Predictors of noise exposure in construction workers

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ABSTRACT

Construction workers are exposed to hazardous noise from a wide variety of tools and equipment. This study aims to determine the workplace tasks associated with being exposed to occupational construction noise above the Australian standard ($L_{Aeq,8h} \geq 85$ dB). The paper also explores the predictors of personal hearing protection use amongst construction industry workers. One hundred construction workers from a range of construction occupations were recruited. Participants wore a dosimeter for a working shift that recorded their time weighted eight-hour equivalent noise exposure levels ($L_{Aeq,8h}$). Interviewers used specialised occupational exposure survey software, OccIDEAS, to collect information about the tools and equipment used during the same working shift. $L_{Aeq,8h}$ results ranged from 71 dB to 101 dB with 46% of participants having an $L_{Aeq,8h}$ equal to or over the Australian Exposure Standard (85 dB). Results showed that the personal use of planers, sanders and grinders; large machinery; and power hammers were strongly associated with having an $L_{Aeq,8h}$ over 85 dB. Only 41% of workers who had an $L_{Aeq,8h} \geq 85$ dB wore hearing protection all the time they performed noisy tasks.

1 INTRODUCTION

Workers in the construction industry are at higher risk of noise exposure (Masterson et al. 2013; Schneider, Paoli and Brun 2005). Over the last four decades, researchers and regulatory bodies worldwide have reported construction noise exposure levels that exceed occupational health and safety limits (Kenney and Ayer 1975; Gill 1980; Sinclair and Haflidson 1995; Neitzel, Stover and Seixas 2011). Despite being a well-documented hazard, dangerous noise levels still continue in this industry (Seixas et al. 2012; Williams 2013).

The link between noise exposure and permanent hearing loss is well established (ISO 2013). Hearing loss is common amongst construction workers (Leensen, Van Duivenbooden and Dreschler 2011; Arndt et al. 1996; Seixas et al. 2012) with estimates of prevalence of hearing loss in these workers of around 60% (Dement et al. 2005; Hong 2005) compared with the United States general population prevalence of 15% (Blackwell, Lucas and Clarke 2014). The longer workers are employed in the construction industry the more likely they are to have a hearing loss. Hong (2005) showed that 89% of operating engineers who had worked in the industry for 30-39 years had a hearing loss with the prevalence increasing to 100% for those who had worked for 40 years or more. Compensation claims also provide an indication of the incidence of noise-induced hearing loss in the construction sector (Daniell et al. 2002). In Australia over the three year period 2008-2011, half of the ten occupations that had the most compensation claims for noise-induced hearing loss were associated with the construction industry (Safe Work Australia 2014).

The construction industry employs over one million Australians; 9% of the working population (ABS 2010). In Australia the majority of construction workers (62%) are employed by businesses with less than 20 employees (ABS 2013). Employees of smaller businesses often contract their services to numerous building companies. As a result, a construction worker may work in a variety of worksites with diverse building types over the course of a year.

Noise in the construction industry is complex and dynamic. In a single day, a construction worker may use over ten different tools, just one piece of equipment continuously or use no tools at all. Other workers on-site, through their use of equipment, can also be a potential source of noise (Seixas et al. 2001). Furthermore, workers' daily tasks, environment and shift length may vary day to day making it difficult to track noise exposure at either a site or for the individual worker.

Personal hearing protection is often used as a means of reducing noise exposure. However, appropriate use of hearing protection in the construction industry relies on workers to gauge their risk of unsafe noise exposure. Neitzel and Seixas (2005) found that construction workers who reported they always wore hearing protection when needed in fact only wore it one third of the time they were exposed to noise levels (L_{Aeq}) above 85 dB.

This study investigated the determinants of noise exposure for construction workers in Western Australia. The aim was to identify which tools and equipment contribute most to the daily noise exposure of these workers. Hearing protection use was also investigated in relation to equipment use and workers' characteristics. By isolating the tool groups that contribute most to noise exposure and understanding the determinants of hearing protection use, the results add to the evidence that informs hearing loss prevention programs in this industry.

2 METHODS

2.1 Subjects

The study population comprised 103 volunteers employed in construction industries from 35 different worksites across the Perth (Western Australia) metropolitan area. The sample was a purposive sample recruited through connections of friends and colleagues as well as construction company management. Recruitment occurred from March to August 2015. Participants from a range of construction and building trades were sought. Workplaces included large and small construction sites; civil engineering sites (e.g. bridge building); and commercial and residential renovation/maintenance.

2.2. Noise exposure measurement

All participants wore a Bruel & Kjaer Type 4448 personal noise dosimeter for a full working shift. Calibration occurred before each use. Recordings were made according to International Organization for Standardization (ISO) measurement standards (pro-mode, no alarms) indicating a 3 dB exchange rate in accordance with Australian Standards (AS/NZS 2005).

Researchers placed dosimeters on the worker's left shoulder and instructed participants to not remove or cover the instrument. After collecting the dosimeter, the researchers downloaded the information using the Protector Type 7825 software. A post measurement level check was conducted once all dosimeters were collected prior to reassignment. The software calculated the $L_{EX,8h}$ [dB] and also recorded the shift length. The $L_{EX,8h}$ [dB] is equivalent to the $L_{Aeq,8h}$ measurement in accordance to AS/NZS1269.1:2005. Each $L_{Aeq,8h}$ result was then categorised as either exposed or not exposed using an 85 dB cut point (National Occupational Health & Safety Commission 2000). $L_{Aeq,8h}$ results do not take into account any reduction in noise levels that wearing ear protection may provide (National Occupational Health & Safety Commission 2000). Only continuous noise was under consideration for this study.

2.3 Interview

At the end of the participant's shift a researcher collected the dosimeter and conducted an interview using OccIDEAS a web-based application used to manage occupational exposure assessment (Fritschi et al. 2009) www.occideas.org. Interviews took approximately 10 minutes each to complete. The OccIDEAS interview questions related to the work shift completed whilst wearing the dosimeter and included questions about the tools and equipment the participant had used; the length of time they had used each piece of equipment/tool; use of hearing protection at any time during their shift; and the presence of background noise. Choice of tools and equipment covered in the interview was determined on the basis of whether they emit an equivalent steady state noise (L_{Aeq}) of 80 dB or more. One hundred and sixty tools/equipment were included. The interview also included demographic questions and questions pertaining to hearing testing. Participants were asked whether they had undertaken a hearing test within the last three years and, if so, whether it was organised by their employer.

Job title was categorised using the most detailed level of classification of the ANZSCO coding (Australian Bureau of Statistics 2009).

2.4 Analysis

Descriptive analysis of demographic information and tool use were undertaken. Tools were categorised into eight groups (Table 1) and the total time each participant used tools in each category was determined. Background noise from tools was classified as a binary variable indicating if noise from others using tools or noise from onsite plant equipment (including generators and pumps) was present.

Table 1: Categorisation of construction industry tool use into tool groups

Tool Group	Included tools
Drills, wrenches and power gun tools	Regular hand held drills, hammer or masonry drills, impact wrenches, and nail guns.
Manual hand tools	Hammers, sledge hammers, chisel and hammer used together, hand saws, scraper/sander, and trowels.
Construction vehicles and trucks	Excavators, front end loaders, bull dozers, pipe laying vehicles and trucks.
Spraying, vacuuming or blowing systems	Hand held air blowers, spraying systems, and vacuum systems (standard and industrial).
Planers, sanders and grinders	Sanders (including belt and rotary), grinders, power scraping trowels and planers.
Saws	All saws including circular, concrete, metre, band, radial/drop, reciprocating, table and bench.
Large machinery and power hammers	Compactors, rammers, rollers, tampers, chipping hammers and jack hammers.
Concrete tools, welding and other	Concrete pumps, concrete trucks, concrete vibrators, welding equipment, deslagging and chipping, and all other construction equipment that makes a noise above 80 dB(A).
Background	Equipment noise from others on site and onsite plant equipment (e.g. pumps or generators).

To investigate the predictors of having a full shift time weighted average noise exposure above the Australian exposure standard (i.e. $L_{Aeq,8h} \geq 85$ dB) (National Occupational Health & Safety Commission 2000) logistic regression modelling was undertaken. Tool group use, the total time using tools, shift length and worker characteristics were all considered potential predictors. Univariate models were used to examine the relationship between each potential predictor and the odds of having a $L_{Aeq,8h} \geq 85$ dB. The variables that had a conservative association (p-value <0.10) with noise exposure were then included in a multivariable model.

Further univariate analysis were performed using the same variables but with hearing protection as the outcome variable. This binary dependent variable denoted whether personal hearing protection (e.g. ear plugs and ear muffs) was used by the participant at any time during their shift. Those variables that had an association with hearing protection use ($p < 0.10$) were included in a further multivariable model.

3 RESULTS

Due to two technical errors with the dosimeters and one loss to follow up, three participants were excluded from the analysis, leaving 100 participants. The participants' age ranged from 17 to 61 years old (mean 33.6 years) and all were male (Table 2). Thirty-seven percent of participants worked for companies with fewer than 20 employees and 58% had undergone tertiary education or training beyond high school (e.g. trade certificate or diploma). Shift lengths ranged from 4 to 10 hours, with a mean of 7.5 hours (SD 1.2).

Participants were from 22 different occupational groups categorised by ANSZCO description (Australian Bureau of Statistics 2009) and further grouped as shown in Table 3. The average full-shift $L_{Aeq,8h}$ of the sample population was 83.5 dB (5.8 dB SD) with 46% having a $L_{Aeq,8h}$ equal to or over 85 dB.

Table 2: Distribution of construction workers' characteristics (n=100) undertaking noise study

Characteristic	Category	n
Sex	Male	100
	Female	0
Age (mean 33.6, SD 11.0, median 32, range 17-61)	17-24 years	23
	25-34 years	32
	35-44 years	27
	45-54 years	16
	55-64 years	2
Country of birth	Australia	69
	United Kingdom	13
	Ireland	6
	New Zealand	4
	Other	7
	Missing	1
Highest education level	High school or less	42
	Trade certificate/diploma	52
	Bachelor degree or higher	6
Language spoken at home	English	99
	Other	1
Size of company (number of employees)	Sole trader (1)	4
	Micro Business (2-4)	15
	Small (5-19)	18
	Medium (20-200)	41
	Large (>200)	21
	Missing	1
Shift length from dosimeter (hours)	Mean 7.5 , SD 1.2, range 4-10	
Total time using tools (hours)	Mean 2.8, SD 2.7, range 0-9	
Hearing protection	Used at least once during shift	46
	Not worn during shift	54

Table 3: Mean, standard deviation of full shift exposure levels ($L_{Aeq,8h}$) and percentage equal to or over the 85 dB exposure limit by occupation (n=100) in a sample of construction workers

Occupation	n	$L_{Aeq,8h}$		$L_{Aeq,8h}$ ≥ 85 dB	
		Mean	SD	n	%
Electrician and electronic trade workers	20	80.4	4.6	6	30%
Carpenter	16	85.4	5.9	10	63%
Builder's labourer	13	86.5	6.5	9	69%
Manager, building associate and safety officer	12	80.1	5.0	3	25%
Plumber	10	85.4	4.8	6	60%
Bricklayer and stonemason	7	87.3	4.2	4	57%
Crane operators and chasers	4	85.0	1.5	1	25%

Steel fixer	3	81.1	6.1	1	33%
Fibrous plasterer	2	86.8	8.8	1	50%
Floor finisher	2	76.1	1.6	0	0%
Gasfitter	2	79.7	1.7	0	0%
Metal fabricator	2	87.5	1.1	2	100%
Scaffolder	2	83.7	2.5	1	50%
Roof tiler	1	90.6	N/A	1	100%
Other	4	79.3	6.7	1	25%
Total	100	83.5	5.8	46	46%

Eighty-five percent of participants reported using at least one tool that had a $L_{Aeq} \geq 80$ dB during their shift with 40% using more than four different tools (Table 4). Two participants reported using ten or more tools. On average, participants used 3.2 tools per working shift (median = 3). The total time participants reported using tools that emit a steady state equivalent noise over 80 dB ranged from 5 minutes to 9 hours with a mean of 3.28 hours (SD 2.7).

Table 4: Tool group use: number of individual tools used in each group and time spent using each tool group (n=100) in a sample of construction workers

Tool group	Number of tools used within each category						Tool use time - among those who used at least one tool (hours)			
	One or more	0	1	2	3	≥4	Mean	SD	Min	Max
Manual hand tools	65	35	15	26	15	9	1.80	2.02	0.03	7.17
Drills, wrenches and power gun tools	32	68	26	5	0	1	1.30	1.73	0.03	7.00
Saws	29	71	26	3	0	0	0.97	0.86	0.02	3.00
Planers, sanders and grinders	28	72	25	2	1	0	0.68	0.60	0.03	2.56
Concrete, welding and other tools	19	81	17	2	0	0	1.45	1.75	0.08	6.00
Construction vehicles and trucks	19	81	13	5	1	0	1.72	1.88	0.17	8.00
Large machinery and power hammers	14	86	14	0	0	0	0.45	0.29	0.05	1.00
Spraying, vacuuming and blowing systems	10	90	9	1	0	0	0.84	0.93	0.08	3.25
All categories combined	85	15	8	17	20	40	3.28	2.71	0.08	9.00

Half the sample reported using two or more manual hand tools (e.g. hammer, sledge hammer, hand saw). For those who used manual tools, the average total time of use on these tools was 1.8 hours. The tool groups of construction vehicles; drills, wenches and power guns; manual hand tools; and concrete, welding and other tools all had average use time over 1 hour with maximum use time over 6 hours.

Seventy-six percent of participants reported the presence of background noise caused by plant equipment or others using tools nearby.

Table 5: Association between tool use, reported background noise and worker characteristics and (1) $L_{AEq,8h} \geq 85$ dB and (2) hearing protection use – univariate analyses (n=100, construction workers)

Variable		Noise Exposure ($L_{Aeq,8h} \geq 85$ dB)			Used hearing protection at least once		
		No	Yes	Univariate OR (CI)	No	Yes	Univariate OR (CI)
Use of drills wrenches and power gun tools	No	40	28	1.00 (ref)	36	32	1.00 (ref)
	Yes	14	18	1.84 (0.79-4.29)	17	14	0.93 (0.39 - 2.17)

Use of manual hand tools	No	23	12	1.00 (ref)	23	12	1.00 (ref)
	Yes	31	34	2.1 (0.90-4.9)*	30	34	2.17 (0.93 - 5.10)*
Use of construction vehicles and trucks	No	43	38	1.00 (ref)	45	35	1.00 (ref)
	Yes	11	8	0.82 (0.30 - 2.26)	8	11	1.77 (0.64 - 4.86)
Use of spraying, vacuuming and blowing systems	No	49	41	1.00 (ref)	49	40	1.00 (ref)
	Yes	5	5	1.195 (0.32-4.42)	4	6	1.84 (0.48 - 6.96)
Use of planers, sanders and grinders	No	43	29	1.00 (ref)	47	24	1.00 (ref)
	Yes	11	17	2.29 (0.94-5.6)*	6	22	7.18 (2.57 - 20.07)**
Use of saws	No	44	27	1.00 (ref)	43	28	1.00 (ref)
	Yes	10	19	3.09 (1.25 - 7.64)**	10	18	2.76 (1.12 - 6.85)**
Use of large machinery and power hammers	No	51	35	1.00 (ref)	51	34	1.00 (ref)
	Yes	3	11	5.34 (1.30-20.55)**	2	12	9.00(1.89-42.77)**
Use of concrete, welding and other tools	No	46	35	1.00 (ref)	45	35	1.00 (ref)
	Yes	8	11	1.81 (0.66-4.97)	8	11	1.77 (0.64 - 4.86)
Background noise reported	No	12	12	1.00 (ref)	15	9	1.00 (ref)
	Yes	42	34	0.81 (0.32 - 2.03)	38	37	1.62 (0.63 - 4.16)
Education level (past secondary schooling)	No	22	20	1.00 (ref)	24	17	1.00 (ref)
	Yes	32	26	0.89 (0.40 - 1.98)	29	29	1.41 (0.63 - 3.16)
Company size (number of employees)	<20	20	18	1.00 (ref)	18	19	1.00 (ref)
	≥20	34	28	0.92 (0.41 - 2.06)	35	27	0.73 (0.32 - 1.65)
		Mean (SD)					
Age (years)		34 (11.7)	33 (10.2)	0.99 (0.95 - 1.03)			0.98 (0.95 - 1.02)
Shift length from dosimeter (hours)		7.5 (1.3)	7.6 (1.3)	1.11 (0.81 - 1.51)			0.99 (0.73 - 1.35)
Total Time using tools (hours)		2.0 (2.6)	3.7 (2.7)	1.28 (1.09 - 1.50)**			1.16 (1.00 - 1.34)*

** p<0.05 * p<0.10

The single variable models (Table 5) showed that the use of 3 tool groups (large machinery and power hammers; planers, sanders and grinders; and saws) increased the odds of having an $L_{Aeq,8h}$ over or equal to 85 dB. The total time a worker used tools generating noise over 80 dB(A) was also significantly associated with having full shift exposure over the limit. Age, shift length and education level had little effect on the odds of being exposed to noise (Table 5).

Table 6: Multivariable logistic regression models for association between work characteristics for (1) $L_{AEq,8h}$ ≥ 85 dB and (2) hearing protection use (n=100, construction workers)

Variable		Multivariate Model 1 Noise Exposure $L_{Aeq,8h}$ ≥ 85 dB	Multivariate Model 2 Hearing Protection Use
Use of planers, sanders and grinders	No	1.00 (ref)	1.00 (ref)

	Yes	2.37(0.89-6.30)*	10.50 (3.40-32.41)**
Use of saws	No	1.00 (ref)	1.00 (ref)
	Yes	1.83(0.64-5.25)	2.01(0.62-6.49)
Use of large machinery and power hammers	No	1.00 (ref)	1.00 (ref)
	Yes	5.44(1.34-22.04)**	13.25(2.55-68.77)**
Use of manual hand tools	No	1.00 (ref)	1.00 (ref)
	Yes	1.07(0.38-3.06)	1.57 (0.50-4.99)
Total time using equipment (hours)		1.20 (1.01-1.44)**	1.01(0.83-1.23)

** p<0.05 * p<0.10

In the adjusted model (Table 6), the odds of a $L_{Aeq,8h}$ over the limit were 2.37 (CI 0.89-6.30) times higher for workers who used a tool in the planers, sanders and grinders category and 5.44 (CI 1.34-22.04) times higher for those who used tools in the large machinery or power hammers category compared with workers who did not use those respective tools (Table 6). Forty percent of participants used at least one tool from either of these two groups. The odds of having an exposure level above the limit was 1.83 higher for workers using saws compared with workers not using saws, although this result was not statistically significant. For every hour longer a worker used noisy (>80 dB) tools, the odds of $L_{Aeq,8h} \geq 85$ dB increased by 20%.

Forty six percent of participants wore hearing protection at some time during their working shift (Table 2). Those who were exposed to $L_{Aeq,8h} \geq 85$ dB had higher odds of wearing hearing protection at some time during their shift (OR=4.7, CI 2.02-11.13) (data not shown). Of those workers with an $L_{Aeq,8h}$ above or equal to 85 dB, 67% reported wearing hearing protection at least once during their working day, whereas of those who had an $L_{Aeq,8h}$ below 85 dB, only 30% reported wearing hearing protection. However, among those with an $L_{Aeq,8h} \geq 85$ dB only 41% reported wearing hearing protection all the time they performed noisy tasks.

The tool groups associated with exposure were also associated with hearing protection use. The adjusted multivariate analysis showed those who used equipment in the tool group large machinery and power hammers, or planers, sanders and grinders, were found to have over a tenfold increase in the likelihood of wearing hearing protection, although these estimates lacked precision.

Almost half of participants (47%) had not taken a hearing test in the last three years. Among the exposed group, the proportion was similar (52%). Of those who had a hearing test, 80% reported their employer paid for it. Having an $L_{Aeq,8h} \geq 85$ dB for the working shift was not associated with having had a hearing test in the past three years (p = 0.183).

Participants who worked for a large company were more likely to have had an employer paid hearing test (55%) than those working for a smaller company (21%) (p = 0.001).

4 DISCUSSION

This study demonstrated that the use of certain tool groups increases the likelihood of having a full shift time weighted average, over the Australian exposure standard of 85 dB. The four tool groups of planers, sanders and grinders; large machinery and power hammers; saws; and hand tools had positive associations with exposure, although the last two were not statistically significant in the multivariate regression model. The tools associated with exposure were widely used. Forty percent of participants used at least one tool from either the planers, sanders and grinders or the large machinery and power hammers group, and 65% used at least one hand tool.

Personal characteristics such as age, company size and education level were not associated with full shift time weighted average exposure to noise. Similarly, the presence of background noise was not found to be associated with the odds of exposure.

The total time using noisy construction tools was associated with exposure. However, the tool groups shown to substantially increase the odds of exposure, that is planers, sanders and grinders and large machinery and power hammers, were found to have average use times of less than 45 minutes with no participant using a tool in either of these tool groups for more than three hours.

This study was opportunistic and used data from a validation study. As such it was not a random sample of construction workers and the sample size was limited. However, the population of workers sampled in our study encompassed a large range of occupations in the construction industry including project manager and building associates whereas previous studies often sample a more limited range of occupations (Neitzel et al. 1999; Reeb-Whitaker et al. 2004). The mean $L_{Aeq,8h}$ of all participants in our study was 83.5 dB, less than average $L_{Aeq,8h}$ findings from most other studies of construction workers; 87.8 dB (Seixas et al. 2005) and 86.5 dB (Reeb-Whitaker et al. 2004). However, the proportion of workers with an $L_{Aeq,8h}$ above 85 dB in our sample (46%) was similar to the 45% fraction derived by Williams (2013) to estimate the noise exposure in Australian workers for this industry.

Measuring full shift exposure levels is important as it demonstrates which workers are at risk of developing noise-induced hearing loss (Prince et al. 1997). However, full shift measurements contribute little to identifying the circumstances contributing to noise exposure and are therefore inadequate to guide noise prevention programs for industries where a large variability of noise sources occur. Our study used full shift measurements as well as tool use information to explore determinants of construction workers' full shift exposure.

Our results confirm that construction workers' noise exposure is multifaceted. The number and type of tools used and the high percentage of workers reporting background noise are indications of this complex noise environment. This unique fluctuating sound environment makes implementing noise control difficult. However, the results demonstrate that when workers use certain tool groups their odds of having an $L_{Aeq,8h} \geq 85$ dB increase significantly. Reducing noise exposure caused by planers, sanders and grinders; large machinery and power hammers; saws; and hand tools would lead to a reduction in full shift exposures for this population. Although elimination or substitution may not be possible for reducing noise from these identified tools groups, engineering methods, including modifying existing equipment (Roberts 2014) and maintaining tools (Safe Work Australia 2015) may be effective. Encouraging the purchase of quieter models of equipment may also be a method of reducing noise exposure (CDC 2014). As substitution or engineering controls may only provide some reduction in noise levels, additional administration controls could also be applied including limiting individuals' daily time on these tools (Safe Work Australia 2015). Finally, once engineering and administration controls have been exhausted, encouraging workers to maintain continual and correct personal hearing protection use whilst using the tool groups highlighted in this analysis should be recommended as a default.

4.1 Hearing protection use

Tool groups that were associated with exposure were also associated with hearing protector use. Planers sanders and grinders; large machinery and power hammers; saws and manual hand tools were associated with hearing protection use as well as exposure. However, saws and manual hand tools were not statistically significant after adjusting for other tool use and time spent using tools. Only 64% of participants who reported using a saw reported using hearing protectors at any time during the day. Considering most saws have a steady state equivalent noise level over 96 dB(A) (Kerr, Brosseau and Johnson 2002; McClymont and Simpson 1989) encouraging greater use of hearing protection among saw users is warranted.

Personal ear protection can be an ineffective method of preventing hearing loss (Groenewold et al. 2014). Although ear plugs, ear muffs and other hearing protectors can reduce noise exposure, the inconsistency of their use and varied attenuation ability makes it hard to predict their effectiveness. Williams (2012) demonstrated that if hearing protection is only worn for half the time that hazardous noise is present, only a 3 dB reduction at best to a workers daily time weighted average ($L_{Aeq,8h}$) occurs. Workers in the construction industry have been shown to be poor users of hearing protection. Neitzel and Seixas (2005) found construction workers only used hearing protection for less than a quarter of the time that exposure occurred. The US NHANES survey found the construction industry had the largest number of workers who were exposed to hazardous noise but did not wear hearing protection (Tak, Davis and Calvert 2009). Thirty-three percent of participants who exceeded the Australian full shift limit of 85 dB in our study reported they did not wear hearing protectors at all during the day.

Demographic characteristics of the workers, such as age and company size did not influence hearing protection use. Having further education past high school potentially was associated with hearing protection use, although this was not a statistically significant result. Edelson et al. (2009) found similar findings in their study amongst US construction workers, although this study showed education level to be a strong predictor of hearing protection use with those with a higher education (past high school) having six times the odds of wearing hearing protection.

4.2 Hearing testing

Employer paid hearing testing was not associated with exposure in this study, rather testing was more likely to occur if a worker was employed by a large (≥ 20 employees) company.

4.3 Limitations

The sample was not random. Although a range of companies and occupations were included, they may not be an accurate representation of the construction industry population. The sample size was constrained to a hundred workers, which reduced the power to detect associations and could have led to imprecision in the results. However, the statistically significant results do show the use of some tool groups were positively associated with time weighted full shift exposure levels. Although interviews were conducted with participants at the end of their working shift, participant data could be subject to recall or social desirability bias.

4.3 Conclusion

This study has investigated the determinants of noise exposure in the construction industry. The noise environment of construction sites are often deemed “too complex” to initiate successful noise control programs, leading to a reliance on personal hearing protection use (Edelson et al. 2009; Lusk, Kerr and Kauffman 1998). This paper examined workplace tool use and participant characteristics in relation to full shift noise exposure and hearing protection use with the aim to give direction to noise prevention programs. While the study was small, the results indicate that reducing exposure from the tool groups of planers, sanders and grinders; large machinery and power hammers; saws and manual hand tools could considerably reduce workers personal exposure in the workplace.

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