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Occupational Noise Exposure of Nightclub Bar Employees in Ireland

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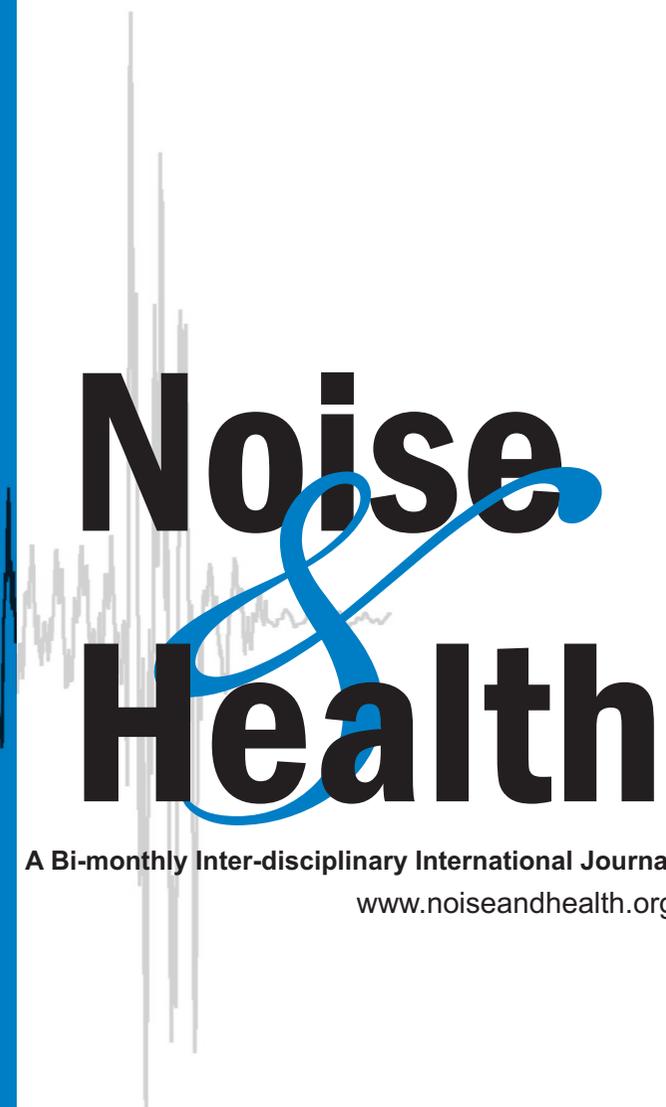
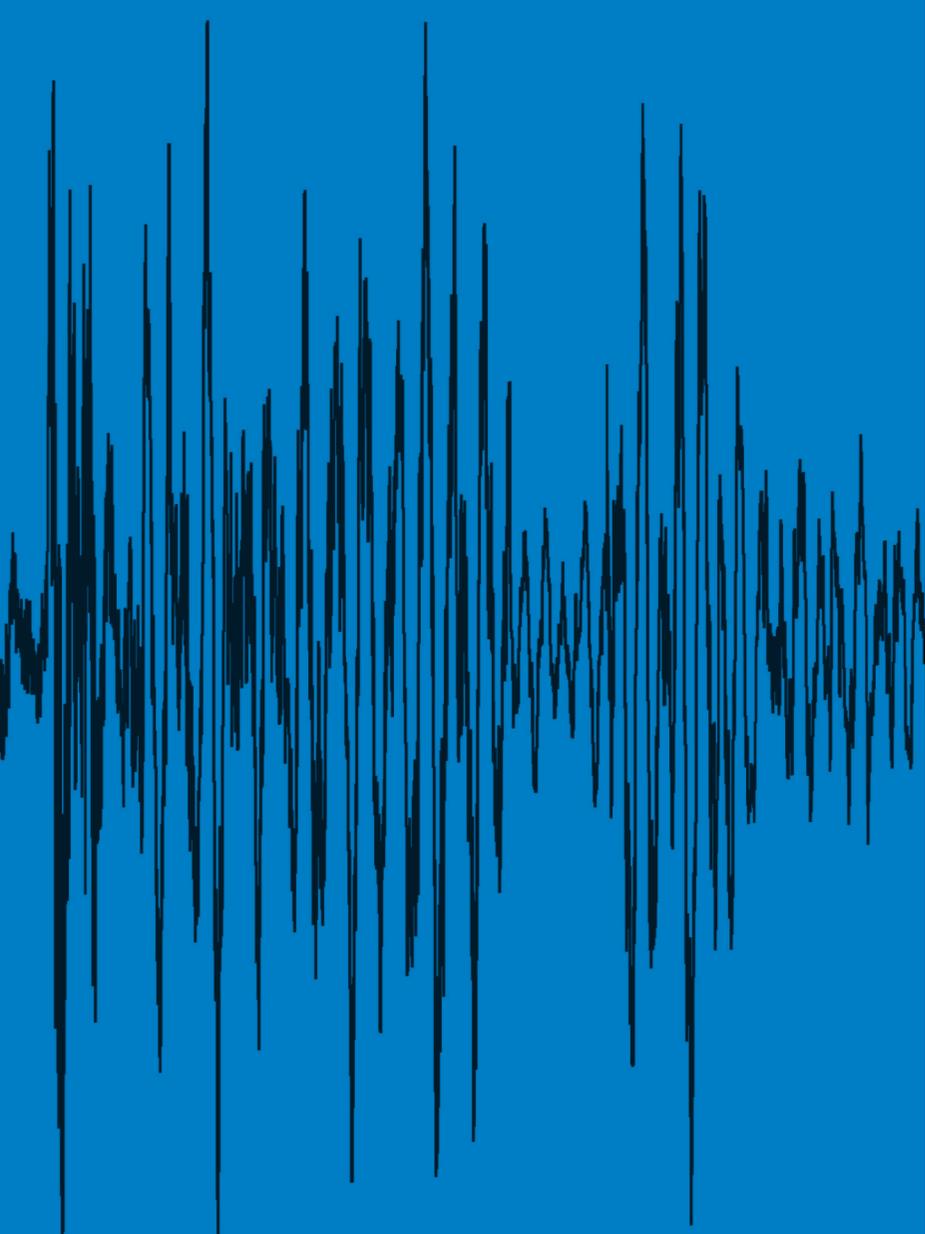
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Occupational noise exposure of nightclub bar employees in Ireland

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Abstract

Due to the transposition of the EU Directive 2003/10/EC into Irish Law, the entertainment sector was obligated to comply with the requirements of the Safety, Health and Welfare at Work (General Application) Regulations 2007, Chapter 1 Part 5: Control of Noise at Work since February 2008. Compliance with the Noise Regulations was examined in 9 nightclubs in Ireland. The typical daily noise exposure of 19 bar employees was measured using 2 logging dosimeters and a Type 1 fixed position sound level meter. Physical site inspections identified nightclub noise control measures. Interviews and questionnaires were used to assess the managers and employees awareness of the noise legislation. The average bar employee daily noise exposure ($L_{EX,8h}$) was 92 dBA, almost 4 times more than the accepted legal limit. None of the venues examined were fully compliant with the requirements of the 2007 Noise Regulations, and awareness of this legislation was limited.

Keywords: Daily noise exposure, nightclubs, noise legislation, occupational

Introduction

Noise-Induced hearing loss (NIHL) is the most commonly reported occupational disease in Europe with over 13 million employees reporting that they are affected by it.^[1] Directive 2003/10/EC revised the minimum occupational noise requirements to reduce the risk of employees developing NIHL.^[2] Previous noise legislation, the European Communities (Protection of Workers) (Exposure to Noise) Regulations 1990, was revoked and replaced in 2006 when the Directive was transposed into the Irish Safety, Health and Welfare at Work (General Application) Regulations 2007 under Chapter 1 Part 5: Control of Noise at Work.^[3,4] The Irish entertainment sector was permitted to operate under the old 1990 Regulation until 15th February 2008 to allow for the adaption of the new regulations. Since 2008, the 2007 Noise Regulations have been in effect.

It is a considerable challenge to protect employees and manage legislative compliance in entertainment venues while still

delivering the aural experience the customer expects.^[5] Prior to the changes in occupational noise legislation, worldwide studies indicated employee occupational noise exposure in nightclubs was above $L_{EX,8h}$ 85 dBA.^[6-9] While there have been significant studies internationally identifying occupational noise exposure, since the changes to the legislation in 2006, there have been no publications of bar employee noise exposure in nightclubs. In Ireland, there is little or no research on occupational noise exposure of nightclub employees. An Irish study of patron noise exposure in nightclubs found that dance floors exceeded 90 dBA.^[10] However, assessing employee noise exposure using dance floor noise levels is clearly inadequate.^[11]

Due to the logarithmic measurement of noise, a 3 decibel reduction is the equivalent of the sound pressure level decreasing two-fold. Under the new 2007 Noise Regulations, time-weighted lower and upper exposure action values were reduced by 5 decibels. If exceeded, specific actions must be taken to reduce the NIHL risk. For example, employers must conduct a noise risk assessment when exposure levels reach 80 dBA and at 85 dBA, employers must ensure employees are wearing hearing protection. The 2007 Noise Regulations introduced a daily noise exposure limit value of 87 dBA. This refers to the time-weighted average of noise measured over an 8 hour day.^[4]

In Irish law, there is no definition of a nightclub. Irish nightclubs are categorized as “licensed premises” requiring a separate “dance licence” under the Public Dance Hall Act, 1935.^[12] Irish nightclubs are permitted to serve alcohol until

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02:30 if they have an Intoxicating Liquor Licence and have obtained a Special Exemption Order (SEO).^[13] Prior to the 2008 amendment of the Intoxicating Liquor Act, nightclubs were permitted to serve alcohol until 03:30.^[14] Each night a nightclub opens to the public, they must obtain a SEO, which currently costs €410. A nightclub that opens for 3 nights per week will pay €63,960 per annum to serve alcohol until 02:30.^[15] The time period from 02:30 - 03:00 is “drinking up time” when no entertainment can be provided. On Sunday nights, the SEO only extends nightclub operating hours to 01:30, which includes the 30 minutes drinking up period.

The Irish licensing system is different from other European countries where flexible opening hours and permits may allow venues to remain open for 24 hours. The Irish Nightclub Industry Association (INIA) is currently campaigning to extend Dublin nightclub operating hours to 04:00 and to 02:30 outside Dublin, regardless of the weeknight.^[16] Currently, the INIA categorize a nightclub under the following criteria:

A premises, which only opens after 22:00; charges an admission fee; has a dedicated dance floor area; uses a SEO’s to operate outside of normal public house hours. The INIA estimates that there are currently 300 nightclubs operating in Ireland, employing 2400 people.^[17]

This study was designed to explore current bar employee noise exposure in Irish nightclubs and to examine nightclub compliance with their obligations under the Noise Regulations, 2007 legislation.

Methods

A nightclub was classed as suitable if it satisfied the following criteria:

- (1) It was a licensed venue, which served alcohol and opened to the public after 22:00.
- (2) It had a dedicated dancefloor area.
- (3) An admission fee was charged at the door.
- (4) It had a SEO.

To establish bar staff occupational noise exposure, 2 logging dosimeters and a sound level meter (SLM) were used. Apart from Club D, where only one bar employee was available, 2 bar-staff in each nightclub wore a tamperproof Type 2 dosimeter (Brüel and Kjaer 4445E). Microphones were attached to the employee’s shoulder, 10 cm from the ear. Both dosimeters were field calibrated at 114 dBA using a sound calibrator before and after the sampling period. At a minimum continuous one-minute, $L_{Aeq,T}$ ’s were recorded between the hours of 23:30 - 01:00.

A Type 1 integrated SLM (Brüel and Kjaer 2238) was placed in a fixed position behind the bar closest to the dancefloor in

each nightclub. The SLM was calibrated at 94 dBA using a sound calibrator before and after use. The SLM recorded the noise level in the bar area to establish a noise level trend. The SLM was switched on at 23:30, 00:15, and 01:00 for 8 minutes in order to calculate a representative L_{Aeq} .

Noise measurement instrument set up

The configuration of the dosimeters were:

- Range – 70 - 140 dBA.
- Time weighting – Fast.
- Frequency weighting- A-weighting.
- Frequency weighting peaks - C weighting.
- Exchange rate – 3 dB.
- Threshold – 70 dBA.
- Criteria level – 85 dBA.
- Logging – Every one minute.

The configuration of the sound level meter was:

- Range – 60 - 140 dBA.
- Band width - 1/1 Octave Bands.
- Global statistics - Fast time weighting and a frequency weighting.
- Number of scans – 30.
- Global measures – A and L frequency weightings.
- Tolerance level – 0.5 dBA.

Brüel and Kjaer “Protector 7825” software was used to obtain, archive, and post-process the measurements.

Numerical analysis

The formulae for $L_{EP,d}$ (equivalent of $L_{EX,8h}$) and $L_{EP,w}$, as defined by ISO 1999:1990, were utilized.^[18]

$$L_{EP,d} = 10 \log_{10} \left[\frac{1}{T_0} \sum_{i=1}^{i=n} \left(T_i 10^{0.1(L_{Aeq,T})_i} \right) \right]_{dBA} \quad L_{EP,w} = 10 \log_{10} \left[\frac{1}{5} \sum_{i=1}^{i=m} 10^{0.1(L_{EP,d})_i} \right]_{dBA}$$

Where

T_0 = number of seconds in an 8 hour working day (28,800 s),

i = period of the sampling,

n = is the number of individual periods in the working day,

T_i = is the duration of period i ,

$L_{Aeq,T}$ = the equivalent continuous A-weighted sound pressure level that represents the sound the person is exposed to during period i ,

Where

m = number of working days the person is exposed to noise during a week,

$(L_{EP,d})_i$ = is the $L_{EP,d}$ for working day i .

Results

The following findings are based on data collected in 9 Leinster nightclubs. Six of the nightclubs were located in urban areas outside of Dublin. Table 1 highlights the opening nights and opening hours of the 9 nightclubs that participated in the research. Three of the nightclubs were located in a

city center location. If a nightclub was located in an urban area, which was not a city, it was classified as being located in a town. Unless otherwise indicated, the opening hours of nightclubs were 23:30 – 03:00.

Bar employee noise measurements using dosimeters

Table 2 summarizes data obtained for the main parameters recorded by the dosimeters attached to the 17 participating bar employees. In all nightclubs, except Club D, 2 bar employees working in the same bar location wore a dosimeter each. In Club D, there was only one bar person available to wear the dosimeter.

Nightclub bar employees were found to have an $L_{EX, 8h}$ between 88.6 - 96.8 dBA. Interpersonal employee variation in $L_{EX, 8h}$ was thought to be related to different locations within the same bar area e.g. one employee may have been in closer proximity to the loudspeakers than the other employee. The data indicates the average bar employee worked a 5 hour shift exposed to an arithmetical average $L_{EX, 8h}$ of 92.2 dBA.

This is 5 dBA higher than the legally accepted exposure limit value according to the Noise Regulations, 2007. When the weekly exposure calculation was estimated, based on a 3 day week, only 24% (4/17) of the employees did *not* exceed the exposure limit value of 87 dBA.

All nightclubs bar employee’s noise exposures exceeded the legal lower and upper exposure action values, 80 dBA and 85 dBA respectfully. Club I employees were the only employees observed to be wearing hearing protection during their work shift. The Noise Regulations, 2007 L_{Cpeak} (peak pressure) 140 dBC exposure limit value and upper exposure action values were never exceeded. However, the L_{Cpeak} one bar employee exceeded the lower exposure action value of 135 dBC.

Nightclub bar area noise characteristics

The L_{Aeq} ’s in the 9 nightclub bar areas ranged from 77 - 98 dBA. During operation of the nightclubs, the L_{Aeq} was observed to rise with time. Figure 1 shows that the L_{Aeq} was

Table 1: Specific details of the 9 nightclub premises participating in the research

	Location	Opening nights	Total floor area	Distance from bar area to dance floor	Number of loudspeakers
Club A	Town	Thurs – Sun ^x	294 m ²	3.0 m	6
Club B	City center	Thurs – Mon ^x	480 m ²	10.0 m	11
Club C	Town	Fri – Sun ^x	320 m ²	3.5 m	13
Club D	Town	Thurs – Sat	312 m ²	4.0 m	19
Club E	City center	Thurs – Sat ^y	546 m ²	4.5 m	24
Club F	Town	Thurs – Sun	632 m ²	5.8 m	30
Club G	City center	Wed – Sat	281 m ²	5.6 m	11
Club H	Town	Sat – Sun	498 m ²	6.0 m	13
Club I	Town	Wed – Sun	512 m ²	4.0 m	21

^xOpening hours Sunday 23:30 – 02:00, ^yOpening hours Thursday – Saturday are 23:00 – 03:00

Table 2: Nightclub bar employee daily personal noise exposure levels

		L_{Aeq} dBA	L_{Cpeak} dBC	Typical hours worked per night	$L_{EX, 8h}$ dBA	Typical number of nights open per week	$L_{EP, w}$ dBA	Type of music played
Club A	1	98.5	135.6	5 h	96.5	4	94	Pop
	2	98.8	131.6	5 h	96.8	4	95	Pop
Club B	3	89.5	125.2	6 h	89.9	5	88	Dance/Rave
	4	89.8	124.9	6 h	88.6	5	86	Dance/Rave
Club C	5	89.8	128.6	6 h	88.6	3	86	Pop
	6	92.0	125.1	4.5 h	89.5	3	87	Pop
Club D	7	95.3	123.5	4.5 h	92.8	3	91	All genres
Club E	8	92.9	128.3	5.5 h	91.3	3	89	Pop
	9	94.0	128.5	4 h	91.0	3	89	Pop
Club F	10	95.0	128.5	4.5 h	92.5	4	90	Pop
	11	96.2	129.8	5 h	94.2	4	92	Pop
Club G	12	95.8	129.0	6 h	94.6	4	92	Pop
	13	95.7	131.5	6 h	94.5	4	92	Pop
Club H	14	93.8	130.2	5.5 h	92.2	2	90	Pop
	15	93.4	126.2	5.5 h	92.0	2	90	Pop
Club I	16	91.8	132.7	4.5 h	89.3	5	87	All genres
	17	94.3	128.9	4.5 h	91.8	5	90	All genres
Mean value		93.9	128.7	-	92.2	-	90	
Standard Deviation		2.6	3.1	-	2.8	-	2.7	-

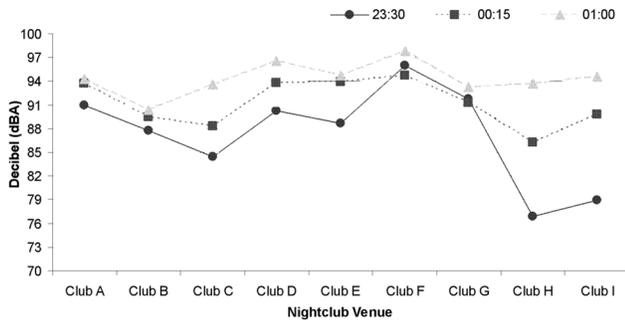


Figure 1: Plot indicating the L_{Aeq} noise levels in each nightclub bar area. The figure shows the L_{Aeq} measured at 3 fixed times, 23:30, 00:15, and 01:00

loudest at 01:00 for all of the nightclubs. Club F, at 01:00, had the highest L_{Aeq} (98 dBA) while Club B was 4 times lower at L_{Aeq} 90 dBA. Although it would have been beneficial to continue measuring the noise level trend until the level fell, this was not possible during the current noise measurements due to restricted access after 01:00 in the nightclubs. The noise level rose from 23:30 to 01:00 by an average of 7 dBA (87 – 94 dBA). Similar findings have been reported in other studies^[6,8] and are referred to as the cocktail effect whereby the noise levels tend to rise as time passes. The highest noise levels are expected between 00:30 to 01:00.

The standard deviation between nightclubs at 23:30 (5.9 dBA) was greater than at any other time of the night. As time passed, the standard deviation decreased: At 00:15, it was 3.0 dBA and at 01:00, it was 2.6 dBA.

The expanded SLM 1/1 octave band frequencies of the 00:15 bar area L_{Aeq} data from Figure 1 are shown in Figure 2. It is evident that the lower frequencies (63 and 125 Hz) were more prominent than the mid to high frequencies. The 63 and 125 Hz frequencies were higher than 90 dBA in 89% of the nightclubs. Club A and Club D had the highest average L_{Aeq} in each frequency band.

Management interviews

All 9 nightclub managers participated in a 30-minute structured interview. Seven of the managers interviewed were male. Two were female. The managers were aged 26–40. Eight reported that they had a safety statement, but only 2 had a noise risk assessment. None of the managers had these documents available in the premises to view. The Health and Safety Authority (HSA), in Ireland, had never inspected any of the nightclubs for compliance with noise legislation.

Three of the managers were aware that there had been a revision to occupational noise legislation but did not know from what date it was in effect. None of the managers interviewed were able to nominate the decibel level, at which a noise risk assessment is required to be carried out

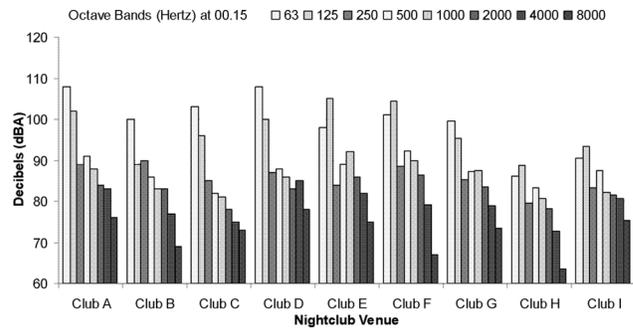


Figure 2: Breakdown of the sound level meter 1/1 octave bands for each nightclub premises at 00:15. The figure highlights the octave band frequencies in Hertz (Hz)

(lower exposure action value - 80 dBA). They also were not aware of the noise level, at which it was obligatory for employees to wear hearing protection (upper exposure action value - 85 dBA). The exposure limit value (87 dBA) was also not known by all the managers. Noise training had not been provided to any employee in the 9 participating nightclubs.

None of the participating nightclubs offered hearing tests or provided noise information to employees. Hearing protection was provided by 2 nightclub managers (Club F and Club I): E.A.R Classic earplugs in Club F and a clear gel putty commonly used as a swimmers earplug in Club I; however, it was only worn by employees in Club I. In Club F, the wearing of hearing protection was at the discretion of the employees, while in Club I, it was a condition of the employee contract to wear hearing protection.

Employee questionnaires

In total, 43 employee questionnaires were completed. The gender breakdown was 42 % female to 58% male. The average age of nightclub employees was 24.8 years. Eighty two percent of the questionnaires were filled out by bar employees although other categories of nightclub workers were included e.g. security (2%), glass collectors (9%), cloakroom attendants (5%), and DJ's (2%).

Nightclub employees worked an average of 20 hours per week, had a work shift of 5 hours and took a 15 minute break. Rotation of staff does not commonly occur. None of the bar staffs were called to carry out duties in the cloakrooms or ticket sales. The mean number of years of employment in the nightclub industry was 5.5 years.

Only 2 nightclub employees were aware of occupational noise legislation that restricts the noise levels, to which an employee can be exposed. Neither employee was able to name the legislation nor when it was enacted in the nightclub sector. An employee in Club F knew the decibel levels at which hearing protection should be made available to staff i.e. 80 dBA. However, none of the nightclub employees knew

the noise level, at which hearing protection should be worn or the average noise level that an employee should not exceed over an 8 hour working day.

Measurement of Nightclub Compliance with the Noise Regulations, 2007

All nightclub bar employee's daily noise exposure exceeded both the lower and upper exposure action values of 80 dBA and 85 dBA, respectively. Consequently, certain actions should have been taken to control the noise risk to these employees. Only 2 nightclubs had a noise risk assessment while 8 of the nightclubs had a safety statement. Hearing protection was available for employees to use in 2 of the nightclubs; however, it was only worn by employees in one venue. None of the venues provided hearing tests or noise awareness training to employees. There was no signage indicating hearing protection zones or barriers in place to restrict access to areas with noise levels in excess of $L_{EX, 8h}$ 85 dBA.

Discussion

This exploratory research gives an insight into Irish nightclub bar staff's current noise exposure. When calculating the employee daily noise exposure limit value, establishing the duration of the employees shift is thought to be crucial.^[11] A combination of noise risk assessment techniques were applied in order to ensure a representative $L_{EX, 8h}$ was calculated. There was less than a 2 decibel difference between the $L_{EX, 8h}$ of each of the bar staff in each participating nightclub. According to Whitfield (1998), an interpersonal variability of 0 - 2 dBA indicates that personal noise exposure levels are a reliable measure of noise exposure in the nightclub bar areas.^[6]

Sound levels at or above 85 dBA with exposures of 8 hours a day will produce permanent NIHL after several years repeated exposure.^[19] All of the nightclub bar employees $L_{EX, 8h}$ exceeded the 87 dBA daily exposure limit value. The $L_{EX, 8h}$ varied between 88.6 - 96.8 dBA. This is comparable to other studies where the $L_{EX, 8h}$ range was 89 - 94 dBA.^[6,8,9] The average nightclub employee had a $L_{EX, 8h}$ of 92 dBA, 5 dBA higher than the exposure limit value. It has been suggested that the minimum level to provide satisfactory music entertainment is 94 - 96 dBA.^[20] Thus, it is probably no surprise that 100% of the nightclub premises exceeded the lower and upper exposure action values. Bar employees in Club B, Club C, and Club I had the lowest $L_{EX, 8h}$ while Club A was the loudest. The logarithmic scale for noise measurement means that bar employees in Club A were exposed to a sound pressure level 4 times that of Club B bar employees. The National Institute for Occupational Safety and Health (1998) estimated that there is an increased risk (of 8%) that a person will experience hearing loss in the frequency range 1 - 4 kHz when exposed to noise levels of 90 dBA or above.^[21]

When calculating an employee's exposure limit value, consideration must be given to the attenuation benefits provided by suitable earplugs or earmuffs. Hence, the $L_{EX, 8h}$ in Table 2 represents the noise level reaching bar employees unprotected ears during their shift. The only exception is Club I where ear plugs were worn by all employees. Therefore, for Club I employees, their revised $L_{EX, 8h}$ were approximately 76 dBA when the 1/1 octave bands of the noise and the attenuation provided by hearing protection were taken into consideration. This equates to a reduction of almost 4 times the sound energy than Club A employees were experiencing i.e. a 20 decibel difference. The Club I manager indicated that hearing protection was mandatory. The employees signed off on their commitment to wear hearing protection as part of their employee contract at the beginning of their employment. It appears that the nightclub sector has a lot lower usage level of hearing protection than other industries. The Health and Safety Authority's (HSA) annual report of 2009 found that >80% of 472 premises inspected used hearing protection.^[22]

All of the nightclub bar employees $L_{EX, 8h}$ exceeded the lower exposure action value of 80 dBA set by the Noise Regulations, 2007. Once the lower exposure action value was exceeded, the nightclub was legally obliged to conduct a noise risk assessment. It is a requirement of Irish health and safety legislation that the results of any risk assessment must be written into the safety statement. There was a distinct lack of noise risk assessments carried out on the nightclub premises visited in this study. While 89% of nightclubs had a safety statement, only 2 had a noise risk assessment. This observation calls into question the quality and usefulness of these safety statements. A nightclub, which plays loud music, would be expected to consider noise a hazard. Neither of the noise risk assessments viewed in the nightclubs had been updated since the change in the noise legislation in 2008, and control measures relied highly on the use of personal hearing protection. An extensive survey by Birmingham City Council found that only 1 of 31 nightclubs inspected had a satisfactory noise risk assessment.^[23]

Noise levels recorded by the SLM increased from 23:30 to 01:00 in all 9 nightclubs. Bickerdike and Gregory (1980) noted that, in general, the sound levels in nightclubs tended to rise by about 5 dBA during the evening.^[24,25] The variation in the L_{Aeq} could be a result of the DJ's turning up the music to correct for the increase in sound absorption caused by the arrival of more patrons into the nightclub and patron-generated noise. The larger variation in decibel level standard deviation at 23:30 may be attributed to some nightclubs only turning the music up as the patrons arrive, for example in Club I, while other nightclubs like Club F had high noise levels from the beginning of the night. Adjusting the noise level depending on the number of people present in the nightclub may be beneficial in reducing unnecessary employee noise exposure. However, without a sound limiter, DJs have to rely on their hearing to determine whether the

nightclub was sufficiently loud for the patrons. An exposure to loud noise can lead people to experience reduced hearing sensitivity. This can make the music appear to be quieter as time passes, leading to the noise level being turned up by the DJs.

The HSA had never inspected any of the nightclubs for noise legislation compliance. The enforcing agency has an important role to play in ensuring the compliance of industry to legislation. An increase in inspections and one to one guidance from the enforcement agency helps amplified music venues improve compliance with the noise legislation.^[7] Clearly, the role of inspections and interaction with enforcement officers is a significant issue. There is a clear need for resourcing in this area to stimulate awareness and compliance. Currently, the number of inspectors is not adequate, and officers dedicated to this sector, at least for a period, would be desirable.

Risk, if poorly communicated, can lead to perceived risks being escalated to an unsubstantiated level. It was evident that the nightclub managers were not keeping up to date with developments in Noise Regulations.

This exploratory research reveals a profound lack of knowledge and poor implementation of the 2007 Noise Regulations. Ignorance of the legislation is never a viable defense in health and safety liability cases. Studies on the evaluation of hearing loss from amplified music have shown the prevalence of NIHL when an individual was exposed for more than 7 hours per week.^[25] The INIA proposal for city center nightclubs to extend their alcohol licence to 04:00 would increase the exposure of nightclub employees to amplified music. In addition, the proposal that the 04:00 - 04:30 drink up time would permit amplified music to play would lead to an increased noise exposure for nightclub employees. Although Club B was open 4 nights per week, employees were only exposed to amplified music for a maximum of 11 hours in the week. If the INIA proposal was adopted by Government, the bar employee's exposure to amplified music in Club B would increase by 9 additional hours (or 82%). As the calculation of noise exposure is based on the duration of exposure and the noise level, an increase in exposure time of 82% for nightclub employees could be of concern, especially if suitable control measures were not in place. The INIA report highlighted the alcohol-related health issues associated with the extension of nightclub opening hours.^[16] However, they did not refer to the effect the increase in nightclub opening hours might have on employee exposure to amplified noise.

Conclusions

None of the venues examined were fully compliant with the requirements of the noise legislation. In the UK, it has been estimated that the cost impact of the 3 dBA reduction in noise exposure would save the UK health sector £1.6 Bn over 40 years.^[26]

Limitations

This study involves a single visit per venue. While the data is consistent across all clubs studied, it might be useful to revisit a number of these venues for additional data. Numerous studies have reported that measuring in the same nightclub on different nights gave results, which were repeatable within 1 - 2 dBA.^[6,8,9] Thus, a nightclub that was described as being "quiet" e.g. Club B with noise levels below 90 dBA, remained as such when measured again and a "noisier" nightclub, with noise levels in excess of 90 dBA, would tend to be consistently noisy e.g. Club A and Club G. A weekly calculation of noise exposure was based on a hypothetical 3 day working week.

The SLM placed in the bar area closest to the dance floor was used to measure the characteristics of the sound in the nightclubs. Ideally, where a nightclub had more than one bar area, a SLM would have been placed in each area. However, due to equipment availability limitations, only one bar area was measured in each nightclub. According to Whitfield (1998) measurements taken in the bar area closest to the dance floor and sound system, between 23:00 and 01:00, represent the worst case scenario for nightclub noise.^[6] Almost all (89%) of the nightclubs who participated in this research did not open their doors to the public until 23:30; therefore, the SLM measurements were not recorded until 23:30 rather than 23:00.

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We thank the nightclub managers for participating in our study and granting access to the nightclub employees and allowing us to measure the sound levels in their venues.

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