

Effects of noise on errors, injuries and subjective health of nursing staff

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ABSTRACT

Research on low levels of occupational noise exposure (where there is no risk to hearing) suggests that this level of noise may be a risk factor for injuries and errors but have no effect on subjective reports of health when other job characteristics are controlled for. The present study continued this research by conducting a survey of 870 nursing staff. The survey collected information on subjective noise exposure, job characteristics (e.g. demands, control, support, working hours, and other aspects of the physical environment), demographics, and personality. Initial univariate analyses showed that those reporting more frequent noise exposure had more injuries/cognitive failures, greater stress at work, and worse general health as well as more anxiety and depression. Subsequent multi-variate logistic regressions controlled for job and personal characteristics. These analyses showed that noise still had a significant effect on injuries/errors and stress at work. In contrast, the effects of noise on general health and mental health were no longer significant when the other factors were covaried. These results largely confirm findings from other occupational groups exposed to similar levels of noise.

INTRODUCTION □

Research [1; 2] suggests that occupational noise exposure may have more detrimental direct effects on health and safety than does environmental noise. This could reflect occupational noise being louder and more frequent but it could also reflect the different samples and methods used in occupational and community studies. Indeed, there are some studies [3] using similar methods and samples to study occupational and environmental exposure that have shown that noise outside of work has a greater negative impact, possibly because of issues relating to control and the degree to which the sound is perceived as unwanted. It is also possible that noise at work may continue to impact on well-being outside of work and that combined noise exposure (from work and outside work) may be the key factor.

This paper reports a study of noise and nurses which is part of a research programme investigating effects of noise on safety at work (injuries; errors) and subjective reports of health from workers. Previous papers [4; 5; and 6] provide the rationale behind the research

[4] and report analyses from a general working sample [5; 6]. Early research (see [7] and [8] for reviews) suggested that noise increases the risk of accidents and impairs the health of workers. However, other research [9; 10] suggested that the effects of noise on health and safety outcomes may reflect other factors at work. Another study [10] addressed two key issues in noise research. The first was whether effects of noise might reflect other correlated attributes. In the workplace noise exposure is often associated with other negative factors such as exposure to fumes or having to carry out demanding tasks. Associations between noise and outcomes such as accidents and injuries could be caused by the noise per se or they could reflect other job characteristics associated with noise exposure. Similar issues are seen in the study of community noise, where effects of transport noise have been interpreted in terms of air pollution [11].

Another issue examined in the research programme has been the explanation of non-auditory effects of noise. It has often been the case that noise effects have been interpreted in terms of an increase in stress [12]. However, research has shown that environmental noise exposure does not lead to reliable effects on key outcomes of the stress process (stress hormones [13]; immune parameters [14]; and mental health [15]). Research has not often addressed the issue of whether occupational noise exposure influences both perceived stress and mental health outcomes. If noise exposure influences these measures then one needs to determine whether these effects reflect associations with other psychosocial stressors or are independent effects of noise. This was investigated here and the present study also examined effects of noise on cognitive failures and injuries at work. This was done by conducting analyses of a large sample of nursing staff. The aim was to determine whether noise influences the stress process (independently from other occupational factors) and whether effects of noise on injuries and cognitive failures were due to noise or correlated attributes. The next section reviews research on noise and safety at work.

The effects of noise on accidents at work have been studied for many years (see [16] for a review of the early research). Results from cross-sectional studies have produced conflicting results, with some showing a greater accident rate in high noise areas [17] but others [18] demonstrating no effect of noise. All of the early studies suffered from the problem that noise exposure was confounded with other uncontrolled factors (dangerous machinery; exposure to fumes; and shiftwork). This led to intervention studies [19] the results from which suggested that a reduction in noise exposure led to lower accident rates. However, these results could be interpreted in other ways (e.g. changes in morale) and a reduction in injuries was seen in both workers who used hearing protectors regularly (the noise reduction intervention) and those who did not. Another issue is the definition of an accident. In some studies it is likely that an accident refers to an injury requiring medical attention whereas in others the injuries are likely to have been more minor. There is a need, therefore, to examine associations between noise exposure and both accidents and minor injuries. Many everyday errors (failures of attention, memory or action) do not lead to accidents. However, in certain contexts human error is a major cause of accidents and it is important to determine whether noise exposure influences the occurrence of cognitive failures. One study [20] compared self-reports of everyday errors given by people who lived in a high aircraft noise area with those given by people in a quieter area. The results showed that those in the high noise group reported a greater frequency of cognitive failures. It is now important to determine whether such associations are also observed in the workplace, and whether they reflect noise or other correlated job characteristics. The outcome studied here, therefore, was the combination of injuries and cognitive failures, or, in other words, injuries which had a greater likelihood of being due to human error.

More recent research [21] has shown that perceptions of noise exposure were related to reports of accidents, minor injuries and cognitive failures. Clear dose-response effects were

observed which suggests that some causal relationships were present. Analyses were carried out to determine whether the associations between noise exposure and the outcomes reflected noise or other correlated job characteristics. The association between noise and accidents largely reflected other job characteristics. In contrast to this, controlling for other factors and excluding those exposed to other physical agents did not remove the effects of noise exposure on minor injuries or cognitive failures. The effect of noise on minor injuries was greater at higher perceived intensities (levels which left a ringing in the ears). However, the effect on cognitive failures was most apparent in those who perceived that background noise disturbed their concentration. As this last measure of noise exposure implies a functional deficit it is not too surprising that it should be associated with another measure of cognitive problems. In many jobs the noise exposure may be sufficient to disturb concentration but will not be deafening. Cognitive failures will be correlated with the risk of minor injuries which supported the use of a combined measure of error/injury.

The present study extends the above research by including a greater number of psychosocial characteristics in the analyses. Research on the combined effects of occupational hazards [22] found that the physical working environment (of which noise exposure formed a part) was significantly associated with safety at work even when psychosocial factors were covaried. In contrast, the physical working environment was no longer associated with stress and mental health when psychosocial factors (job demands, control, social support and effort-reward imbalance) were included in the analyses. The present investigation re-examined this issue with the focus being on perceptions of noise exposure and a model of the stress process outlined below.

Many models of stress (see [23] for a review) start with negative job characteristics, such as job demands or high extrinsic effort, and positive resources such as control or social support. Perceived stress is seen as an imbalance between demands and control/support. Negative mental health changes (increases in anxiety and depression) then often result if the person is unable to cope with the demands. In order to assess whether noise influences the stress process one needs to look at associations between noise and stress and noise and mental health. One then needs to determine whether these effects reflect other psychosocial stressors or whether there are independent effects of noise on stress which could underlie many of the non-auditory effects of noise on health. In order to determine whether any effects of noise are specific to mental health, or possibly reflect health measured by self-report, a measure of general health was also included.

METHOD

Participants

In total 870 people participated in the survey. The participants consisted of 795 females and 75 males. The mean age was 45 years (age range was 22–67 years). People were invited to participate in an advert placed in an issue of the Royal College of Nursing (RCN) Bulletin. Letters were also sent to a random selection of 5000 people registered with the RCN and living in the South West of England. An information sheet was sent out with the questionnaires. This included a description about the aims of the project. Ethical approval was given by the Cardiff University, School of Psychology Ethics Committee, and the survey completed with the informed consent of the person.

Procedure

Letters were sent out with a blank address label. Participants were asked to write their address on the label and return it to the researchers in the freepost envelope provided. This label was used to post the questionnaire and no personal details were kept. People who responded to the advert in the RCN Bulletin were asked to phone and leave their address or e-mail with their address. The questionnaires were returned anonymously with no identifiers attached therefore no reminders or follow ups were completed.

Materials

The questionnaire was designed to examine job characteristics, individual differences, general health, mental health, stress and safety at work. Measures relevant to the present article, and the origin of these questions, are described below.

Measurement of perceptions of noise exposure at work

Perceived noise exposure was measured by a question [6] that asked about exposure to noise that disturbed concentration. A 4-point scale (from 'Never' to 'Often') was used to respond to the question.

Measurement of injuries and cognitive failures at work

The frequency of minor injuries (not requiring medical attention from another person e.g. cuts and bruises) and cognitive failures [6] were rated using a 5-point scale ('not at all' to 'very frequently'):

"How frequently do you find that you have problems of memory (e.g., forgetting where you put things), attention (e.g., failures of concentration) or action (doing the wrong thing) at work?"

This measure has been shown to be highly correlated with established measures of cognitive failure (e.g., the Cognitive Failures Questionnaire).

Measurement of stress, anxiety and depression and general health

Stress at work was measured using a 5-point scale from "Not at all" to "Extremely stressed" [24]. Anxiety and depression were measured using the Hospital Anxiety and Depression Scale [25]. General health was measured using a single question [26]: "Over the past 12 months, how would you say your health in general has been?" (5 point response scale from "Very good" to "Very bad").

Psychosocial stressors

The 21-item version of the Effort-Reward Imbalance Questionnaire [27] was as used in the Whitehall II Study [28]. Three subscales measured intrinsic effort (internal motivations e.g. "over commitment" to work) extrinsic effort (external pressures) and internal reward (adequate rewards). Participants respond on a four-point likert scale indicating to what extent (if experienced) they find the suggested work situations distressing. A 27-item version of the Job Content Questionnaire [29; 30] was used. Four subscales measured job demands (workload, time pressure); decision authority (control over decisions); skill discretion (opportunity to use skills); and levels of social support. Participants responded as to how often they experienced the suggested situations at work on a four point likert-scale.

Control variables

The following variables were also included in the regressions to control for other factors: age, gender, income, educational level, social class based on occupation, full/part-time employment, negative affectivity and working hours [31]

RESULTS

The noise exposure variable was dichotomised to form a low noise exposure group (Seldom or Never exposed; N =560) and a high noise exposure group (Often or Sometimes exposed; N =303). The outcome variables were also dichotomised. In the case of injuries/cognitive failures the high group consisted of those with occasional to very frequent injuries/cognitive failures and the low group those who responded not at all or sometimes.

Initial univariate analyses were conducted and the associations between reported noise exposure and the outcomes are shown in Table 1.

Table 1: Cross-tabulation between reported noise exposure and outcomes

Variable	Infrequent Noise	Frequent Noise	Significance
General Health (Bad/very bad)	5.4%	10.6%	Chi square=7.9 p = 0.005
Perceived work stress (very or extremely stressed)	25.0%	45.4%	Chi square=37.2 p<0.001
Injuries/Cognitive Failures (Occasionally to very frequently)	22.4%	33.3%	Chi square=12.2 p<0.001
Clinical anxiety (score > 11)	20.7%	36.0%	Chi square=22.8 p<0.001
Clinical depression (score > 11)	4.3%	8.8%	Chi square=7.1 p<0.01

The above results show that reported noise exposure was associated with health and safety outcomes. Multi-variate logistic regressions were then carried out to determine whether the effects remained significant when demographics, other job characteristics and personality were co-varied. These analyses showed that the effects of noise on general health, anxiety and depression were no longer significant when other factors were controlled for. However, the association between noise and injuries/cognitive failures and noise and perceived stress at work remained significant (see Table 2).

Table 2: Logistic regression results (significant effects of noise)

Variable	Odds Ratio	Confidence Intervals	Significance
Injuries/Cognitive failures	1.47	1.04-2.06	p<0.05
Perceived work stress	1.68	1.19-2.36	p<0.005

DISCUSSION

The present results confirmed that initial univariate analyses show that more frequent noise exposure (at a level where there is no risk to hearing) is associated with health and safety outcomes. Multi-variate analyses, controlling for possible confounding factors, showed that some of the effects that were associated with noise in the univariate analyses were no longer significant when other job characteristics and individual differences were adjusted for. This pattern of results confirms findings from earlier studies using similar survey methodologies but different samples and measures [6; 22]. Also in agreement with earlier results was the finding that more frequent noise exposure was associated with injuries and cognitive failures, a result which remained significant even when other factors were controlled for. More frequent noise exposure was also associated with higher levels of perceived stress at work. This result differs from earlier research and reasons for this discrepancy are addressed below.

The first underlying mechanism considered here is the effects of noise on attention and injury. In the present study attention and injury were combined in order to focus on injuries due to human error. A better way to examine this would have been to ask about causes of the injury. However, there may have been a reluctance to acknowledge error and so the covariation of a higher probability of injury and the propensity to make errors was considered appropriate. There is a large literature on noise and impaired attention (see [32] for a review) and several underlying mechanisms have been suggested. One type of effect that has been put forward to account for effects of noise on attention is “over-arousal”. Another arousal based explanation focuses on the other end of the arousal continuum and is based on the results showing that noise can increase fatigue. Attention is best at moderate levels of arousal because the person can select relevant cues from irrelevant ones. As arousal increases the person becomes too selective and misses relevant information as well. Another view is that accidents reflect the masking of information or interference with internal speech. Noise effects have also been explained in terms of increased distraction and that may be important in terms of errors and injuries. A more detailed explanation of these results requires further information about the causes of the injury and the type of noise exposure leading up to it.

One must now consider what underlies the association between noise and perceived stress at work which has not been observed in other job types. The previous research on this topic showed that stress was largely accounted for by job demands and lack of control or support. Other research [33] has shown that there are many different causes of stress in nurses and noise may be associated with some of these. Interaction with the public is often a source of stress in nurses and this may be associated with an increase in noise. Further research is required to provide a profile of nurses’ noise exposure and to relate this to subsequent levels of reported stress. What is also interesting is that the increased levels of stress associated with more frequent noise exposure did not lead to clinical outcomes. This suggests that coping strategies were in place that prevented the development of mental health problems. This supports the view that one should examine a more detailed well-being profile and consider both negative and positive appraisals and outcomes as well as a range of individual differences (coping, attributional style, personality and lifestyle).

In summary, the present study has shown that frequent low level noise exposure can influence the well-being and safety at work of nurses. Future research must provide more detailed information on noise exposure and on the underlying mechanisms. The present approach provides a good foundation for future developments in this area and has demonstrated that it is essential to adjust for possible confounding factors.

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