

## **Effects of noise on the well-being of railway staff**

Andrew P Smith<sup>1</sup>, Hugo N Smith<sup>1</sup>

<sup>1</sup> Centre for Occupational and Health Psychology, School of Psychology, Cardiff University, 63 Park Place, Cardiff, CF10 3AS, UK

Corresponding author's e-mail address: [smithap@cardiff.ac.uk](mailto:smithap@cardiff.ac.uk)

### **ABSTRACT**

The present study involved a survey of over 1,000 rail staff and the objective was to determine the effects of noise on well-being. One of the major problems with noise surveys has been the lack of control of confounding factors and the present study used a measuring instrument (the Smith Well-being Questionnaire - SWELL) that records information on demographics, lifestyle and personality, as well as job characteristics. The outcomes measured included illness caused or made worse by work, presenteeism, mental health problems, musculo-skeletal disorders, stress at work, job satisfaction, fatigue, work-life balance and life stress. Over 40% of the sample reported frequent exposure to high levels of noise and in some jobs this was much higher. After controlling for possible confounders, noise was found to predict fatigue at work, job satisfaction, presenteeism, musculo-skeletal disorders, illness caused or made worse by work, work-life balance, life stress and general anxiety/depression. These findings suggest that noise reduces the well-being of railway staff. Further research is needed on the non-auditory effects of the frequent and loud noise exposure in this transport sector.

### **INTRODUCTION**

#### **Railway noise**

There has been considerable research on the effects of railway noise and this has fallen into several categories. First, there has been research on hearing loss in rail staff [1]. This is because there are occasions when the noise from trains or the noise in maintenance depots can be extremely loud and prolonged. Secondly, there has been research on community annoyance related to railway noise [2] which has largely followed approaches developed to study effects of other types of transport noise. Finally, there has been research looking at railway noise exposure and health outcomes [3]. This has also been extended to consider cognitive functioning [4].

#### **Health and well-being of rail staff**

In 2012 more than half a million people were employed in the rail industries of the EU [5]. Research carried out in the UK between April 2009 and March 2010 has shown that 3.5

million working hours were lost to work-related ill health in the rail industry [6]. The rail network requires a diverse workforce to operate, upgrade and maintain the system. The main types of staff are management and administrative staff, those involved in operations and traffic (e.g. station staff and train crew), those carrying out track operations and maintenance (e.g. signallers; track engineers), train maintenance engineers and other operational staff. In the UK the running of the track is under the control of Network Rail. Separate operating companies are then responsible for the passenger and freight services. The present study involved a survey of the staff of a passenger railway company in the UK. The survey covered all of the categories shown above apart from staff dealing with the track.

Many of the health and safety issues faced by rail staff have been the problems faced by heavy industry. European statistics [7] show that accidents in the rail industry have slowly decreased over the years. However, psychosocial problems such as stress have now become more prevalent [8] and these, along with musculo-skeletal disorders, are the most common problems. Risk factors include: lone working; irregular working hours; job demands; pressure from customers and other members of staff; conflicting tasks; and having to comply with strict regulations. Noise is also a major issue and, again, this comes from many different sources and activities.

## **Well-being**

Management of psychosocial issues has become a major topic of concern for the rail industry. This has led to development of a "Railway Health and Well-being Roadmap" [9] and a more holistic approach to health and well-being. This has followed the three components of employee well-being approach [10] which identifies psychological well-being, physical well-being and social well-being. These areas are clearly related and while the main focus here is on psychological well-being the present study also has implications for the other areas.

The study described here was part of a program of research on well-being at work. This started with research that aimed to address "What is a good job?" [11]. A key finding from that project was that one has to examine both positive and negative outcomes rather than inferring one from the other. This view fits with research showing that positive and negative emotions involved different brain processes. Much of our previous research on well-being at work has focused on negative outcomes such as stress and fatigue [12; 13]. In contrast, research on well-being largely deals with life satisfaction, happiness and positive affect [14].

Another feature of the present research was that it used a process model similar to those developed in stress [15; 16; 17] and fatigue research [18]. Such models start with job characteristics that may influence well-being (e.g. negative characteristics such as job demands; positive characteristics such as control and support), appraisals (e.g. perceived stress; job satisfaction) and outcomes (health outcomes such as anxiety and depression, musculoskeletal disorders and illnesses caused or made worse by work; absenteeism; accidents; presenteeism and performance efficiency). In addition to work-related factors it is important to measure individual characteristics (e.g. positive personality and healthy lifestyle). It is also important to assess life outside of work and work-life balance.

In order to measure the multiple constructs described above it is necessary to use short scales. This approach has been used by Williams & Smith [19] and many of the items in the present survey were developed in the Well-being Process Questionnaire (WPQ). These items have been shown to be highly correlated with the longer scales from which they were derived and to show the predicted associations between job characteristics, appraisals and outcomes [20; 21]. In other words, the survey measured both positive and negative aspects of well-being (job characteristics; appraisals; and outcomes) using single items which had been shown to

correlate highly with longer scales. These single items also showed the same predictive validity as the longer scales.

Another aim of the project was to extend the sample to consider a very different occupation from the ones studied in previous research. Indeed, much of the previous research on well-being has used public sector employees (e.g. nurses; teachers and university staff) and there have been very few investigating blue collar workers as well.

### **Noise and well-being at work**

This paper addresses three key topics in noise research. The first relates to the effects of noise on well-being at work using a wider range of measures than previous studies. The second is whether effects of noise are specific or reflect other correlated attributes. In the workplace noise exposure is often associated with other negative factors such as exposure to dangerous machinery or having to perform demanding tasks. If one finds associations between noise levels and outcomes such as stress or mental health one needs to ask whether it is the noise per se that leads to such effects or whether other job characteristics associated with noise exposure underlie these associations.

The third issue examined here is the explanation of non-auditory effects of noise. It has often been the case that noise effects have been explained in terms of an increase in stress. However, recent studies (reviewed in [22; 23]) suggest that environmental noise exposure does not lead to reliable effects on key outcomes of the stress process (stress hormones; immune parameters; and mental health). Research has often not 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 examine whether such effects reflect associations with other psychosocial stressors or are independent effects of noise. This was investigated here using a recently developed measuring instrument (the Smith Well-being Questionnaire – [24]) plus some questions which were especially relevant for rail workers. The present study examined the effects of noise on a wide range of well-being outcomes: musculo-skeletal disorders; job satisfaction; fatigue; illness caused or made worse by work; presenteeism; efficiency at work; happiness at work; absenteeism and accidents at work. Work-life balance and general life outcomes (life stress; life satisfaction; life happiness; and life anxiety/depression) were also examined. Established predictors of the outcomes, and possible confounding factors, were also measured (lifestyle; personality; job demands; control/support at work; working hours; and exposure to fumes) and controlled for in the analyses.

## **METHOD**

The present study was carried out with the approval of the Ethics Committee, School of Psychology, Cardiff University, and the informed consent of the participants.

The questionnaire used was based on the Smith Well-being Questionnaire (SWELL, [24]). It was designed to provide a detailed profile of the well-being of the organisation. It also allows consideration of specific issues and the one of interest here was the association between noise exposure and different outcomes. Initially, univariate analyses were carried out to examine any associations with reported noise exposure. Following this subsequent analyses adjusted for possible confounders (e.g. other aspects of the physical environment such as fumes; working patterns – shiftwork; job characteristics such as demands, control/support; personality; and lifestyle).

## Sample

1099 employees of a train company completed the questionnaire (Mean age: 44.25 years, range: 77.8% Male). This represented a response rate of approximately 50%. The main job types were train drivers, conductors, engineers, station staff, administrators, managers and catering stewards. Participants who completed the survey were entered into a prize draw.

## Questionnaire

This is shown in Appendix 1. Self-reported noise exposure (measured on a scale of 1 -10, "Not at all" to "Very much so") was the independent variable and the work-related outcomes were: musculo-skeletal problems; stress at work; job satisfaction; fatigue; illness caused or made worse by work; presenteeism; efficiency at work; anxiety/depression because of work; happiness at work; absenteeism and accidents at work. Work-life balance and general outcomes (life stress; life satisfaction; life happiness; and life anxiety/depression) were also examined. Established predictors of the outcomes, and possible confounding factors, were also measured: lifestyle; personality; job demands; control/support at work; working hours; and exposure to fumes.

## RESULTS

Over 40% of the sample reported frequent exposure to high levels of noise (7 or more on the 10 point rating scale) and in some jobs the incidence of noise exposure was much higher (e.g. train drivers: 62%; maintenance engineers: 82%).

A factor analysis (varimax rotation; eigenvalues > 1) was carried out on the predictor variables. This revealed a 3 factor solution. The first factor accounted for 30.0% of the variance and consisted of noise, fumes and doing shiftwork. The second factor accounted for 21.1% of the variance and consisted of positive personality, a healthy lifestyle and control/support at work. The final factor accounted for 15.4% of the variance and consisted of job demands. A similar analysis was carried out on the outcome variables. This produced a four factor solution. The first factor accounted for 32.4% of the variance and included work and life measures of happiness, satisfaction and efficiency at work. The second factor accounted for 10.2% of the variance and included fatigue, work-life balance and stress at work. The third factor accounted for 7.3% of the variance and included life stress and general anxiety/depression. The final factor accounted for 6.7% of the variance and included absenteeism and accidents at work.

Correlations between the predictor factor scores and the outcome factor scores were calculated. The factor including noise was significantly correlated with the fatigue/stress at work factor ( $r=0.26$   $p < 0.001$ ) and the absence/accidents factor ( $r=0.11$   $p < 0.005$ ). Job demands and personality/lifestyle/control-support were also correlated with these outcomes. Noise alone was significantly correlated with the fatigue/stress at work factor ( $r=0.23$   $p < 0.001$ ) and the absence/accidents factor ( $r=0.10$   $p < 0.005$ ).

The next set of analyses examined whether the effects of noise remained significant when the noise variable was dichotomised into high (a rating > 6) or low exposure groups. The outcome variables were also dichotomised and chi-square tests carried out on the cross-tabs. Initial analyses examined the dichotomised outcome factors and confirmed that high noise was associated with greater fatigue/stress at work (chi square = 24.4  $p < 0.001$ ) and also with life stress/general anxiety (chi square = 4.4  $p < 0.05$ ). Similar analyses were then conducted for

the individual outcome variables. The results of these analyses are shown in Table 1. These confirm the significant associations between noise and the outcomes.

**Table 1:** High/low noise exposure and outcomes

Outcome	Low noise	High Noise	Significance
High Fatigue	50.0%	68.4%	Chi-square = 37.0 p< 0.001
High Stress at Work	34.5%	44.0%	Chi-square = 10.1 p=0.001
Poor work-life balance	42.1%	59.1%	Chi-square = 30.3 p<0.001

Multi-variate logistic regressions including all the other predictors were then carried out to determine whether the effects of noise remained significant when possible confounding factors and age were covaried. All of the outcomes were examined as effects of noise not apparent in univariate analyses may occur when the variance due to other factors is removed. These results are shown in Table 2. There were no significant effects of noise for: happiness, life satisfaction, absenteeism, accidents or stress at work. Some of these variables had shown no significant effects of noise in the univariate analyses (e.g. happiness/job satisfaction) whereas others had (e.g. stress at work) but the multi-variate analyses showed that the effect of noise could be accounted for by other job characteristics (in the case of stress at work by job demands). Fatigue and work-life balance had been significantly associated with noise in the univariate analyses and these effects remained significant in the multi-variate analyses. The effect on work-life balance was associated with other more general effects of noise on mental health (life stress and general anxiety/depression). Some other effects of noise were also present. Job satisfaction was lower in those who reported greater noise exposure. Higher noise exposure was also associated with greater presenteeism (working when not healthy) and in reporting of illness caused or made worse by work. Noise exposure also showed a significant association with musculo-skeletal disorders.

**Table 2:** Logistic regressions adjusting for other predictors

Outcome	Noise OR	CI	Significance
Fatigue	1.68	1.19-2.39	p < 0.005
Work-life balance	1.47	1.08-2.02	p < 0.05
Life stress	1.64	1.20-2.26	p < 0.005
Anxiety/depression	1.58	1.01-2.45	p < 0.05
Job satisfaction	2.28	1.24-4.16	p < 0.01
Presenteeism	1.43	1.03-2.03	p < 0.05
Musculo-skeletal disorders	1.83	1.29-2.59	p<0.001
Illness caused or made worse by work	2.09	1.46-2.98	p < 0.001

## DISCUSSION

The present study examined the relationship between reported noise exposure and aspects of well-being. This was carried out in a large sample and involved the complete range of jobs present in a passenger rail company. Multiple wellbeing outcomes were included and these covered both negative and positive outcomes and assessed these both at work and outside work. Other job characteristics were also assessed and the effects of these variables covaried in the analyses. Individual characteristics such as lifestyle and personality were also assessed

and included as factors in the multi-variate analyses. In summary, the study had many positive features (large sample size, holistic approach to well-being, and control of possible confounders).

Over 40% of the sample were exposed to frequent noise and in some jobs this was much higher. Noise exposure was associated with other negative job characteristics (exposure to fumes and shiftwork) and the effects of these, and other psychosocial work characteristics (demands, control and support) were co-varied, as were lifestyle and personality. The results showed that noise was associated with greater fatigue at work, higher presenteeism and greater reporting of illness caused or made worse by work. Job satisfaction was also lower in those exposed to noise. The incidence of musculo-skeletal disorders was also greater in the high noise group but this probably reflects the nature of the jobs associated with noise exposure rather than noise per se. These effects of noise in the work place require further investigation, using longitudinal designs to examine causality and an objective measurement of noise.

The results also suggested that the effects of noise carried over into life outside of work. This is not surprising given that noise was associated with greater fatigue, which would persist after work has finished, and with greater illness associated with work. The workers exposed to noise reported greater illness associated with work and they were more likely to continue working when ill (greater presenteeism). The effects of illness caused by work would not be restricted to the work place but would carry over into life outside of work. This effect of work can plausibly account for the reduction in work-life balance reported by the high noise group. This, in turn, is reflected in the higher life stress and more mental health problems reported by the high noise group. This persistence of the effects of occupational noise exposure to life outside of work provides a plausible mechanism for the development of chronic disease induced by noise at work. Future research needs to examine the presence of chronic disease in rail workers with and without high noise exposure to address this issue. Research has shown that it is important to recover from work [25] and this might be a useful strategy to reduce the persistence of the negative effects of occupational noise exposure.

## REFERENCES

- [1] Lie, A., Skogstad, M., Johnsen, T.S., Engdahl, B., & Tambs, K. (2016). Noise-induced hearing loss in a longitudinal study of Norwegian railway workers. *BMJ Open*, 6(9). doi: 10.1136/bmjopen-2016-011923.
- [2] Pennig, S., & Schady, A. (2014). Railway noise annoyance: exposure-response relationships and testing a theoretical model by structural equation analysis. *Noise Health*, 16(73), 388-99. doi: 10.4103/1463-1741.144417.
- [3] Seider, A., Wagner, M., Schubert, M., Dröge, P., Römer, K., Pons-Kühnemann, J., Swart, E., Zeeb, H., & Hegewald, J. (2016). Aircraft, road and railway traffic noise as risk factors for heart failure and hypertensive heart disease – a case control study based on secondary data. *J Hyg Environ Health*, 219(8), 749-758. doi: 10.1016/j.ijheh.2016.09.012.
- [4] Elmenhorst, E.M., Quehl, J., Müller, U., & Basner, M. (2014). Nocturnal air, road, and rail traffic noise and daytime cognitive performance and annoyance. *J Acoust Soc Am*, 135(1), 213-22. doi: 10.1121/1.4842475.
- [5] Eurostat (2014). 'Employment in principal railway enterprises, by type of activity.'
- [6] Office of Rail Regulation (2011). 'ORR overview of work related ill health in the GB rail industry in 2010.' Retrieved from [http://orr.gov.uk/data/assets/pdf\\_file/0009/5796/work\\_related\\_ill\\_health\\_overview\\_2010.pdf](http://orr.gov.uk/data/assets/pdf_file/0009/5796/work_related_ill_health_overview_2010.pdf).
- [7] Eurostat (2012). 'Statistics Explained Archive, Vol.4 – Agriculture, environment, energy and transport statistics'.
- [8] Marczak, M., & Hassard, J. (2015). Psychosocial issues for rail workers. [https://oshwiki.eu/wiki/Psychosocial\\_issues\\_for\\_rail\\_workers](https://oshwiki.eu/wiki/Psychosocial_issues_for_rail_workers).
- [9] RSSB (2014). Railway Health and Wellbeing Roadmap. <https://www.rssb.co.uk/improving-industry-performance/workforce-health-and-well-being/health-and-well-being-roadmap>
- [10] Robertson, I., & Cooper, C. (2011). Wellbeing: Productivity and Happiness at Work. London: Palgrave MacMillian. doi: 10.1057/9780230306738.
- [11] Smith, A.P., & Wadsworth, E. (2011). A holistic approach to stress and well-being. Part 5: what is a good job? *Occupational Health (At Work)*, 8/4, 25-27. ISSN 1744-2265.
- [12] Smith, A., Allen, P., & Wadsworth, E., Davey Smith, G., & Peters, T. (2000). The Scale of Occupational Stress: the Bristol Stress and Health at Work Study. HSE Books. Report 265/2000.
- [13] Smith, A., Allen, P., & Wadsworth, E. (2006). Seafarer fatigue: the Cardiff Research Programme. MCA: Southampton. Retrieved from [http://www.dft.gov.uk/mca/research\\_report\\_464.pdf](http://www.dft.gov.uk/mca/research_report_464.pdf).
- [14] Diener, E., Suh, E. M., Lucas, R. E., & Smith, H. L. (1999). Subjective well-being: Three decades of progress. *Psychological Bulletin*, 125(2), 276-302.
- [15] Mark, G. M., & Smith, A. P. (2008). Stress models: A review and suggested new direction. In Houdmont, J., & Leka, S. (Ed.) *Occupational Health Psychology: European Perspectives on research, education and practice. Vol. 3. EA-OHP series.*(pp. 111-144). Nottingham University Press.
- [16] Mark, G., & Smith, A. P. (2011). Effects of occupational stress, job characteristics, coping and attributional style on the mental health and job satisfaction of university employees. *Anxiety, Stress and Coping*, 25, 63-78. doi: 10.1080/10615806.2010.548088
- [17] Mark, G., & Smith, A. P. (2012). Occupational stress, job characteristics, coping and mental health of nurses. *British Journal of Health Psychology*, 17, 505-521. doi: 10.1111/j.2044-8287.2011.02051.x
- [18] Smith, A. P., & Smith, H. N. (2017). Workload, fatigue and performance in the rail industry. H-Workload: 1st International Symposium on Human Mental Workload: Models and Applications. Dublin.
- [19] Williams, G. M., & Smith, A. P. (2012). A holistic approach to stress and well-being. Part 6: The Well-being Process Questionnaire (WPQ Short Form). *Occupational Health (At Work)*, 9/1. 29-31. ISSN 1744-2265.
- [20] Williams, G., & Smith, A. P. (2013). Measuring well-being in the workplace: Single item scales of depression and anxiety. In Anderson, M. (Ed.) *Contemporary Ergonomics and Human Factors 2013.* (pp. 87-94). CRC Press: Taylor & Francis. London. ISBN 978-1-138-00042-1.

- [21] Williams, G. M., & Smith, A. P. (2016). Using single-item measures to examine the relationships between work, personality, and well-being in the workplace. *Psychology: Special Edition on Positive Psychology*, 7, 753-767. DOI: 10.4236/psych.2016.76078
- [22] Smith, A.P. (2010). Noise and health: Why we need more research. In *Inter-Noise, Lisbon, Portugal*, 409, 1-7. Portuguese Acoustical Society.
- [23] Smith, A. P. (2011). Effects of noise, job characteristics and stress on mental health and accidents, injuries and cognitive failures at work. In *10th International Congress on Noise as a Public Health Problem*. Institute of Acoustics: London. Pg 486-492.
- [24] Smith, A. P., & Smith, H. N. 2017. An international survey of the well-being of employees in the business process outsourcing industry. *Psychology*, 8, 160-167. ISSN Online: 2152-7199. DOI: 10.4236/psych.2017.81010
- [25] Zijlstra, F. R., Cropley, M., & Rydstedt, L. W. (2014). 'From recovery to regulation: an attempt to reconceptualize 'recovery from work''. *Stress Health, England*: 30 (3), pp. 244-252. doi: 10.1002/smi.2604



## APPENDIX

### Questionnaire to assess well-being of rail staff (SWELL, Smith & Smith, 2017)

1. Age (years):
2. Gender: M/F
3. Job description:

4. Health-related behaviours

A healthy lifestyle involves taking exercise, eating a balanced diet, not smoking, not drinking excessive amounts of alcohol, and not being overweight. To what extent do you have a healthy life style?

Not at all Very much so

1    2    3    4    5    6    7    8    9    10

5. Personality

People often describe themselves as being positive (“seeing” the glass as half full) or negative (“seeing the glass as half empty”). How would you describe yourself?

Very negative Very positive

1    2    3    4    5    6    7    8    9    10

Thinking about the last 6 months:

6. Life satisfaction

How satisfied are you with life in general?

Not at all Very much so

1    2    3    4    5    6    7    8    9    10

7. Life stress

How much stress have you had in your life in general?

Very little A great deal

1    2    3    4    5    6    7    8    9    10

8. Happiness

Would you say you are generally happy?

Not at all Very much so

1    2    3    4    5    6    7    8    9    10

9. Anxious/Depressed

Would you say that you generally feel anxious or depressed?

Not at all Very much so

1    2    3    4    5    6    7    8    9    10

10. Musculo-skeletal problems

Do you suffer from musculo-skeletal disorders (e.g. arthritis; back pain; sciatica; repetitive strain injury)?

Not at all Very much so  
1 2 3 4 5 6 7 8 9 10

11. Noise

Are you exposed to noise at work?

Not at all Very much so  
1 2 3 4 5 6 7 8 9 10

12. Shift work/Night work

Do you work shifts or work at night? Yes/No

13. Fumes

Are you exposed to fumes, dust or solvents at work?

Not at all Very much so  
1 2 3 4 5 6 7 8 9 10

14. Job demands

How demanding do you find your job (e.g. do you have constant pressure, have to work fast, have to put in great effort)?

Not at all demanding Very demanding  
1 2 3 4 5 6 7 8 9 10

15. Job control and support

Do you feel you have control over your job and support from fellow workers?

Not at all Very much so  
1 2 3 4 5 6 7 8 9 10

16. Perceived stress at work

How much stress do you have at work?

Very little A great deal  
1 2 3 4 5 6 7 8 9 10

17. Job satisfaction

Are you satisfied with your job?

Not at all Very much so  
1 2 3 4 5 6 7 8 9 10

18. Physical and mental fatigue

How physically or mentally tired do you get at work?

Not at all tired Very tired  
1 2 3 4 5 6 7 8 9 10

19. Illness caused or made worse by work

Have you had an illness (either physical or mental) caused or made worse by work?

Yes/No

20. Presenteeism

Do you ever come to work when you are feeling ill and knowing you can't do your job as well as you would like to?

Yes/No

21. Efficiency at work

How efficiently do you carry out your work?

Not very efficiently

Very efficiently

1    2    3    4    5    6    7    8    9    10

22. Work-life balance

Do you find your job interferes with your life outside work or your life outside of work interferes with your job?

Never

Very often

1    2    3    4    5    6    7    8    9    10

23. Happy at Work

Are you happy at work?

Never

Very often

1    2    3    4    5    6    7    8    9    10

24. Anxious/Depressed because of work

Are you anxious or depressed because of work?

Never

Very often

1    2    3    4    5    6    7    8    9    10

25. Absenteeism

Approximately how many days sick leave have you had in the last 12 months? \_\_\_\_\_

26. Accidents at work

How many accidents requiring medical attention have you had in the last 12 months? \_\_\_\_\_