instrumental groups.

Regarding help-seeking behaviour, there was no statistical association between being worried about noise and having had a recent test or seeking help; 50% of the musicians reported that they were worried about noise at work, however less than a third had taken a hearing test in the last three years. These findings suggest that being concerned about noise at work is not, in itself, enough to prompt help-seeking behaviour. Qualitative data showed that insufficient knowledge and awareness of options were reasons provided for not seeking having had a hearing test, and that a large proportion of those who had undertaken a test did

so because it was convenient, subsidised or offered by their employer. Providing key information about hearing test and protection options for people experiencing symptoms of hearing loss is therefore critical in prompting them to seek help. Qualitative data also showed that the uptake of hearing protection can occur 'too late', with damage to hearing already having been done. Whilst the British Society of Audiology (BSA) currently stipulate that advice about NIHL be provided alongside a hearing test (BSA, 2016), it would be advantageous for musicians to be provided with information before they experience symptoms to support improved protection behaviours and uptake.

The most salient motivating factor for the use of hearing protection was found to be exposure to loud sound, as has been found in previous research (e.g. Patel, 2008). Performing or attending a loud gig or concert, especially in the presence of symptoms of hearing loss (often tinnitus), was found to strongly prompt an individual to seek protection. Furthermore, musicians with existing hearing loss who were also more worried about noise at work were more likely to wear protection, suggesting that the personal experience of hearing problem prompts the use of hearing protection. Decisions to use protection in 'real time' are most strongly influenced by loud noise at a level considered to be 'unsafe', which prompts the question 'How should musicians judge when a sound is too loud?' Chasin (2009) has outlined the approximate relationship (averaged over different instruments and styles) between musicians' subjective judgements of loudness and the measurement of sound level in decibels[5]. He argues that in general musicians are able to play a passage marked with a particular dynamic (e.g. mezzo forte) with similar intensities. However, there will inevitably be differences in musicians' perceptions of loudness, and therefore times when the sound level is likely to be damaging to one's hearing, but is not perceived as such. Future technologies may allow performers to monitor sound levels in real time, and increasingly

[5] For example, pianissimo is generally 30-50 dB, fortissimo is 90-110dB (see Chasin, 2009, p. 130)

research is exploring the role of smartphone applications for this purpose (e.g. Kardous & Shaw, 2014).

A key finding was the tension between the opinion that musicians should wear hearing protection in order to attenuate loud sound and the need to maintain accurate perception of sounds relative to their co-performers. This finding builds on prior research (e.g. Laitinen & Poulsen, 2008; Patel, 2008). In the present study, the vast majority of participants reported that they should wear protection but far fewer reported actually doing so. Further research should systematically explore musicians' engagement with different types of hearing protection over time, frequency of use and perceived effectiveness.

There were a number of methodological limitations associated with the research. Although the sample included band/amplified musicians, it consisted predominantly of orchestral/acoustic musicians. Future research on hearing health and protection should aim to target musicians from amplified genres. It is also likely that there is a response bias, with those experiencing hearing problems being more likely to complete the survey which may have affected the prevalence of hearing loss. With regards to survey design, future research should carefully delineate between hearing loss and hearing problems, and rating scales should be used instead of multiple response formats. This would facilitate statistical analysis of the relative contribution of multiple variables on hearing outcomes, the systematic testing of hypotheses and the control of confounding variables such as age. Nonetheless, the study has highlighted trends in hearing health among professional musicians who both rely on their hearing and who may be at increased risk of hearing damage due to their work, and further highlights the on-going complexities of hearing protection use in musical settings.

Acknowledgement

We are grateful to HMUK for providing the data reported in this study. HMUK have used the results to develop the *Musicians'* Hearing Health Scheme, a partnership between HMUK, Musicians' Hearing Services and the Musicians' Union, which provides specialist advice, hearing assessments and bespoke hearing protection to professional musicians (see https://www.hearformusicians.org.uk/)

References

Action on Hearing Loss. (2011). Facts and figures on hearing loss and tinnitus. https://www.actiononhearingloss.org.uk/about-us/our-research-and-evidence/facts-and-figures/

Backus, B., & Williamon, A. (2009, 15-18 December 2009). Evidence of noise-induced hearing loss among orchestral musicians. Paper presented at the International Symposium on Performance Science, Aukland, New Zealand.

Behar, A., Wong, W., & Kunov, H. (2006). Risk of hearing loss in orchestral musicians. Medical Problems of Performing Artists, 21, 164-168.

British Society of Audiologists (2016). Practice Guidance: Common Principles of Rehabilitation for Adults in Audiology Services. Accessed 11/03/2018. http://www.thebsa.org.uk/wp-content/uploads/2016/10/Practice-Guidance-Common-Principles-of-Rehabilitation-for-Adults-in-Audiology-Services-2016-3.pdf.

Chasin, M. (1996). Musicians and the prevention of hearing loss. San Diego, CA: Singular Publishing.

Chasin, M. (2009). Hearing loss in musicians: Prevention and Management. San Diego, CA: Plural Publishing.

Chasin, M. (2010). Hear the Music: Hearing Loss Prevention for Musicians. Available here: http://marshallchasinassociates.ca/pdf/Hear_the_Music_2010.pdf. Accessed 11/03/2018

Chasin, M. (2018). Music in noise. ENT & Audiology News, 27(3), 50-51.

Emmerich, E., Rudel, L., & Richter, F. (2008). Is the audiologic status of professional musicians a reflection of the noise exposure in classical orchestral music? Eur Arch Otorhinolaryngol, 265(7), 753-758

Gembris, H., Heye, A. & Seifert, A. (2018). Health problems of orchestral musicians from a life-span perspective: Results of a large-scale study. Music & Science, 1. DOI: 10.1177/2059204317739801

Help Musicians UK (2014). Health and well-being survey results. http://issuu.com/helpmusiciansuk/docs/help_musicians_uk_health_and_wellbe?e=10405134/8971874. Accessed online 11/03/2018.

Help Musicians UK (2015). Musicians' Hearing survey results. https://www.hearformusicians.org.uk/survey-results. Accessed online 11/03/2018.

Jamieson, A. (2015). Uses of and attitudes towards hearing protection in the sound and music industries: results of a pilot study. In Proceedings of the Audio Engineering Society 58th International Conference, Aalborg, Denmark, June 28-30.

Jiang, W., Zhao, F., Guderley, N. & Manchaiah, V. (2016). Daily music exposure dose and hearing problems using personal listening devices in adolescents and young adults: A systematic review. International Journal of Audiology, 55(4), 197-205.

Kardous, C. A. & Shaw, P. B. (2014). Evaluation of smartphone sound measurement applications. Journal of the Acoustical Society of America, 135. http://dx.doi.org/10.1121/1.4865269

Laitinen, H., & Poulsen, T. (2008). Questionnaire investigation of musicians' use of hearing protectors, self reported hearing disorders, and their experience of their working environment. International Journal of Audiology, 47(4), 160-168.

Lancet (2016). Hearing loss: an important global health concern. Volume 387, Issue 10036, 11–17 June 2016, Page 2351. DOI: https://doi.org/10.1016/S0140-6736(16)30777-2

Liberman, M. C., Epstein, M. J., Cleveland, S. S., Wang, H., & Maison, S. F. (2016) Toward a Differential Diagnosis of Hidden Hearing Loss in Humans. PLoS ONE 11(9): e0162726. doi:10.1371/journal.pone.0162726

Niquette, P. (2006). Hearing protection for musicians. Hearing Review. http://www.hearingreview.com/2006/03/hearing-protection-for-musicians/. Accessed 11/03/2018.

Opperman, D. A., Reifman, W., Schlauch, R. & Levine, S. (2006). Incidence of spontaneous hearing threshold shifts during modern concert performances. Otolaryngol Head Neck Surg, 134(4), 667-673.

Patel, J. (2008). Musicians' hearing protection: A review. Prepared by the Heath and Safety Laboratory for the Heath and Safety Executive. (Ref: RR664). http://www.hse.gov.uk/research/rrpdf/rr664.pdf. Accessed 11/03/2018

Phillips, S. L., Henrich, V. C., & Mace, S. T. (2010). Prevalence of noise-induced hearing loss in student musicians. International Journal of Audiology, 49(4), 309-316.

Potier, M., Hoquet, C., Lloyd, R., Nicolas-Puel, C., Uziel, A., & Puel, J.-L. (2009). The risks of amplified music for disc-jockeys working in nightclubs. Ear and Hearing, 30(2), 291-293.

Royster, J., Royster, L., & Killion, M. (1991). Sound exposures and hearing thresholds of symphony-orchestra musicians. Journal of the Acoustical Society of America, 89(6), 2793-2803.

Schink, T., Kreutz, G., Busch, V., Pigeot, I., & Ahrens, W. (2014). Incidence and relative risk of hearing disorders in professional musicians. Occupational and Environmental Medicine. doi:10.1136/oemed-2014-102172

Schmidt, J.M., Verschuure, J., & Brocaar, M. (1994). Hearing loss in students at a Conservatory. International Journal of Audiology, 33(4), 185-194.

Schmidt, J. H., Pedersen, E. R., Juhl, P. M., Christensen-Dalsgaard, J., Andersen, T. D., Poulsen, T. & Bælum, J. (2011). Sound exposure of symphony orchestra musicians. Ann Occup Hyg, 55(8), 893-905.

Sliwinska-Kowalska, M. & Davis, A. (2012). Noise-induced hearing loss. Noise and Health, 14, 274-80.

Yassi A., Pollock N., Tran N. & Cheang M. 1993. Risks to hearing from a rock concert. Can Fam Physician, 39, 1045–1050.

Zander, M. F., Spahn, C., & Richter, B. (2008). Employment and acceptance of hearing protectors in classical symphony and opera orchestras. Noise and Health, 10(38), 14-26.

Zhao, F., Manchaiah, V. K. C., French, D., & Price, S. M. (2010). Music exposure and hearing disorders: An overview. International Journal of Audiology, 49(1), 54-64.

World Health Organisation. (2018). Deafness and hearing loss. http://www.who.int/mediacentre/factsheets/fs300/en/. Accessed online 11/03/2018.