

BMJ Open

Perceived job insecurity and annoyance due to air and noise pollution predict incident self-rated poor health – independent and joint associations in a German national representative cohort study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2016-012815
Article Type:	Research
Date Submitted by the Author:	26-May-2016
Complete List of Authors:	Riedel, Natalie; University of Bremen, Institute of Public Health and Nursing Research Loerbroks, Adrian; University of Düsseldorf, Institute of Occupational and Social Medicine Bolte, Gabriele; University of Bremen; Institute for Public Health and Nursing Research, Dept. 5 Social Epidemiology Li, Jian
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Public health, Occupational and environmental medicine
Keywords:	PUBLIC HEALTH, EPIDEMIOLOGY, OCCUPATIONAL & INDUSTRIAL MEDICINE

SCHOLARONE™
Manuscripts

Only

Research report to BMJ Open

“Perceived job insecurity and annoyance due to air and noise pollution predict incident self-rated poor health – independent and joint associations in a German national representative cohort study”

Natalie Riedel^{*1}, Adrian Loerbroks², Gabriele Bolte¹, Jian Li²

¹ Department of Social Epidemiology, Institute for Public Health and Nursing Research, Health Sciences Bremen, University of Bremen, Grazer Straße 4, 28359 Bremen, Germany

² Institute for Occupational, Social, and Environmental Medicine, Center for Health and Society, Faculty of Medicine, University of Düsseldorf, Universitätsstraße 1, Düsseldorf 40225, Germany

* Correspondence to Natalie Riedel, Telephone: +49 421 218-68827, Email: nriedel@uni-bremen.de

Key words perceived job insecurity, annoyance due to noise and air pollution, perceived uncontrollability, self-rated health, prospective study

Word count: 2,524

ABSTRACT

Background Economic restructuring has contributed to increasing job insecurity and traffic-related pollution in residential areas. Both job insecurity and exposure to noise and air pollution are known determinants of population health and can concur in peoples' lives. This may hold true particularly for socially disadvantaged subpopulations. Nevertheless, the potential independent and joint links of those exposures to health have been rarely examined so far. We aimed to contribute to the scarce body of evidence.

Methods Information on perceived job insecurity and exposures to noise and air pollution as expressed by annoyance as well as on self-rated health were gathered from two waves of the population-based German Socioeconomic Panel (2009 and 2011, N=6,544). We performed multivariable Poisson regression to examine the independent and joint risk of poor health in 2011 by perceived job insecurity and annoyance due to noise and air pollution in 2009.

Results After the 2-year follow-up in 2011, 571 (8.7 %) participants rated their health as poor. The risk of reporting incident poor health was increased by roughly 40 % in employees reporting high vs low perceived job insecurity and annoyance due to noise and air pollution, respectively. This risk increased when both exposures were present at higher levels (RR=1.95 (1.49, 2.55)).

Conclusions Work-related and environmental exposures may accumulate and have a joint health impact. Elaboration on the link between occupational and residential exposures is warranted in light of their concurrence and their implications for health inequities.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

STRENGTHS AND LIMITATIONS

- Both perceived job insecurity and annoyance due to traffic-related exposures have advanced as major risk factors for population health. Although they are likely to concur, their independent and joint health effects have not been studied yet.
- In this prospective, population-based study, we could document that perceived job insecurity and annoyance due to noise and air pollution show both independent and joint associations with incident self-rated poor health.
- Subjective measures of job insecurity and exposure to noise and air pollution indicate indirect, perceptual pathways of psychological stress. Thus, we could not detect direct physiological effects due to the objective intractability of these two exposures.
- Our study underlines the need to integrate work-related and environmental research both conceptually and empirically.

INTRODUCTION

With labour markets growing more and more unpredictable, perceptions of job insecurity have increased across European Union member states and beyond.¹⁻³ Longitudinal studies have consistently shown that high job insecurity predicts poor health outcomes.⁴

In addition to perceived job insecurity, current economic phenomena (e.g. restructuring) are associated with an increase in transportation during the past decades,⁵⁻⁷ which constitutes a major cause for chronic exposure to noise and air pollution in residential areas. Traffic-related noise and ultrafine particulate matter air pollution have been identified as the most important environmental challenges in Western European cities,⁸ which has been illustrated by estimating an enormous number of healthy life years lost from noise annoyance (i.e. 654 000 disability-adjusted life-years).⁹

In view of these current developments, it is plausible to assume that job insecurity and traffic-related exposures are likely to concur in residential and occupational contexts. This may hold true particularly for socially disadvantaged subpopulations (e.g.^{3, 10}). This notion is in line with social epidemiological models on health determinants and inequities, which highlight the accumulation of exposures across contexts.^{11, 12} However, there is little research linking different types of work-related and residential exposures to health in one single study, although there are studies on traffic-related air and noise pollution modelling peoples' (outdoor) exposures in both occupational and residential contexts (e.g.¹³ for a study on asthma and¹⁴ for a study on blood pressure). We are aware of only one cross-sectional study suggesting an accumulation of physiological impacts of objective residential and occupational noise exposure and/or self-reported job strain on myocardial infarction while adjusting for air pollution.¹⁵

In the current study, we aim to contribute to this scarce body of evidence by examining the independent and joint associations of perceived job insecurity and annoyance due to noise and air pollution with self-rated poor health in a representative sample of the German working population. In doing so, we focus on indirect psychological pathways from these two contextual exposures to health and recur to parallel lines of argumentation within both occupational health and environmental psychology (e.g. Conservation of Resources Theory by Hobfoll in^{16, 17} or the Appraisal Theory by Lazarus and Folkman in¹⁸⁻²⁰). That is, we assume that perceived job insecurity and annoyance due to noise and air pollution in the residential area may share the same stress-based mechanism to produce poor health: perceived uncontrollability of exposure and its feared or unwanted consequences of resource loss, (mal-

)adaptive behavioural responses implying (vain) resource investment and subsequent physiological costs, and finally, adverse health outcomes.

METHODS

Study population and study sample

We retrieved our study sample from the German Socio-Economic Panel (GSOEP), a national survey conducted annually by face-to-face interviews in representatively selected households since 1984.²¹ All household members aged 18 + were eligible for participation after giving their informed consent. Our prospective, complete case analysis is primarily based on data from the 2009 and 2011 waves covering topics such as work and employment (including job insecurity) in the individual questionnaire as well as housing and environmental exposures in the household questionnaire (incl. annoyance due to noise and air pollution). Using the household code as a key variable, the household data was merged to the individual data. Given our study aim, we restricted our analysis to participants employed (total: N=11,381, complete cases: N=9,493, 83.4%) in our baseline in 2009 and still remaining in the GSOEP in our follow-up in 2011 (N=7,339, response rate=77.5 %). Further, we considered only those who were in good health in 2009 (see measures below). Thus, our study sample included 6,544 participants (89.2 % of 7,339) living in 4,626 households.

The GSOEP is compliant with national data. It is evaluated by the German Council of Science and Humanities at the German Institute for Economic Promotion (DIW) and is explicitly intended for epidemiological analyses.²¹

Exposure and outcome measures

At our baseline in 2009, perceived job insecurity was assessed by participants' anticipated probability of losing their job within the next two years on a 10 % decrement scale.²²⁻²³ A cut-off point of ≥ 50 % on this scale was found to be both conceptually meaningful and statistically efficient to differentiate between perceived lower and higher job insecurity²⁴ (we call the participants with perceived higher job insecurity shortly 'job insecure').

Annoyance due to noise and air pollution in the residential area was derived from the household representatives' reporting of the degree of disturbance. Though not source-specific, we may regard these variables as proxy for perceived exposures related to traffic as main emission source. Household-specific disturbance values were assigned to the individuals belonging to the same household at the respective address. While rated separately on five

point Likert scales, disturbances due to noise and air pollution were highly correlated ($r_s = 0.67$). In line with an earlier GSOEP study,²⁵ we summed up the values of both items, with higher values signalling a higher degree of disturbance (called hereafter ‘environmental annoyance’). We dichotomised this sum scale whose scores ranged from 2 (not at all affected by both noise and air pollution) to 10 (very strongly affected by both noise and air pollution) at the cut-off point ≥ 5 . Thus, environmental annoyance was assumed to be present at higher levels in 2009 if households perceived disturbance due to noise and / or due to air pollution as being just bearable, strong, or very strong (we call these participants shortly ‘environmentally annoyed’). This cut-off point served both statistical efficiency and empirical relevance. Sensitivity analyses using two alternative cut-off points (≥ 4 and ≥ 6) did not reveal substantial differences in effect sizes of environmental annoyance in relation to self-rated poor health (see statistical analyses below). Similar cut-off points have been employed to indicate higher levels of noise annoyance on five point Likert scales in previous population-based studies.^{17, 26, 27}

Finally, the dichotomised information on job insecurity and environmental annoyance was combined in one composite variable with four exposure categories, with ‘perceived lower job insecurity and lower environmental annoyance’ as reference group as compared to the categories ‘perceived higher job insecurity and lower environmental annoyance’, ‘perceived lower job insecurity and higher environmental annoyance’, as well as ‘perceived higher job insecurity and higher environmental annoyance’.

We inferred our incident outcome variable from one single question making participants rate their health on five point Likert scale. Those who reported their health as ‘not so good’ or ‘bad’ were defined as having a poor health.

Potential confounders

Besides age and gender, we considered educational attainment (continuous, as measured by years of formal education), personal net income (continuous, log-transformed for multivariable analysis due to skewness), marital status, and contract type (permanent as opposed to non-permanent contract) as indicators of participants’ socio-demographic and economic position at our baseline in 2009. Health-related behaviour was mostly measured in the wave prior to our baseline by current smoking, alcohol consumption, physical exercise, and body mass index (see²⁴).

Statistical analyses

Differences in potential confounders between levels of perceived job insecurity and environmental annoyance were determined by Student's t-test or Chi-Square test. Associations of perceived job insecurity and environmental annoyance in 2009 with an incident self-rated poor health in 2011 were quantified by risk ratios (RRs) with 95% confidence intervals (CIs) using Poisson regression with a log-link function. To account for household clustering, we integrated a sandwich variance estimator in the Poisson regression models by means of the household code as cluster identifier.²⁸ First, we simultaneously entered perceived job insecurity and environmental annoyance in 2009 as independent predictors of a self-rated poor health in 2011. Second, we estimated their joint effects as measured by the composite exposure variable. In both regression series, we adjusted for age and gender in model I as well as for socio-demographic and economic position and health-related behaviour in model II in order to assess robustness of associations. Statistical analyses were performed using SAS, version 9.4

RESULTS

On average, 1.4 persons lived in one household in 2009, with the household size ranging from one to five individuals. One in five participants reported higher job insecurity or higher environmental annoyance. Both exposures co-occurred in 373 (5.7 %) participants; among job insecure participants, odds of being environmentally annoyed were elevated by 50 % (OR 1.50, 95% CI 1.27 - 1.67). Characteristics of the study sample stratified by the two levels of perceived job insecurity and environmental annoyance are shown in table 1. Lower personal net income levels, the unmarried and separated/divorced/widowed status as well as non-permanent contracts were more prevalent among participants characterised by perceived higher job insecurity or higher environmental annoyance. Job insecure participants were two years younger at an average and more often lower educated. Overweight and obesity as well as physical inactivity were more common among job insecure participants, whereas the opposite was true for regular alcohol consumption. No clear behavioural pattern could be observed for the two levels of environmental annoyance.

Table 1 Characteristics of the study population at baseline in 2009 (N=6,544) stratified by levels of perceived job insecurity (JI) and of environmental annoyance (EA)

Characteristics, n (%)	Lower JI 5,055 (77.25)	Higher JI 1,489 (22.75)	p value	Lower EA 5,227 (79.87)	Higher EA 1,317 (20.13)	p value
Continuous variables, mean (SD)						
Age (years)	43.71 (10.85)	41.68 (11.19)	< 0.0001	43.26 (10.90)	43.18 (11.18)	0.8140
Education (years)	13.12 (2.83)	12.37 (2.48)	< 0.0001	12.94 (2.77)	13.00 (2.79)	0.4329
Personal net income per month (€)	1835 (1389)	1375 (1067)	< 0.0001	1757 (1359)	1623 (1238)	0.0112
Categorical variables, n (%)						
Female	2407 (47.62)	747 (50.17)	0.0833	2497 (47.77)	657 (49.89)	0.1698
Marital status						
Unmarried	1202 (23.78)	441 (29.62)	<.0001	1268 (24.26)	375 (28.47)	0.0028
Separated/divorced/widowed	444 (8.78)	142 (9.54)		461 (8.82)	125 (9.49)	
Married	3409 (67.44)	906 (60.85)		3498 (66.92)	817 (62.03)	
Non-permanent contract	1116 (22.08)	475 (31.90)	<.0001	1237 (23.67)	354 (26.88)	0.0151
Current smoking	1463 (28.94)	504 (33.85)	0.0003	1561 (29.86)	406 (30.83)	0.4955
Regular alcohol consumption	1028 (20.34)	260 (17.46)	0.0142	1045 (19.99)	243 (18.45)	0.2086
Physical exercise						
Never	1279 (25.30)	440 (29.55)	<.0001	1390 (26.59)	329 (24.98)	0.0536
Less than once a week	1517 (30.01)	505 (33.92)		1579 (30.21)	443 (33.64)	
At least once a week	2259 (44.69)	544 (36.53)		2258 (43.20)	545 (41.38)	
Body mass index						
Normal	2489 (49.24)	725 (48.69)	0.1616	2531 (48.42)	683 (51.86)	0.0606
Overweight	1859 (36.78)	527 (35.39)		1940 (37.11)	446 (33.86)	
Obesity	707 (13.99)	237 (15.92)		756 (14.46)	188 (14.27)	

JI: job insecurity; EA: environmental annoyance
Differences were determined by Student's t-test or Chi-Square test.

After the 2-year follow-up in 2011, 571 (8.7 %) participants rated their health as poor. 305 (53.4 %) of these incident cases were female. As evident in table 2, job insecure participants and environmentally annoyed participants had comparable risks of reporting incident poor health. The excess risk for each exposure was estimated to increase by 40 % in the first Poisson regression series on independent effects. In the second series on joint effects, the

composite exposure variable confirmed the main effects of both variables in the exposure categories ‘perceived higher job insecurity and lower environmental annoyance’ and ‘perceived lower job insecurity and higher environmental annoyance’. The joint exposure to both perceived higher job insecurity and high environmental annoyance at baseline was associated with a double excess risk of self-rated poor health two years later. Associations remained stable throughout adjustment procedure as shown by models I and II.

Table 2 Independent and joint associations of job insecurity (JI) and environmental annoyance (EA) with incident self-rated poor health (RRs and 95% CI)

Independent effects of JI and EA		Model I	Model II
n (%)			
Lower JI (ref.)	5,055 (77.25)	1	1
Higher JI	1,489 (22.75)	1.43 (1.20, 1.69)	1.37 (1.16, 1.63)
Lower EA (ref.)	5,227 (79.87)	1	1
Higher EA	1,317 (20.13)	1.43 (1.20, 1.70)	1.44 (1.21, 1.71)
Joint effects of JI and EA		Model I	Model II
n (%)			
Lower JI + lower EA (ref.)	4,111 (68.82)	1	
Higher JI + lower EA	1,116 (17.05)	1.44 (1.17, 1.77)	1.39 (1.13, 1.71)
Lower JI + higher EA	944 (14.43)	1.44 (1.17, 1.79)	1.46 (1.18, 1.81)
Higher JI + higher EA	373 (5.70)	2.07 (1.54, 2.64)	1.95 (1.49, 2.55)

JI: job insecurity; EA: environmental annoyance
RR: risk ratio; 95 % CI: confidence interval
Model I: adjustment for age and gender
Model II: model I additionally adjusted for education, income, marital status, contract type, smoking, alcohol consumption, physical exercise, and body-mass-index

DISCUSSION

In line with earlier population-based studies on either job insecurity (e.g.^{29, 30}) or annoyance due to noise pollution and / or air pollution (e.g.^{17, 25}), we observed positive associations with self-rated poor health. What is more, we could document that these exposures, if examined based on same data base, show both independent and joint associations with incident self-rated poor health. Our findings of additive associations are similar to the patterns observed by¹⁵ on myocardial infarction, though comparability is limited due to a different work-related exposure (job strain) and different measurements of traffic-related exposure(s).

Based on Appraisal Theory and Conservation of Resources Theory which is used both in occupational health research and environmental psychology (e.g. studies by^{16, 18} and reviews by^{2, 4} for occupational health research as well as studies by^{17, 19, 20} and reviews by^{31, 32} for environmental psychological approaches), we suggest that both associations may originate

from low perceived control over resource maintenance. Psychological stress may result from the experience and subsequent expectation that any efforts and resources spent to prevent resource loss fail to yield the desired or any effect at all. Job insecurity has been conceptually linked to “powerlessness to exercise workplace rights”² and unfavourable physical and psychosocial work conditions undermining employees’ capacity to draw and replenish resources. Annoyance due to noise and air pollution has been conceived as a psychological stress reaction to a lack of coping resources needed to counter the perceived environmental threat to health, which may likewise result in powerlessness to claim citizens’ rights to environmental health. Moreover, stress may arise from resource depletion, since employees blindly start investing resources in coping strategies associated with high physiological costs and negative (subjective) health outcomes, like overworking in order not to lose the job² or withdrawing from work while ruminating^{4, 18} or fostering avoidance and comforting cognitions while suffering from high levels of stress due to noise.¹⁹

These theoretical considerations imply a shared stress-based mechanism, as we showed that perceived job insecurity and annoyance due to noise and air pollution are each associated with incident self-rated poor health and that the strength of any such relationship further increases in case of a joint exposure. In view of the co-occurrence of high job insecurity and high environmental annoyance and their links to health in our sample, we should further elaborate on the theoretical linkages between residential and occupational contexts. A recent conceptual model from occupational health research presents precarious employment to influence health via material deprivation including residential neighbourhood quality.² The differences in personal net income by levels of perceived job insecurity and environmental annoyance in our study sample may give an indication of this pathway, although we could not disclose the causal sequence of job insecurity and residential exposures to noise and air pollution.

Furthermore, the results for the composite exposure variable revealed that the relative absence (or lower values) of one exposure does not reduce the vulnerability to the other remaining exposure. It seems promising for future research to address resources that may exert protective effects in both occupational and residential contexts. Such resources may be personal (like perceived external employability in face of job insecurity¹⁶ or selection, optimisation and compensation strategies in face of uncontrollability feelings arising from effort-reward-imbalance³³) or contextual (like green areas and soundscapes allowing for relaxation and restoration^{34, 35} or area-wide improvements rendering neighbourhood perception more positive³⁶) or both.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

It is a shortcoming of our study that we relied on subjective measures of work-related and environmental exposures, only. These indicate indirect, perceptual pathways of psychological stress, whereas direct physiological effects due to the objective intractability of job insecurity as well as of air and noise pollution cannot be detected. Objective conditions should be added in future analyses to fathom the interplay of direct and indirect pathways (e.g.¹⁷) and to recognise differential patterns of confounding and moderating variables. Given the distributional discrepancy between road traffic noise and noise annoyance, for example, evidence for social inequalities in road traffic exposure largely varies by the indicators used.²⁶ In addition, we did not consider changes in exposure due to residential relocation or to regained job security between 2009 and 2011, which might have led to an underestimation of true associations between the two perceived exposures and self-rated poor health (as implied by³⁷ investigating the association of environmental disadvantage on self-rated poor health based on the GSOEP). However, perceived job insecurity has been found to have an aftereffect even after its cessation²⁹ and self-selection according to noise sensitivity and noise annoyance could not be corroborated in empirical studies.³⁶ Furthermore, we did not have information on the perceived emission sources and other non-acoustical variables accounting for differences in noise annoyance, such as attitudes towards noise sources and trust in regulatory authorities.^{20, 31, 32, 38, 39}

To the best of our knowledge, this is the first study to analyse the independent and joint associations of perceived job insecurity and annoyance due to noise and air pollution with incident self-rated poor health. If confirmed elsewhere, our findings call for more research integrating objectively intractable and subjectively uncontrollable exposures from different sectors to understand the multi-causality of health (inequities) as implied by social epidemiological models on the social and societal determinants of health (see for an overview Krieger¹², for example).

Authors' contribution

NR wrote the draft of the manuscript. AL, GB, and JL substantially contributed to the line of argumentation and revision of the manuscript. JL prepared the data including merging procedures. NR and JL conducted the statistical analyses.

Acknowledgments

The authors are grateful to the German Institute for Economic Promotion (DIW), Berlin, for the Provision of the German Socio-economic Panel (GSOEP) data employed for the current manuscript.

NR is currently funded for a research project within the framework of the Institutional Strategy of the University of Bremen. This strategy is financed by the German Federal Government's and the Federal States' 'Excellence Initiative'.

Conflicts of interests

None declared.

Patient consent

Obtained by the German Socioeconomic Panel.

Ethics Approval

Obtained by the German Socioeconomic Panel.

Data sharing statement

The German Socioeconomic Panel is a public-use data set that can be obtained from the German Institute for Economic Promotion (DIW), Berlin.

REFERENCES

1 van Gyes G, Szeker L. Impact of the crisis on working conditions in Europe. European Foundation for the Improvement of Living and Working Conditions; 2013 [04 May 2016]; <http://www.eurofound.europa.eu/observatories/eurwork/comparative-information/impact-of-the-crisis-on-working-conditions-in-europe>.

2 Benach J, Vives A, Amable M, et al. Precarious Employment: Understanding an Emerging Social Determinant of Health. *Annu Rev Public Health* 2014;35:229–53.

3 Landsbergis PA, Grzywacz JG, LaMontagne AD. Work Organization, Job Insecurity, and Occupational Health Disparities. *Am J Industrial Medicine* 2014;57:495–515.

4 deWitte H, Pienaar J, de Cuyper N. Review of 30 Years of Longitudinal Studies on the Association Between Job Insecurity and Health and Well-Being: Is There Causal Evidence? *Australian Psychologist* 2016;51:18–31.

5 Umweltbundesamt [Statistics on Transport] 2012; [04 May 2016]; <http://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/4364.pdf>.

6 European Commission. EU transport in figures. Statistical pocketbook 2013. 2013; [04 May 2016]; [<http://ec.europa.eu/transport/facts-fundings/statistics/doc/2013/pocketbook2013.pdf>].

7 European Commission. White Paper. Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. 2011; [04 May 2016]; <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0144&from=EN>.

8 European Environmental Agency. Noise in Europe; 2014 [04 May 2016]; <http://www.eea.europa.eu/publications/noise-in-europe-2014>.

9 World Health Organization Regional Office for Europe. Burden of disease from environmental noise. Quantification of healthy life years lost in Europe; 2011 [04 May 2016]; http://www.who.int/quantifying_ehimpacts/publications/e94888/en/.

10 World Health Organization Regional Office for Europe. Environmental health inequalities in Europe. Assessment report; 2012 [04 May 2016] http://www.euro.who.int/__data/assets/pdf_file/0010/157969/e96194.pdf.

11 World Health Organisation Commission on Social Determinants of Health. Closing the gap in a generation. Health equity through action on the social determinants of health. 2008 [04 May 2016]; http://apps.who.int/iris/bitstream/10665/43943/1/9789241563703_eng.pdf.

12 Krieger N. Epidemiology and the people's health. Theory and context. New York: Oxford University Press.

13 Lindgren A, Björk J, Stroh E, Jakobsson K. Adult asthma and traffic exposure at residential address, workplace address, and self-reported daily time outdoor in traffic: A two-stage case-control study. *BMC Public Health* 2010;10:716.

14 Méline J, Van Hulst A, Thomas F et al. Road, rail, and air transportation noise in residential and workplace neighborhoods and blood pressure (RECORD Study). *Noise and Health* 2015;17(78):308-319.

15 Selander J, Bluhm G, Nilsson M, et al. 2013. Joint effects of job strain and road-traffic and occupational noise on myocardial infarction. *Scand J Work Environ Health* 2013;39(2):195-203.

- 16 deCuyper N, Mäkikangas A, Kinnunen U, et al. Cross-lagged associations between perceived external employability, job insecurity, and exhaustion: Testing gain and loss spirals according to the Conservation of Resources Theory. *J Organiz Behav* 2012; 33:770–788.
- 17 Riedel N, Köckler H, Scheiner J, et al. Objective exposure to road traffic noise, noise annoyance and self-rated poor health – framing the relationship between noise and health as a matter of multiple stressors and resources in urban neighbourhoods. *J Env Planning and Management* 2015;58(2):336–356.
- 18 van der Elst T, De Cuyper N, Baillien E, et al. Perceived Control and Psychological Contract Breach as Explanations of the Relationships Between Job Insecurity, Job Strain and Coping Reactions: Towards a Theoretical Integration. *Stress and Health* 2016; 32(2):100–16.
- 19 van Kamp I. Coping with noise and its health consequences. Groningen, The Netherlands: The University of Groningen 1990.
- 20 Kroesen M, Molin EJE, van Wee B. Testing a theory of aircraft noise annoyance: A structural equation analysis. *J Acoust Soc Am* 2008;123(6):4250–4260.
- 21 Schupp J. [The Socioeconomic Panel (SOEP)]. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2012;55:767–74.
- 22 Bethge M, Radoschewski FM, Muller-Fahrnow W. [Job insecurity as risk for adverse health effects amongst German workers: a cohort study]. *Gesundheitswesen* 2008;70:381–6.
- 23 Muenster E, Rueger H, Ochsmann E, et al. Association between overweight, obesity and self-perceived job insecurity in German employees. *BMC Public Health* 2011;11:162.
- 24 Loerbroks A, Bosch JA, Douwes J et al. Job insecurity is associated with adult asthma in Germany during Europe's recent economic crisis: a prospective cohort study. *J Epidemiol Community Health* 2014; 68:1196–1199.
- 25 Pollack CE, von dem Knesebeck O, Siegrist J. Housing and health in Germany. *J Epidemiol Community Health* 2004;58:216–222.
- 26 Riedel N, Scheiner J, Müller G, et al. Assessing the relationship between objective and subjective indicators of residential exposure to road traffic noise in the context of environmental justice. *J Env Planning Management* 2014;57(9):1398–1421.
- 27 Kohlhuber M, Mielck A, Weiland S, et al. Social inequality in perceived environmental exposures in relation to housing conditions in Germany. *Env Research* 2006; 101(2):246–255.
- 28 Zou G, Donner A. Extension of the modified Poisson regression model to prospective studies with correlated binary data. *SMM Research* 2011;22(6): 661–670.
- 29 Ferrie JE, Shipley MJ, Stansfeld SA, et al. Effects of chronic job insecurity and change in job security on self reported health, minor psychiatric morbidity, physiological measures, and health related behaviours in British civil servants: the Whitehall II study. *J Epidemiol Community Health* 2002;56:450–4.
- 30 Lazlo KD, Pikhart H, Kopp MS et al. Job insecurity and health: A study of 16 European countries. *Soc Sci Med* 2010;70:867–874.
- 31 Job RFS. The influence of subjective reactions to noise on health effects of the noise. *Environmental International* 1996;22(1):93–104.

32 Stallen PJM. A theoretical framework for environmental noise annoyance. *Noise Health* 1999; 1:69-79.

33 Shang L, Riedel N, Loerbroeks A et al. The association between effort-reward imbalance and depressive symptoms is modified by selection, optimization, and compensation strategy. *JOEM* 2015; 57(11):1222-1227.

34 Ward Thompson C, Roeb J, Aspinall P et al. More green space is linked to less stress in deprived communities: Evidence from salivary cortisol patterns. *Landscape and Urban Planning* 2012;105(3):221-229.

35 van Kamp I, Klæboe R, Brown AL, et al. Soundscapes, human restoration and quality of life. In: Kang J, Schulte-Fortkamp eds. *Soundscape and the Built Environment*. Abdington, UK: CRC Press, Taylor & Francis Group: 43-68.

36 Brown AL, van Kamp I. Response to a change in transport noise exposure: Competing explanations of change effects. *J Acoust Soc Am* 2009;125(2):905–914.

37 Baar J, Romppel M, Igel U, et al. The association between physical environment and health: indicating the direction of effects using German panel data. *Int J Occup Environ Health*. 2016 Jan 29:1-6. [Epub ahead of print]

38 Flindell IH, Stallen PM. Non-acoustical factors in environmental noise. *Noise Health* 1999;1(3):11-6.

39 Guski R. Personal and social variables as co-determinants of noise annoyance. *Noise Health* 1999; 1(3): 45–56.

STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

STROBE Statement		Checklist of items that should be included in reports of cohort studies	
	Item No	Recommendation	Check
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	done, p. 1 (title), p. 2 (abstract, indicating panel data and prospective analysis)
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	done, p. 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	done, p. 4
Objectives	3	State specific objectives, including any prespecified hypotheses	done, pp. 4-5
Methods			
Study design	4	Present key elements of study design early in the paper	done, p. 5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	done, p. 5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	done, p. 5
		(b) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	done, pp. 5-6
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	done, pp. 5-6
Bias	9	Describe any efforts to address potential sources of bias	n/a ¹
Study size	10	Explain how the study size was arrived at	done, p. 5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	done, p. 5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	done, pp. 6-7
		(b) Describe any methods used to examine subgroups and interactions	n/a
		(c) Explain how missing data were addressed	done, p. 5
		(d) If applicable, explain how loss to follow-up was addressed	n/a ¹
		(e) Describe any sensitivity analyses	done, p. 6
Results			
Participants	13*	(a) Report numbers of individuals at each stage of	done, p. 5

		study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	n/a ¹
		(c) Consider use of a flow diagram	n/a ¹
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	done, pp. 7-8
		(b) Indicate number of participants with missing data for each variable of interest	done, p. 5
		(c) Summarise follow-up time (eg, average and total amount)	done, pp. 7-8
Outcome data	15*	Report numbers of outcome events or summary measures over time	done, p. 8
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	done, pp. 6, 8-9
		(b) Report category boundaries when continuous variables were categorized	done, pp. 5-6
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	done, p. 6
Discussion			
Key results	18	Summarise key results with reference to study objectives	done, p. 9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	done, p. 11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	done, pp. 10-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	done, p. 11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	n/a

*Give information separately for exposed and unexposed groups.

¹ Analysis of secondary data from a national representative cohort study

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.

For peer review only

BMJ Open

Do perceived job insecurity and annoyance due to air and noise pollution predict incident self-rated poor health? A prospective analysis of independent and joint associations using a German national representative cohort study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2016-012815.R1
Article Type:	Research
Date Submitted by the Author:	08-Aug-2016
Complete List of Authors:	Riedel, Natalie; University of Bremen, Institute of Public Health and Nursing Research Loerbroks, Adrian; University of Düsseldorf, Institute of Occupational and Social Medicine Bolte, Gabriele; University of Bremen; Institute for Public Health and Nursing Research, Dept. 5 Social Epidemiology Li, Jian
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Public health, Occupational and environmental medicine
Keywords:	PUBLIC HEALTH, EPIDEMIOLOGY, OCCUPATIONAL & INDUSTRIAL MEDICINE

SCHOLARONE™
Manuscripts

Only

Research report to BMJ Open

“Do perceived job insecurity and annoyance due to air and noise pollution predict incident self-rated poor health? A prospective analysis of independent and joint associations using a German national representative cohort study”

Natalie Riedel^{*1}, Adrian Loerbroks², Gabriele Bolte¹, Jian Li²

¹ Department of Social Epidemiology, Institute for Public Health and Nursing Research, University of Bremen, Grazer Straße 4, 28359 Bremen, Germany

² Institute for Occupational, Social, and Environmental Medicine, Center for Health and Society, Faculty of Medicine, University of Düsseldorf, Universitätsstraße 1, Düsseldorf 40225, Germany

* Correspondence to Natalie Riedel, Telephone: +49 421 218-68827, Email: nriedel@uni-bremen.de

Key words perceived job insecurity, annoyance due to noise and air pollution, perceived uncontrollability, self-rated health, prospective study

Word count: 2,948

ABSTRACT

Background Current economic and social change has contributed to increasing job insecurity and traffic-related pollution in residential areas. Both job insecurity and exposure to noise and air pollution are known determinants of population health and can concur in peoples' lives. This may hold true particularly for socially disadvantaged subpopulations. Nevertheless, the potential independent and joint links of those exposures to health have been rarely examined so far. We aimed to contribute to the scarce body of evidence.

Methods Information on perceived job insecurity and exposures to noise and air pollution as expressed by annoyance as well as on self-rated health were gathered from two waves of the population-based German Socioeconomic Panel (2009 and 2011, N=6,544). We performed multivariable Poisson regression to examine the independent and joint risk of poor health in 2011 by perceived job insecurity and annoyance due to noise and air pollution in 2009.

Results After the 2-year follow-up in 2011, 571 (8.7 %) participants rated their health as poor. The risk of reporting incident poor health was increased by roughly 40 % in employees reporting high vs. low perceived job insecurity and annoyance due to noise and air pollution, respectively. This risk increased when both exposures were present at higher levels (RR=1.95 (1.49, 2.55)).

Conclusions Work-related and environmental exposures may accumulate and have a joint health impact. Elaboration on the link between occupational and residential exposures is warranted in light of their concurrence and their implications for health inequities.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

STRENGTHS AND LIMITATIONS

- Both perceived job insecurity and annoyance due to traffic-related exposures have advanced as major risk factors for population health. Although they are likely to concur, their independent and joint health effects have not been studied yet.
- In this prospective, population-based study, we could document that perceived job insecurity and annoyance due to noise and air pollution show both independent and joint associations with incident self-rated poor health.
- Subjective measures of job insecurity and exposure to noise and air pollution indicate indirect, perceptual pathways of psychological stress. Thus, we could not detect direct physiological effects due to the objective intractability of these two exposures.
- Our study underlines the need to integrate work-related and environmental research both conceptually and empirically.

INTRODUCTION

With labour markets growing more and more unpredictable, perceptions of job insecurity have increased across European Union member states and beyond.¹⁻³ Longitudinal studies have consistently shown that high job insecurity predicts poor health outcomes.⁴

In addition to perceived job insecurity, other components of current economic and social change (e.g. job specialisation, globalisation, double breadwinner households) are associated with an increase in transportation in the European Union during the past decades.⁵⁻⁷ A further increase in freight traffic is still expected despite the economic crisis in 2009.⁷ Motorised transportation constitutes a major cause for chronic, local exposure to noise and air pollution.^{5, 8, 9} Traffic-related noise and ultrafine particulate matter air pollution have been identified as the most important environmental challenges in Western European cities,⁸ which has been illustrated by estimating an enormous number of healthy life years lost from noise annoyance (i.e. 654 000 disability-adjusted life-years).⁹

In view of these current developments, it is plausible to assume that job insecurity and traffic-related exposures are likely to concur in residential and occupational contexts. This may hold true particularly for socially disadvantaged subpopulations (e.g.^{3, 10}). This notion is in line with social epidemiological models on health determinants and inequities, which highlight the accumulation of exposures across contexts.^{11, 12} However, there is little research linking different types of work-related and residential exposures to health in one single study, although there are studies on traffic-related air and noise pollution modelling peoples' (outdoor) exposures in both occupational and residential contexts (e.g.¹³ for a study on asthma and¹⁴ for a study on blood pressure). We are aware of only one cross-sectional study suggesting an accumulation of physiological impacts of objective residential and occupational noise exposure and/or self-reported job strain on myocardial infarction while adjusting for air pollution.¹⁵

In the current study, we aim to contribute to this scarce body of evidence by examining the independent and joint associations of perceived job insecurity and annoyance due to noise and air pollution with self-rated poor health in a representative sample of the German working population. In doing so, we focus on indirect psychological pathways from these two contextual exposures to health and recur to parallel lines of argumentation within both occupational health and environmental psychology (e.g. Conservation of Resources Theory by Hobfoll in^{16, 17} or the Appraisal Theory by Lazarus and Folkman in¹⁸⁻²⁰). That is, we assume that perceived job insecurity and annoyance due to noise and air pollution in the

residential area may share the same stress-based mechanism to produce poor health: perceived uncontrollability of exposure and its feared or unwanted consequences of resource loss, (mal-)adaptive behavioural responses implying (vain) resource investment and subsequent physiological costs, and finally, adverse health outcomes.

METHODS

Study population and study sample

We retrieved our study sample from the German Socio-Economic Panel (GSOEP), a national survey conducted annually by face-to-face interviews in representatively selected households since 1984.²¹ All household members aged 18 + were eligible for participation after giving their informed consent. Our prospective, complete case analysis is primarily based on data from the 2009 and 2011 waves covering topics such as work and employment (including job insecurity) in the individual questionnaire as well as housing and environmental exposures in the household questionnaire (incl. annoyance due to noise and air pollution). Using the household code as key variable, household-level information was added to the data on each individual in the household. Given our study aim, we restricted our analysis to participants employed (total: N=11,381, complete cases: N=9,493, 83.4%) in our baseline in 2009 and still remaining in the GSOEP in our follow-up in 2011 (N=7,339, response rate=77.5 %). Further, we considered only those who were in good health in 2009 (see measures below). Thus, our study sample included 6,544 participants (89.2 % of 7,339) living in 4,626 households.

The GSOEP is compliant with national laws. It is evaluated by the German Council of Science and Humanities at the German Institute for Economic Promotion (DIW) and is explicitly intended for epidemiological analyses.²¹

Exposure and outcome measures

At our baseline in 2009, perceived job insecurity was assessed by participants' anticipated probability of losing their job within the next two years on a 10 % decrement scale.²²⁻²³ A cut-off point of ≥ 50 % on this scale was found to be both conceptually meaningful and statistically efficient to differentiate between perceived lower and higher job insecurity²⁴ (we call the participants with perceived higher job insecurity shortly 'job insecure').

Annoyance due to noise and air pollution in the residential area was derived from the household representatives' reporting of the degree of disturbance. Though not source-specific, we may regard these variables as proxy for perceived exposures related to traffic as main

emission source. Household-specific disturbance values were assigned to the individuals belonging to the same household at the respective address. While rated separately on five point Likert scales, disturbances due to noise and air pollution were highly correlated ($r_s = 0.67$). In line with an earlier GSOEP study,²⁵ we summed up the values of both items, with higher values signalling a higher degree of disturbance (called hereafter 'environmental annoyance'). We dichotomised this sum scale whose scores ranged from 2 (not at all affected by both noise and air pollution) to 10 (very strongly affected by both noise and air pollution) at the cut-off point ≥ 5 . Thus, environmental annoyance was assumed to be present at higher levels in 2009 if households perceived disturbance due to noise and / or due to air pollution as being just bearable, strong, or very strong (we call these participants shortly 'environmentally annoyed'). This cut-off point served both statistical efficiency and empirical relevance. Sensitivity analyses using two alternative cut-off points (≥ 4 and ≥ 6) did not reveal substantial differences in effect sizes of environmental annoyance in relation to self-rated poor health (see statistical analyses below). Similar cut-off points have been employed to indicate higher levels of noise annoyance on five point Likert scales in previous population-based studies.^{17, 26, 27}

Finally, the dichotomised information on job insecurity and environmental annoyance was combined in one composite variable with four exposure categories, with 'perceived lower job insecurity and lower environmental annoyance' as reference group as compared to the categories 'perceived higher job insecurity and lower environmental annoyance', 'perceived lower job insecurity and higher environmental annoyance', as well as 'perceived higher job insecurity and higher environmental annoyance'.

We inferred our incident outcome variable from one single question making participants rate their health on five point Likert scale. Those who reported their health as 'not so good' or 'bad' were defined as having a poor health.

Potential confounders

Besides age and gender, we considered educational attainment (continuous, as measured by years of formal education), personal net income (continuous, log-transformed for multivariable analysis due to skewness), marital status, and contract type (permanent as opposed to non-permanent contract) as indicators of participants' socio-demographic and economic position at our baseline in 2009. Health-related behaviour was mostly measured in the wave prior to our baseline by current smoking, alcohol consumption, physical exercise, and body mass index (see²⁴).

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Statistical analyses

Differences in potential confounders between levels of perceived job insecurity and environmental annoyance were determined by Student's t-text or Chi-Square test. Associations of perceived job insecurity and environmental annoyance in 2009 with an incident self-rated poor health in 2011 were quantified by risk ratios (RRs) with 95% confidence intervals (CIs) using Poisson regression with a log-link function. To account for household clustering, we integrated a sandwich variance estimator in the Poisson regression models by means of the household code as cluster identifier.²⁸ First, we simultaneously entered perceived job insecurity and environmental annoyance in 2009 as independent predictors of a self-rated poor health in 2011. Second, we estimated their joint effects as measured by the composite exposure variable. In both regression series, we adjusted for age and gender in model I as well as for socio-demographic and economic position and health-related behaviour in model II in order to assess robustness of associations. Statistical analyses were performed using SAS, version 9.4

RESULTS

On average, 1.4 persons lived in one household in 2009, with the household size ranging from one to five individuals. One in five participants reported higher job insecurity or higher environmental annoyance. Both exposures co-occurred in 373 (5.7 %) participants; among job insecure participants, odds of being environmentally annoyed were elevated by 50 % (OR 1.50, 95% CI 1.27 - 1.67). Characteristics of the study sample stratified by the two levels of perceived job insecurity and environmental annoyance are shown in table 1. Lower personal net income levels, the unmarried and separated/divorced/widowed status as well as non-permanent contracts were more prevalent among participants characterised by perceived higher job insecurity or higher environmental annoyance. Job insecure participants were two years younger at an average and more often lower educated. Overweight and obesity as well as physical inactivity were more common among job insecure participants, whereas the opposite was true for regular alcohol consumption. No clear behavioural pattern could be observed for the two levels of environmental annoyance.

Table 1 Characteristics of the study population at baseline in 2009 (N=6,544) stratified by levels of perceived job insecurity (JI) and of environmental annoyance (EA) in 2009

Characteristics, n (%)	Lower JI 5,055 (77.25)	Higher JI 1,489 (22.75)	p value	Lower EA 5,227 (79.87)	Higher EA 1,317 (20.13)	p value
Continuous variables, mean (SD)						
Age (years)	43.71 (10.85)	41.68 (11.19)	< 0.0001	43.26 (10.90)	43.18 (11.18)	0.8140
Education (years)	13.12 (2.83)	12.37 (2.48)	< 0.0001	12.94 (2.77)	13.00 (2.79)	0.4329
Personal net income per month (€)	1835 (1389)	1375 (1067)	< 0.0001	1757 (1359)	1623 (1238)	0.0112
Categorical variables, n (%)						
Female	2407 (47.62)	747 (50.17)	0.0833	2497 (47.77)	657 (49.89)	0.1698
Marital status						
Unmarried	1202 (23.78)	441 (29.62)	<.0001	1268 (24.26)	375 (28.47)	0.0028
Separated/ divorced/widowed	444 (8.78)	142 (9.54)		461 (8.82)	125 (9.49)	
Married	3409 (67.44)	906 (60.85)		3498 (66.92)	817 (62.03)	
Non-permanent contract	1116 (22.08)	475 (31.90)	<.0001	1237 (23.67)	354 (26.88)	0.0151
Current smoking	1463 (28.94)	504 (33.85)	0.0003	1561 (29.86)	406 (30.83)	0.4955
Regular alcohol consumption	1028 (20.34)	260 (17.46)	0.0142	1045 (19.99)	243 (18.45)	0.2086
Physical exercise						
Never	1279 (25.30)	440 (29.55)	<.0001	1390 (26.59)	329 (24.98)	0.0536
Less than once a week	1517 (30.01)	505 (33.92)		1579 (30.21)	443 (33.64)	
At least once a week	2259 (44.69)	544 (36.53)		2258 (43.20)	545 (41.38)	
Body mass index						
Normal	2489 (49.24)	725 (48.69)	0.1616	2531 (48.42)	683 (51.86)	0.0606
Overweight	1859 (36.78)	527 (35.39)		1940 (37.11)	446 (33.86)	
Obesity	707 (13.99)	237 (15.92)		756 (14.46)	188 (14.27)	

JI: job insecurity; EA: environmental annoyance
Differences were determined by Student's t-test or Chi-Square test.

After the 2-year follow-up in 2011, 571 (8.7 %) participants rated their health as poor. 305 (53.4 %) of these incident cases were female. Table 2 displays a bivariate association between higher levels of perceived job insecurity or environmental annoyance and incident self-rated poor health.

Table 2 Incident self-rated poor health in 2011 (N=571, 8.7%, out of 6,544) stratified by levels of perceived job insecurity (JI) and of environmental annoyance (EA) in 2009

Characteristic, n (%)	Lower JI 5,055 (77.25)	Higher JI 1,489 (22.75)	p value	Lower EA 5,227 (79.87)	Higher EA 1,317 (20.13)	p value
Incident Self-rated poor health	404 (7.99)	167 (11.22)	<.0001	416 (7.96)	155 (11.77)	<.0001

JI: job insecurity; EA: environmental annoyance
Differences were determined by Chi-Square test.

As evident in table 3, job insecure participants and environmentally annoyed participants had comparable risks of reporting incident poor health. The excess risk for each exposure was estimated to increase by 40 % in the first Poisson regression series on independent effects. In the second series on joint effects, the composite exposure variable confirmed the main effects of both variables in the exposure categories ‘perceived higher job insecurity and lower environmental annoyance’ and ‘perceived lower job insecurity and higher environmental annoyance’. The joint exposure to both perceived higher job insecurity and higher environmental annoyance at baseline was associated with a double excess risk of self-rated poor health two years later. Associations remained stable throughout adjustment procedure as shown by models I and II.

Table 3 Independent and joint associations of job insecurity (JI) and environmental annoyance (EA) with incident self-rated poor health (RRs and 95% CI)

Independent effects of JI and EA		Model I	Model II
n (%)			
Lower JI (ref.)	5,055 (77.25)	1	1
Higher JI	1,489 (22.75)	1.43 (1.20, 1.69)	1.37 (1.16, 1.63)
Lower EA (ref.)	5,227 (79.87)	1	1
Higher EA	1,317 (20.13)	1.43 (1.20, 1.70)	1.44 (1.21, 1.71)
Joint effects of JI and EA		Model I	Model II
n (%)			
Lower JI + lower EA (ref.)	4,111 (68.82)	1	
Higher JI + lower EA	1,116 (17.05)	1.44 (1.17, 1.77)	1.39 (1.13, 1.71)
Lower JI + higher EA	944 (14.43)	1.44 (1.17, 1.79)	1.46 (1.18, 1.81)
Higher JI + higher EA	373 (5.70)	2.07 (1.54, 2.64)	1.95 (1.49, 2.55)

JI: job insecurity; EA: environmental annoyance
RR: risk ratio; 95 % CI: confidence interval
Model I: adjustment for age and gender
Model II: model I additionally adjusted for education, income, marital status, contract type, smoking, alcohol consumption, physical exercise, and body-mass-index

DISCUSSION

In line with earlier population-based studies on either job insecurity (e.g.^{29, 30}) or annoyance due to noise pollution and / or air pollution (e.g.^{17, 25}), we observed positive associations with self-rated poor health. What is more, we could document that these exposures, if examined based on the same database, show both statistically independent and joint associations with incident self-rated poor health. Our findings of additive associations are similar to the patterns observed by¹⁵ on myocardial infarction, though comparability is limited due to a different work-related exposure (job strain) and different measurements of traffic-related exposure(s).

Based on Appraisal Theory and Conservation of Resources Theory which are used both in occupational health research and environmental psychology (e.g. studies by^{16, 18} and reviews by^{2, 4} for occupational health research as well as studies by^{17, 19, 20} and reviews by^{31, 32} for environmental psychological approaches), we suggest that both associations may originate from low perceived control over resource maintenance. Psychological stress may result from the experience and subsequent expectation that any efforts and resources spent to prevent resource loss fail to yield the desired or any effect at all. Job insecurity has been conceptually linked to “powerlessness to exercise workplace rights”² and unfavourable physical and psychosocial work conditions undermining employees’ capacity to draw and replenish resources. Annoyance due to noise and air pollution has been conceived as a psychological stress reaction to a lack of coping resources needed to counter the perceived environmental threat to health, which may likewise result in powerlessness to claim citizens’ rights to environmental health. Moreover, stress may arise from resource depletion, since employees blindly start investing resources in coping strategies associated with high physiological costs and negative (subjective) health outcomes, like overworking in order not to lose the job² or withdrawing from work while ruminating^{4, 18} or fostering avoidance and comforting cognitions while suffering from high levels of stress due to noise.¹⁹

These theoretical considerations imply a shared stress-based mechanism, as we showed that perceived job insecurity and annoyance due to noise and air pollution are each associated with incident self-rated poor health and that the strength of any such relationship further increases in case of a joint exposure. In view of the co-occurrence of high job insecurity and high environmental annoyance and their links to health in our sample, we should further elaborate on the theoretical linkages between residential and occupational contexts. Having been discussed in work stress^{33, 34} and noise research^{19, 35}, the Cognitive Activation Theory of Stress (CATS)^{36, 37} is a valuable, complementary approach to understand potential spill-over effects of exposures from different contexts. This psychobiological theory posits that stress-induced pathophysiological processes are shaped by behavioural outcome expectancies

individuals have learned in response to stress stimuli. The resulting physiological activation level may influence individuals' resilience to future exposures from both contexts. If individuals have learned to attribute the perceived exposure to job insecurity and noise and air pollution to external, intractable causes, they may develop no control or negative expectancies, i.e. generalised helplessness and hopelessness. These types of outcome expectancies can cause pathophysiological changes. By contrast, a positive outcome expectancy in terms of generalised self-efficacy is linked to reduced physiological activation and improved health. That is, a positive behavioural outcome expectancy acquired in the residential context might help a resident survive in the occupational context, whereas threats to an employee's resources in the occupational context could affect her agency and health in the residential context due to no control or negative outcome expectancies.

The results for the composite exposure variable revealed that the relative absence (or lower values) of one exposure does not reduce the vulnerability to the other remaining exposure. It seems promising for future research to address resources that may exert protective effects in both occupational and residential contexts and play a key role in intervention strategies aiming to reduce health inequities. Such resources may be personal (like CATS positive outcome expectancy, perceived external employability in face of job insecurity¹⁶ or selection, optimisation and compensation strategies in face of uncontrollability feelings arising from effort-reward-imbalance³⁸) or contextual (like green areas and soundscapes allowing for relaxation and restoration^{39, 40} or area-wide improvements rendering neighbourhood perception more positive⁴¹) or both.

Linking up with social determinants of health, a recent conceptual model from occupational health research presents precarious employment to influence health via material deprivation including residential neighbourhood quality.² The differences in personal net income by levels of perceived job insecurity and environmental annoyance in our study sample may give a vague indication of this pathway, although we could not disclose the causal sequence of job insecurity and residential exposures to noise and air pollution.

It is a shortcoming of our study that information on annoyance due to noise and air pollution was not available in the individual questionnaire. In view of small household sizes in the GSOEP, we may still assume that our exposure variable from the GSOEP household questionnaire reflects the perceived presence of environmental exposures sufficiently. Furthermore, we relied on subjective measures of work-related and environmental exposures, only. These indicate indirect, perceptual pathways of psychological stress, whereas direct

physiological effects due to the objective intractability of job insecurity as well as of air and noise pollution cannot be detected. Chronic exposure to ultrafine particulate matter and road traffic noise at night-time were recently estimated to be independently related to an indicator of subclinical atherosclerosis.⁴² Objective conditions should be added in future analyses to fathom the interplay of direct and indirect pathways (e.g.¹⁷). It follows from CATS that sustained physiological activation may increase individuals' vulnerability to physical and chemical exposures like air and noise pollution (as is also suggested by socio-environmental epidemiological frameworks of environmental health equity⁴³⁻⁴⁴). Considering potential spillover effects between occupational and residential contexts, future research should look for multiplicative interactions between stressors and resources from both contexts over time. However, we were not able to capture multiplicative effects with our data covering two points in time just two years apart.

It would be crucial to recognise differential patterns of confounding and moderating variables. Given the distributional discrepancy between road traffic noise and noise annoyance, for example, evidence for social inequalities in road traffic exposure largely varies by the indicators used.²⁶ In addition, we did not consider changes in exposure due to residential relocation or to regained job security between 2009 and 2011, which might have led to an underestimation of true associations between the two perceived exposures and self-rated poor health (as implied by⁴⁵ investigating the association of environmental disadvantage on self-rated poor health based on the GSOEP). However, perceived job insecurity has been found to have an aftereffect even after its cessation²⁹ and self-selection according to noise sensitivity and noise annoyance could not be corroborated in empirical studies.⁴¹ Furthermore, we did not have information on the perceived emission sources and other non-acoustical variables accounting for differences in noise annoyance, such as attitudes towards noise sources and trust in regulatory authorities.^{20, 31, 32, 46, 47}

To the best of our knowledge, this is the first study to analyse the independent and joint associations of perceived job insecurity and annoyance due to noise and air pollution with incident self-rated poor health. If confirmed elsewhere, our findings call for more research integrating objectively intractable and subjectively uncontrollable exposures from different sectors to understand the multi-causality of health (inequities) as implied by social epidemiological models on the social and societal determinants of health (see for an overview Krieger¹², for example).

Authors' contribution

NR wrote the draft of the manuscript. AL, GB, and JL substantially contributed to the line of argumentation and revision of the manuscript. JL prepared the data. NR and JL conducted the statistical analyses.

Acknowledgments

The authors are grateful to the German Institute for Economic Promotion (DIW), Berlin, for the Provision of the German Socio-economic Panel (GSOEP) data employed for the current manuscript.

NR is currently funded for the research project “Transforming noise action planning into an instrument for more health equity” within the framework of the Institutional Strategy of the University of Bremen. This strategy is financed by the German Federal Government’s and the Federal States’ ‘Excellence Initiative’.

Conflicts of interests

None declared.

Patient consent

Obtained by the German Socioeconomic Panel.

Ethics Approval

Obtained by the German Socioeconomic Panel.

Data sharing statement

The German Socioeconomic Panel is a public-use data set that can be obtained from the German Institute for Economic Promotion (DIW), Berlin.

REFERENCES

- 1 van Gyes G, Szeker L. Impact of the crisis on working conditions in Europe. European Foundation for the Improvement of Living and Working Conditions; 2013 [04 May 2016]; <http://www.eurofound.europa.eu/observatories/eurwork/comparative-information/impact-of-the-crisis-on-working-conditions-in-europe>.
- 2 Benach J, Vives A, Amable M, et al. Precarious Employment: Understanding an Emerging Social Determinant of Health. *Annu Rev Public Health* 2014;35:229–53.
- 3 Landsbergis PA, Grzywacz JG, LaMontagne AD. Work Organization, Job Insecurity, and Occupational Health Disparities. *Am J Industrial Medicine* 2014;57:495–515.
- 4 deWitte H, Pienaar J, de Cuyper N. Review of 30 Years of Longitudinal Studies on the Association Between Job Insecurity and Health and Well-Being: Is There Causal Evidence? *Australian Psychologist* 2016;51:18–31.
- 5 European Commission. White Paper. Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. 2011; [04 May 2016]; <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0144&from=EN>.
- 6 European Commission. EU transport in figures. Statistical pocketbook 2015. 2015; [04 May 2016]; [<http://ec.europa.eu/transport/facts-fundings/statistics/doc/2015/pocketbook2015.pdf>].
- 7 Umweltbundesamt [Transport in figures] 2012; [04 May 2016]; <http://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/4364.pdf>.
- 8 European Environmental Agency. Noise in Europe; 2014 [04 May 2016]; <http://www.eea.europa.eu/publications/noise-in-europe-2014>.
- 9 World Health Organization Regional Office for Europe. Burden of disease from environmental noise. Quantification of healthy life years lost in Europe; 2011 [04 May 2016]; http://www.who.int/quantifying_ehimpacts/publications/e94888/en/.
- 10 World Health Organization Regional Office for Europe. Environmental health inequalities in Europe. Assessment report; 2012 [04 May 2016] http://www.euro.who.int/__data/assets/pdf_file/0010/157969/e96194.pdf.
- 11 World Health Organisation Commission on Social Determinants of Health. Closing the gap in a generation. Health equity through action on the social determinants of health. 2008 [04 May 2016]; http://apps.who.int/iris/bitstream/10665/43943/1/9789241563703_eng.pdf.
- 12 Krieger N. Epidemiology and the people's health. Theory and context. New York: Oxford University Press.
- 13 Lindgren A, Björk J, Strohm E, Jakobsson K. Adult asthma and traffic exposure at residential address, workplace address, and self-reported daily time outdoor in traffic: A two-stage case-control study. *BMC Public Health* 2010;10:716.
- 14 Méline J, Van Hulst A, Thomas F et al. Road, rail, and air transportation noise in residential and workplace neighborhoods and blood pressure (RECORD Study). *Noise and Health* 2015;17(78):308-319.
- 15 Selander J, Bluhm G, Nilsson M, et al. 2013. Joint effects of job strain and road-traffic and occupational noise on myocardial infarction. *Scand J Work Environ Health* 2013;39(2):195-203.

16 deCuyper N, Mäkikangas A, Kinnunen U, et al. Cross-lagged associations between perceived external employability, job insecurity, and exhaustion: Testing gain and loss spirals according to the Conservation of Resources Theory. *J Organiz Behav* 2012; 33:770–788.

17 Riedel N, Köckler H, Scheiner J, et al. Objective exposure to road traffic noise, noise annoyance and self-rated poor health – framing the relationship between noise and health as a matter of multiple stressors and resources in urban neighbourhoods. *J Env Planning and Management* 2015;58(2):336–356.

18 van der Elst T, De Cuyper N, Baillien E, et al. Perceived Control and Psychological Contract Breach as Explanations of the Relationships Between Job Insecurity, Job Strain and Coping Reactions: Towards a Theoretical Integration. *Stress and Health* 2016; 32(2):100–16.

19 van Kamp I. Coping with noise and its health consequences. Groningen, The Netherlands: The University of Groningen 1990.

20 Kroesen M, Molin EJE, van Wee B. Testing a theory of aircraft noise annoyance: A structural equation analysis. *J Acoust Soc Am* 2008;123(6):4250–4260.

21 Schupp J. [The Socioeconomic Panel (SOEP)]. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2012;55:767–74.

22 Bethge M, Radoschewski FM, Muller-Fahrnow W. [Job insecurity as risk for adverse health effects amongst German workers: a cohort study]. *Gesundheitswesen* 2008;70:381–6.

23 Muenster E, Rueger H, Ochsmann E, et al. Association between overweight, obesity and self-perceived job insecurity in German employees. *BMC Public Health* 2011;11:162.

24 Loerbroks A, Bosch JA, Douwes J et al. Job insecurity is associated with adult asthma in Germany during Europe's recent economic crisis: a prospective cohort study. *J Epidemiol Community Health* 2014; 68:1196–1199.

25 Pollack CE, von dem Knesebeck O, Siegrist J. Housing and health in Germany. *J Epidemiol Community Health* 2004;58:216–222.

26 Riedel N, Scheiner J, Müller G, et al. Assessing the relationship between objective and subjective indicators of residential exposure to road traffic noise in the context of environmental justice. *J Env Planning Management* 2014;57(9):1398–1421.

27 Kohlhuber M, Mielck A, Weiland S, et al. Social inequality in perceived environmental exposures in relation to housing conditions in Germany. *Env Research* 2006; 101(2):246–255.

28 Zou G, Donner A. Extension of the modified Poisson regression model to prospective studies with correlated binary data. *SMM Research* 2011;22(6): 661–670.

29 Ferrie JE, Shipley MJ, Stansfeld SA, et al. Effects of chronic job insecurity and change in job security on self reported health, minor psychiatric morbidity, physiological measures, and health related behaviours in British civil servants: the Whitehall II study. *J Epidemiol Community Health* 2002;56:450–4.

30 Lazlo KD, Pikhart H, Kopp MS et al. Job insecurity and health: A study of 16 European countries. *Soc Sci Med* 2010;70:867–874.

31 Job RFS. The influence of subjective reactions to noise on health effects of the noise. *Environmental International* 1996;22(1):93–104.

- 32 Stallen PJM. A theoretical framework for environmental noise annoyance. *Noise Health* 1999; 1:69-79.
- 33 Kristenson M, Eriksen HR, Sluiter JK, Starke D, Ursin H. Psychobiological mechanisms of socioeconomic differences in health. *Soc Sci Med* 2004;58:1511-22.
- 34 Ree E, Odeen M, Eriksen HR, Indahl A, Ihlebaek C, Hetland J, Harris A. Subjective health complaints and self-rated health: are expectancies more important than socioeconomic status and workload? *IJBM* 2014;21:411-20.
- 35 Klæboe R. Noise and health - Annoyance and Interference. In: Nriagu JO, editor. *Encyclopedia of environmental health*. Amsterdam, London: Elsevier Science; 2011. p. 152-63.
- 36 Ursin H, Eriksen HR. The cognitive activation theory of stress. *Psychoneuroendocrinology* 2004;9:567-92.
- 37 Ursin H, Eriksen HR. Cognitive activation theory of stress (CATS). *Neurosci Biobehavioral R* 2010;34:877-81.
- 38 Shang L, Riedel N, Loerbroeks A et al. The association between effort-reward imbalance and depressive symptoms is modified by selection, optimization, and compensation strategy. *JOEM* 2015; 57(11):1222-1227.
- 39 Ward Thompson C, Roeb J, Aspinall P et al. More green space is linked to less stress in deprived communities: Evidence from salivary cortisol patterns. *Landscape and Urban Planning* 2012;105(3):221-229.
- 40 van Kamp I, Klæboe R, Brown AL, et al. Soundscapes, human restoration and quality of life. In: Kang J, Schulte-Fortkamp eds. *Soundscape and the Built Environment*. Abington, UK: CRC Press, Taylor & Francis Group: 43-68.
- 41 Brown AL, van Kamp I. Response to a change in transport noise exposure: Competing explanations of change effects. *J Acoust Soc Am* 2009;125(2):905-914.
- 42 Kålsch H, Hennig F, Moebus S, et al. Are air pollution and traffic noise independently associated with atherosclerosis: the Heinz Nixdorf Recall Study? *EHJ* 2014;35: 853-860.
- 43 Gee GC, Payne-Sturges DC. Environmental health disparities: A framework integrating psychosocial and environmental concepts. *EHP* 2004;112:1645-53.
- 44 Morello-Frosch R, Shenassa ED. The Environmental "Riskscape" and Social Inequality: Implications for Explaining Maternal and Child Health Disparities. *EHP* 2006;114:1150-53.
- 45 Baar J, Romppel M, Igel U, et al. The association between physical environment and health: indicating the direction of effects using German panel data. *Int J Occup Environ Health*. 2016 Jan 29:1-6. [Epub ahead of print]
- 46 Flindell IH, Stallen PM. Non-acoustical factors in environmental noise. *Noise Health* 1999;1(3):11-6.
- 47 Guski R. Personal and social variables as co-determinants of noise annoyance. *Noise Health* 1999; 1(3): 45-56.

STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Check
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	done, p. 1 (title), p. 2 (abstract, indicating panel data and prospective analysis)
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	done, p. 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	done, p. 4
Objectives	3	State specific objectives, including any prespecified hypotheses	done, pp. 4-5
Methods			
Study design	4	Present key elements of study design early in the paper	done, p. 5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	done, p. 5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	done, p. 5
		(b) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	done, pp. 5-6
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	done, pp. 5-6
Bias	9	Describe any efforts to address potential sources of bias	n/a ¹
Study size	10	Explain how the study size was arrived at	done, p. 5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	done, p. 5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	done, pp. 6-7
		(b) Describe any methods used to examine subgroups and interactions	n/a
		(c) Explain how missing data were addressed	done, p. 5
		(d) If applicable, explain how loss to follow-up was addressed	n/a ¹
		(e) Describe any sensitivity analyses	done, p. 6
Results			
Participants	13*	(a) Report numbers of individuals at each stage of	done, p. 5

		study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	n/a ¹
		(c) Consider use of a flow diagram	n/a ¹
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	done, pp. 7-8
		(b) Indicate number of participants with missing data for each variable of interest	done, p. 5
		(c) Summarise follow-up time (eg, average and total amount)	done, pp. 7-8
Outcome data	15*	Report numbers of outcome events or summary measures over time	done, p. 8
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	done, pp. 6, 8-9
		(b) Report category boundaries when continuous variables were categorized	done, pp. 5-6
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	done, p. 6
Discussion			
Key results	18	Summarise key results with reference to study objectives	done, p. 9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	done, p. 11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	done, pp. 10-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	done, p. 11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	n/a

*Give information separately for exposed and unexposed groups.

¹ Analysis of secondary data from a national representative cohort study

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.

For peer review only

BMJ Open: first published as 10.1136/bmjopen-2016-012815 on 23 January 2017. Downloaded from <http://bmjopen.bmj.com/> on April 9, 2024 by guest. Protected by copyright.

BMJ Open

Do perceived job insecurity and annoyance due to air and noise pollution predict incident self-rated poor health? A prospective analysis of independent and joint associations using a German national representative cohort study

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2016-012815.R2
Article Type:	Research
Date Submitted by the Author:	04-Oct-2016
Complete List of Authors:	Riedel, Natalie; University of Bremen, Institute of Public Health and Nursing Research Loerbroks, Adrian; University of Düsseldorf, Institute of Occupational and Social Medicine Bolte, Gabriele; University of Bremen; Institute for Public Health and Nursing Research, Dept. 5 Social Epidemiology Li, Jian
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Public health, Occupational and environmental medicine
Keywords:	PUBLIC HEALTH, EPIDEMIOLOGY, OCCUPATIONAL & INDUSTRIAL MEDICINE

SCHOLARONE™
Manuscripts

Only

Research report to BMJ Open

“Do perceived job insecurity and annoyance due to air and noise pollution predict incident self-rated poor health? A prospective analysis of independent and joint associations using a German national representative cohort study”

Natalie Riedel^{*1}, Adrian Loerbroks², Gabriele Bolte¹, Jian Li²

¹ Department of Social Epidemiology, Institute for Public Health and Nursing Research, University of Bremen, Grazer Straße 4, 28359 Bremen, Germany

² Institute for Occupational, Social, and Environmental Medicine, Center for Health and Society, Faculty of Medicine, University of Düsseldorf, Universitätsstraße 1, Düsseldorf 40225, Germany

* Correspondence to Natalie Riedel, Telephone: +49 421 218-68827, Email: nriedel@uni-bremen.de

Key words perceived job insecurity, annoyance due to noise and air pollution, perceived uncontrollability, self-rated health, prospective study

Word count: 3,066

ABSTRACT

Background Current economic and social change has contributed to increasing job insecurity and traffic-related pollution in residential areas. Both job insecurity and exposure to noise and air pollution are known determinants of population health and can concur in peoples' lives. This may hold true particularly for socially disadvantaged subpopulations. Nevertheless, the potential independent and joint links of those exposures to health have been rarely examined so far. We aimed to contribute to the scarce body of evidence.

Methods Information on perceived job insecurity and exposures to noise and air pollution as expressed by annoyance as well as on self-rated health were gathered from two waves of the population-based German Socioeconomic Panel (2009 and 2011, N=6,544). We performed multivariable Poisson regression to examine the independent and joint risk of poor health in 2011 by perceived job insecurity and annoyance due to noise and air pollution in 2009.

Results After the 2-year follow-up in 2011, 571 (8.7 %) participants rated their health as poor. The risk of reporting incident poor health was increased by roughly 40 % in employees reporting high vs. low perceived job insecurity and annoyance due to noise and air pollution, respectively. This risk increased when both exposures were present at higher levels (RR=1.95 (1.49, 2.55)).

Conclusions Work-related and environmental exposures may accumulate and have a joint health impact. Elaboration on the link between occupational and residential exposures is warranted in light of their concurrence and their implications for health inequities.

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

STRENGTHS AND LIMITATIONS

- Both perceived job insecurity and annoyance due to traffic-related exposures have advanced as major risk factors for population health. Although they are likely to concur, their independent and joint health effects have not been studied yet.
- In this prospective, population-based study, we could document that perceived job insecurity and annoyance due to noise and air pollution show both independent and joint associations with incident self-rated poor health.
- Subjective measures of job insecurity and exposure to noise and air pollution indicate indirect, perceptual pathways of psychological stress. Thus, we could not detect direct physiological effects due to the objective intractability of these two exposures.
- Our study underlines the need to integrate work-related and environmental research both conceptually and empirically.

INTRODUCTION

With labour markets growing more and more unpredictable, perceptions of job insecurity have increased across European Union member states and beyond.¹⁻³ Longitudinal studies have consistently shown that high job insecurity predicts poor health outcomes.⁴

In addition to perceived job insecurity, other components of current economic and social change (e.g. job specialisation, globalisation, double breadwinner households) are associated with an increase in transportation in the European Union during the past decades.⁵⁻⁷ A further increase in freight traffic is still expected despite the economic crisis in 2009.⁷ Motorised transportation constitutes a major cause for chronic, local exposure to noise and air pollution.^{5, 8, 9} Traffic-related noise and ultrafine particulate matter air pollution have been identified as the most important environmental challenges in Western European cities,⁸ which has been illustrated by estimating an enormous number of healthy life years lost from noise annoyance (i.e. 654 000 disability-adjusted life-years).⁹

In view of these current developments, it is plausible to assume that job insecurity and traffic-related exposures are likely to concur in residential and occupational contexts. This may hold true particularly for socially disadvantaged subpopulations (e.g.^{3, 10}). This notion is in line with social epidemiological models on health determinants and inequities, which highlight the accumulation of exposures across contexts.^{11, 12} However, there is little research linking different types of work-related and residential exposures to health in one single study, although there are studies on traffic-related air and noise pollution modelling peoples' (outdoor) exposures in both occupational and residential contexts (e.g.¹³ for a study on asthma and¹⁴ for a study on blood pressure). We are aware of only one cross-sectional study suggesting an accumulation of physiological impacts of objective residential and occupational noise exposure and/or self-reported job strain on myocardial infarction while adjusting for air pollution.¹⁵

In the current study, we aim to contribute to this scarce body of evidence by examining the independent and joint associations of perceived job insecurity and annoyance due to noise and air pollution with self-rated poor health in a representative sample of the German working population. In doing so, we focus on indirect psychological pathways from these two contextual exposures to health and recur to parallel lines of argumentation within both occupational health and environmental psychology (e.g. Conservation of Resources Theory by Hobfoll in^{16, 17} or the Appraisal Theory by Lazarus and Folkman in¹⁸⁻²⁰). That is, we assume that perceived job insecurity and annoyance due to noise and air pollution in the

residential area may share the same stress-based mechanism to produce poor health: perceived uncontrollability of exposure and its feared or unwanted consequences of resource loss, (mal-)adaptive behavioural responses implying (vain) resource investment and subsequent physiological costs, and finally, adverse health outcomes.

METHODS

Study population and study sample

We retrieved our study sample from the German Socio-Economic Panel (GSOEP), a national survey conducted annually by face-to-face interviews in representatively selected households since 1984.²¹ All household members aged 18 + were eligible for participation after giving their informed consent. Our prospective, complete case analysis is primarily based on data from the 2009 and 2011 waves covering topics such as work and employment (including job insecurity) in the individual questionnaire as well as housing and environmental exposures in the household questionnaire (incl. annoyance due to noise and air pollution). The household questionnaire was answered by the household member who felt to be most competent with regard to household matters (called ‘household representative’ in the GSOEP). Using the household code as key variable, household-level information was added to the data on each individual in the household. Given our study aim, we restricted our analysis to participants employed (total: N=11,381, complete cases: N=9,493, 83.4%) in our baseline in 2009 and still remaining in the GSOEP in our follow-up in 2011 (N=7,339, response rate=77.5 %). Further, we considered only those who were in good health in 2009 (see measures below). Thus, our study sample included 6,544 participants (89.2 % of 7,339) living in 4,626 households.

The GSOEP is compliant with national laws. It is evaluated by the German Council of Science and Humanities at the German Institute for Economic Promotion (DIW) and is explicitly intended for epidemiological analyses.²¹

Exposure and outcome measures

At our baseline in 2009, perceived job insecurity was assessed by participants’ anticipated probability of losing their job within the next two years on a 10 % decrement scale.²²⁻²³ A cut-off point of ≥ 50 % on this scale was found to be both conceptually meaningful and statistically efficient to differentiate between perceived lower and higher job insecurity²⁴ (we call the participants with perceived higher job insecurity shortly ‘job insecure’).

Annoyance due to noise and air pollution in the residential area was derived from the household representatives' reporting of the degree of disturbance. Though not source-specific, we may regard these variables as proxy for perceived exposures related to traffic as main emission source. Household-specific disturbance values were assigned to the individuals belonging to the same household at the respective address. While rated separately on five point Likert scales, disturbances due to noise and air pollution were highly correlated ($r_s = 0.67$). In line with an earlier GSOEP study,²⁵ we summed up the values of both items, with higher values signalling a higher degree of disturbance (called hereafter 'environmental annoyance'). We dichotomised this sum scale whose scores ranged from 2 (not at all affected by both noise and air pollution) to 10 (very strongly affected by both noise and air pollution) at the cut-off point ≥ 5 . Thus, environmental annoyance was assumed to be present at higher levels in 2009 if households perceived disturbance due to noise and / or due to air pollution as being just bearable, strong, or very strong (we call these participants shortly 'environmentally annoyed'). This cut-off point served both statistical efficiency and empirical relevance. Sensitivity analyses using two alternative cut-off points (≥ 4 and ≥ 6) did not reveal substantial differences in effect sizes of environmental annoyance in relation to self-rated poor health (see statistical analyses below). Similar cut-off points have been employed to indicate higher levels of noise annoyance on five point Likert scales in previous population-based studies.^{17, 26, 27}

Finally, the dichotomised information on job insecurity and environmental annoyance was combined in one composite variable with four exposure categories, with 'perceived lower job insecurity and lower environmental annoyance' as reference group as compared to the categories 'perceived higher job insecurity and lower environmental annoyance', 'perceived lower job insecurity and higher environmental annoyance', as well as 'perceived higher job insecurity and higher environmental annoyance'.

We inferred our incident outcome variable from one single question making participants rate their health on five point Likert scale. Those who reported their health as 'not so good' or 'bad' were defined as having a poor health.

Potential confounders

Besides age and gender, we considered educational attainment (continuous, as measured by years of formal education), personal net income (continuous, log-transformed for multivariable analysis due to skewness), marital status, and contract type (permanent as opposed to non-permanent contract) as indicators of participants' socio-demographic and

economic position at our baseline in 2009. Health-related behaviour was mostly measured in the wave prior to our baseline by current smoking, alcohol consumption, physical exercise, and body mass index (see ²⁴).

Statistical analyses

Statistical differences in potential confounders between levels of perceived job insecurity and environmental annoyance were determined by Student’s t-text or Chi-Square test. Associations of perceived job insecurity and environmental annoyance in 2009 with an incident self-rated poor health in 2011 were quantified by risk ratios (RRs) with 95% confidence intervals (CIs) using Poisson regression with a log-link function. To account for household clustering, we integrated a sandwich variance estimator in the Poisson regression models by means of the household code as cluster identifier. ²⁸ First, we simultaneously entered perceived job insecurity and environmental annoyance in 2009 as independent predictors of a self-rated poor health in 2011. Second, we estimated their joint effects as measured by the composite exposure variable. In both regression series, we adjusted for age and gender in model I as well as for socio-demographic and economic position and health-related behaviour in model II in order to assess robustness of associations. Statistical analyses were performed using SAS, version 9.4

RESULTS

On average, 1.4 persons lived in one household in 2009, with the household size ranging from one to five individuals. One in five participants reported higher job insecurity or higher environmental annoyance. Both exposures co-occurred in 373 (5.7 %) participants; among job insecure participants, odds of being environmentally annoyed were elevated by 50 % (OR 1.50, 95% CI 1.27 - 1.67). Characteristics of the study sample stratified by the two levels of perceived job insecurity and environmental annoyance are shown in table 1. Lower personal net income levels, the unmarried and separated/divorced/widowed status as well as non-permanent contracts were more prevalent among participants characterised by perceived higher job insecurity or higher environmental annoyance. Job insecure participants were two years younger at an average and more often lower educated. Overweight and obesity as well as physical inactivity were more common among job insecure participants, whereas the opposite was true for regular alcohol consumption. No clear behavioural pattern could be observed for the two levels of environmental annoyance.

Table 1 Characteristics of the study population at baseline in 2009 (N=6,544) stratified by levels of perceived job insecurity (JI) and of environmental annoyance (EA) in 2009

Characteristics, n (%)	Lower JI 5,055 (77.25)	Higher JI 1,489 (22.75)	p value	Lower EA 5,227 (79.87)	Higher EA 1,317 (20.13)	p value
Continuous variables, mean (SD)						
Age (years)	43.71 (10.85)	41.68 (11.19)	< 0.0001	43.26 (10.90)	43.18 (11.18)	0.8140
Education (years)	13.12 (2.83)	12.37 (2.48)	< 0.0001	12.94 (2.77)	13.00 (2.79)	0.4329
Personal net income per month (€)	1835 (1389)	1375 (1067)	< 0.0001	1757 (1359)	1623 (1238)	0.0112
Categorical variables, n (%)						
Female	2407 (47.62)	747 (50.17)	0.0833	2497 (47.77)	657 (49.89)	0.1698
Marital status						
Unmarried	1202 (23.78)	441 (29.62)	<.0001	1268 (24.26)	375 (28.47)	0.0028
Separated/divorced/widowed	444 (8.78)	142 (9.54)		461 (8.82)	125 (9.49)	
Married	3409 (67.44)	906 (60.85)		3498 (66.92)	817 (62.03)	
Non-permanent contract	1116 (22.08)	475 (31.90)	<.0001	1237 (23.67)	354 (26.88)	0.0151
Current smoking	1463 (28.94)	504 (33.85)	0.0003	1561 (29.86)	406 (30.83)	0.4955
Regular alcohol consumption	1028 (20.34)	260 (17.46)	0.0142	1045 (19.99)	243 (18.45)	0.2086
Physical exercise						
Never	1279 (25.30)	440 (29.55)	<.0001	1390 (26.59)	329 (24.98)	0.0536
Less than once a week	1517 (30.01)	505 (33.92)		1579 (30.21)	443 (33.64)	
At least once a week	2259 (44.69)	544 (36.53)		2258 (43.20)	545 (41.38)	
Body mass index						
Normal	2489 (49.24)	725 (48.69)	0.1616	2531 (48.42)	683 (51.86)	0.0606
Overweight	1859 (36.78)	527 (35.39)		1940 (37.11)	446 (33.86)	
Obesity	707 (13.99)	237 (15.92)		756 (14.46)	188 (14.27)	

JI: job insecurity; EA: environmental annoyance
Differences were determined by Student's t-test or Chi-Square test.

After the 2-year follow-up in 2011, 571 (8.7 %) participants rated their health as poor. 305 (53.4 %) of these incident cases were female. Table 2 displays a bivariate association between higher levels of perceived job insecurity or environmental annoyance and incident self-rated poor health.

Table 2 Incident self-rated poor health in 2011 (N=571, 8.7%, out of 6,544) stratified by levels of perceived job insecurity (JI) and of environmental annoyance (EA) in 2009

Characteristic, n (%)	Lower JI 5,055 (77.25)	Higher JI 1,489 (22.75)	p value	Lower EA 5,227 (79.87)	Higher EA 1,317 (20.13)	p value
Incident Self-rated poor health	404 (7.99)	167 (11.22)	<.0001	416 (7.96)	155 (11.77)	<.0001

JI: job insecurity; EA: environmental annoyance
Differences were determined by Chi-Square test.

As evident in table 3, job insecure participants and environmentally annoyed participants had comparable risks of reporting incident poor health. The excess risk for each exposure was estimated to increase by 40 % in the first Poisson regression series on independent effects. In the second series on joint effects, the composite exposure variable confirmed the main effects of both variables in the exposure categories ‘perceived higher job insecurity and lower environmental annoyance’ and ‘perceived lower job insecurity and higher environmental annoyance’. The joint exposure to both perceived higher job insecurity and higher environmental annoyance at baseline was associated with a double excess risk of self-rated poor health two years later. Associations remained stable throughout adjustment procedure as shown by models I and II.

Table 3 Independent and joint associations of job insecurity (JI) and environmental annoyance (EA) with incident self-rated poor health (RRs and 95% CI)

Independent effects of JI and EA		Model I	Model II
n (%)			
Lower JI (ref.)	5,055 (77.25)	1	1
Higher JI	1,489 (22.75)	1.43 (1.20, 1.69)	1.37 (1.16, 1.63)
Lower EA (ref.)	5,227 (79.87)	1	1
Higher EA	1,317 (20.13)	1.43 (1.20, 1.70)	1.44 (1.21, 1.71)
Joint effects of JI and EA		Model I	Model II
n (%)			
Lower JI + lower EA (ref.)	4,111 (68.82)	1	
Higher JI + lower EA	1,116 (17.05)	1.44 (1.17, 1.77)	1.39 (1.13, 1.71)
Lower JI + higher EA	944 (14.43)	1.44 (1.17, 1.79)	1.46 (1.18, 1.81)
Higher JI + higher EA	373 (5.70)	2.07 (1.54, 2.64)	1.95 (1.49, 2.55)

JI: job insecurity; EA: environmental annoyance
RR: risk ratio; 95 % CI: confidence interval
Model I: adjustment for age and gender
Model II: model I additionally adjusted for education, income, marital status, contract type, smoking, alcohol consumption, physical exercise, and body-mass-index

DISCUSSION

In line with earlier population-based studies on either job insecurity (e.g.^{29, 30}) or annoyance due to noise pollution and / or air pollution (e.g.^{17, 25}), we observed positive associations with self-rated poor health. What is more, we could document that these exposures, if examined based on the same database, show both statistically independent and joint associations with incident self-rated poor health. Our findings of additive associations are similar to the patterns observed by¹⁵ on myocardial infarction, though comparability is limited due to a different work-related exposure (job strain) and different measurements of traffic-related exposure(s).

Based on Appraisal Theory and Conservation of Resources Theory which are used both in occupational health research and environmental psychology (e.g. studies by^{16, 18} and reviews by^{2, 4} for occupational health research as well as studies by^{17, 19, 20} and reviews by^{31, 32} for environmental psychological approaches), we suggest that both associations may originate from low perceived control over resource maintenance. Psychological stress may result from the experience and subsequent expectation that any efforts and resources spent to prevent resource loss fail to yield the desired or any effect at all. Job insecurity has been conceptually linked to “powerlessness to exercise workplace rights”² and unfavourable physical and psychosocial work conditions undermining employees’ capacity to draw and replenish resources. Annoyance due to noise and air pollution has been conceived as a psychological stress reaction to a lack of coping resources needed to counter the perceived environmental threat to health, which may likewise result in powerlessness to claim citizens’ rights to environmental health. Moreover, stress may arise from resource depletion, since employees blindly start investing resources in coping strategies associated with high physiological costs and negative (subjective) health outcomes, like overworking in order not to lose the job² or withdrawing from work while ruminating^{4, 18} or fostering avoidance and comforting cognitions while suffering from high levels of stress due to noise.¹⁹

These theoretical considerations imply a shared stress-based mechanism, as we showed that perceived job insecurity and annoyance due to noise and air pollution are each associated with incident self-rated poor health and that the strength of any such relationship further increases in case of a joint exposure. In view of the co-occurrence of high job insecurity and high environmental annoyance and their links to health in our sample, we should further elaborate on the theoretical linkages between residential and occupational contexts. Having been discussed in work stress^{33, 34} and noise research^{19, 35}, the Cognitive Activation Theory of Stress (CATS)^{36, 37} is a valuable, complementary approach to understand potential spill-over effects of exposures from different contexts. This psychobiological theory posits that stress-induced pathophysiological processes are shaped by behavioural outcome expectancies

individuals have learned in response to stress stimuli. The resulting physiological activation level may influence individuals' resilience to future exposures from both contexts. If individuals have learned to attribute the perceived exposure to job insecurity and noise and air pollution to external, intractable causes, they may develop no control or negative expectancies, i.e. generalised helplessness and hopelessness. These types of outcome expectancies can cause pathophysiological changes. By contrast, a positive outcome expectancy in terms of generalised self-efficacy is linked to reduced physiological activation and improved health. That is, a positive behavioural outcome expectancy acquired in the residential context might help a resident survive in the occupational context, whereas threats to an employee's resources in the occupational context could affect her agency and health in the residential context due to no control or negative outcome expectancies.

The results for the composite exposure variable revealed that the relative absence (or lower values) of one exposure does not reduce the vulnerability to the other remaining exposure. It seems promising for future research to address resources that may exert protective effects in both occupational and residential contexts and play a key role in intervention strategies aiming to reduce health inequities. Such resources may be personal (like CATS positive outcome expectancy, perceived external employability in face of job insecurity¹⁶ or selection, optimisation and compensation strategies in face of uncontrollability feelings arising from effort-reward-imbalance³⁸) or contextual (like green areas and soundscapes allowing for relaxation and restoration^{39, 40} or area-wide improvements rendering neighbourhood perception more positive⁴¹) or both.

Linking up with social determinants of health, a recent conceptual model from occupational health research presents precarious employment to influence health via material deprivation including residential neighbourhood quality.² The differences in personal net income by levels of perceived job insecurity and environmental annoyance in our study sample may give a vague indication of this pathway, although we could not disclose the causal sequence of job insecurity and residential exposures to noise and air pollution.

It is a shortcoming of our study that information on annoyance due to noise and air pollution was not available in the individual questionnaire. Thus, we had to rely on the household representatives' rating. Consequently, the interpretation of our findings may be somewhat hampered, since our environmental annoyance variable is probably influenced by the selection of the household representative at home, her or his consideration of other household

members' environmental perceptions and health as well as the presence or absence of household members during the interview.

Furthermore, we could use subjective measures of work-related and environmental exposures, only. These indicate indirect, perceptual pathways of psychological stress, whereas direct physiological effects due to the objective intractability of job insecurity as well as of air and noise pollution cannot be detected. Chronic exposure to ultrafine particulate matter and road traffic noise at night-time were recently estimated to be independently related to an indicator of subclinical atherosclerosis.⁴² Objective conditions should be added in future analyses to fathom the interplay of direct and indirect pathways (e.g.¹⁷). It follows from CATS that sustained physiological activation may increase individuals' vulnerability to physical and chemical exposures like air and noise pollution (as is also suggested by socio-environmental epidemiological frameworks of environmental health equity⁴³⁻⁴⁴). Considering potential spill-over effects between occupational and residential contexts, future research should look for multiplicative interactions between stressors and resources from both contexts over time. However, we were not able to capture multiplicative effects with our data covering two points in time just two years apart.

It would be crucial to recognise differential patterns of confounding and moderating variables. For instance, bivariate associations of individual characteristics with perceived job insecurity were generally stronger than those with environmental annoyance were. Again, it might reflect a drawback to our study that our environmental annoyance variable was measured at the household level, making direct comparisons of confounder distributions between the two levels of perceived job insecurity and environmental annoyance difficult. What is more, evidence for social inequalities in road traffic exposure largely varies by the indicators used, given the distributional discrepancy between road traffic noise and noise annoyance.²⁶ In addition, we did not consider changes in exposure due to residential relocation or to regained job security between 2009 and 2011, which might have led to an underestimation of true associations between the two perceived exposures and self-rated poor health (as implied by⁴⁵ investigating the association of environmental disadvantage on self-rated poor health based on the GSOEP). However, perceived job insecurity has been found to have an aftereffect even after its cessation²⁹ and self-selection according to noise sensitivity and noise annoyance could not be corroborated in empirical studies.⁴¹ Furthermore, we did not have information on the perceived emission sources and other non-acoustical variables accounting for differences in noise annoyance, such as attitudes towards noise sources and trust in regulatory authorities.^{20, 31, 32, 46, 47}

To the best of our knowledge, this is the first study to analyse the independent and joint associations of perceived job insecurity and annoyance due to noise and air pollution with incident self-rated poor health. If confirmed elsewhere, our findings call for more research integrating objectively intractable and subjectively uncontrollable exposures from different sectors to understand the multi-causality of health (inequities) as implied by social epidemiological models on the social and societal determinants of health (see for an overview Krieger ¹², for example).

For peer review only

BMJ Open: first published as 10.1136/bmjopen-2016-012815 on 23 January 2017. Downloaded from <http://bmjopen.bmj.com/> on April 9, 2024 by guest. Protected by copyright.

Authors' contribution

NR wrote the draft of the manuscript. AL, GB, and JL substantially contributed to the line of argumentation and revision of the manuscript. JL prepared the data. NR and JL conducted the statistical analyses.

Acknowledgments

The authors are grateful to the German Institute for Economic Promotion (DIW), Berlin, for the Provision of the German Socio-economic Panel (GSOEP) data employed for the current manuscript.

NR is currently funded for the research project "Transforming noise action planning into an instrument for more health equity" within the framework of the Institutional Strategy of the University of Bremen. This strategy is financed by the German Federal Government's and the Federal States' 'Excellence Initiative'.

Conflicts of interests

None declared.

Patient consent

Obtained by the German Socioeconomic Panel.

Ethics Approval

Obtained by the German Socioeconomic Panel.

Data sharing statement

The German Socioeconomic Panel is a public-use data set that can be obtained from the German Institute for Economic Promotion (DIW), Berlin.

REFERENCES

1 van Gyes G, Szeker L. Impact of the crisis on working conditions in Europe. European Foundation for the Improvement of Living and Working Conditions; 2013 [04 May 2016]; <http://www.eurofound.europa.eu/observatories/eurwork/comparative-information/impact-of-the-crisis-on-working-conditions-in-europe>.

2 Benach J, Vives A, Amable M, et al. Precarious Employment: Understanding an Emerging Social Determinant of Health. *Annu Rev Public Health* 2014;35:229–53.

3 Landsbergis PA, Grzywacz JG, LaMontagne AD. Work Organization, Job Insecurity, and Occupational Health Disparities. *Am J Industrial Medicine* 2014;57:495–515.

4 deWitte H, Pienaar J, de Cuyper N. Review of 30 Years of Longitudinal Studies on the Association Between Job Insecurity and Health and Well-Being: Is There Causal Evidence? *Australian Psychologist* 2016;51:18–31.

5 European Commission. White Paper. Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. 2011; [04 May 2016]; <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0144&from=EN>.

6 European Commission. EU transport in figures. Statistical pocketbook 2015. 2015; [04 May 2016]; [<http://ec.europa.eu/transport/facts-fundings/statistics/doc/2015/pocketbook2015.pdf>].

7 Umweltbundesamt [Transport in figures] 2012; [04 May 2016]; <http://www.umweltbundesamt.de/sites/default/files/medien/publikation/long/4364.pdf>.

8 European Environmental Agency. Noise in Europe; 2014 [04 May 2016]; <http://www.eea.europa.eu/publications/noise-in-europe-2014>.

9 World Health Organization Regional Office for Europe. Burden of disease from environmental noise. Quantification of healthy life years lost in Europe; 2011 [04 May 2016]; http://www.who.int/quantifying_ehimpacts/publications/e94888/en/.

10 World Health Organization Regional Office for Europe. Environmental health inequalities in Europe. Assessment report; 2012 [04 May 2016] http://www.euro.who.int/__data/assets/pdf_file/0010/157969/e96194.pdf.

11 World Health Organisation Commission on Social Determinants of Health. Closing the gap in a generation. Health equity through action on the social determinants of health. 2008 [04 May 2016]; http://apps.who.int/iris/bitstream/10665/43943/1/9789241563703_eng.pdf.

12 Krieger N. Epidemiology and the people's health. Theory and context. New York: Oxford University Press.

13 Lindgren A, Björk J, Strohm E, Jakobsson K. Adult asthma and traffic exposure at residential address, workplace address, and self-reported daily time outdoor in traffic: A two-stage case-control study. *BMC Public Health* 2010;10:716.

14 Méline J, Van Hulst A, Thomas F et al. Road, rail, and air transportation noise in residential and workplace neighborhoods and blood pressure (RECORD Study). *Noise and Health* 2015;17(78):308-319.

15 Selander J, Bluhm G, Nilsson M, et al. 2013. Joint effects of job strain and road-traffic and occupational noise on myocardial infarction. *Scand J Work Environ Health* 2013;39(2):195-203.

- 16 deCuyper N, Mäkikangas A, Kinnunen U, et al. Cross-lagged associations between perceived external employability, job insecurity, and exhaustion: Testing gain and loss spirals according to the Conservation of Resources Theory. *J Organiz Behav* 2012; 33:770–788.
- 17 Riedel N, Köckler H, Scheiner J, et al. Objective exposure to road traffic noise, noise annoyance and self-rated poor health – framing the relationship between noise and health as a matter of multiple stressors and resources in urban neighbourhoods. *J Env Planning and Management* 2015;58(2):336–356.
- 18 van der Elst T, De Cuyper N, Baillien E, et al. Perceived Control and Psychological Contract Breach as Explanations of the Relationships Between Job Insecurity, Job Strain and Coping Reactions: Towards a Theoretical Integration. *Stress and Health* 2016; 32(2):100–16.
- 19 van Kamp I. Coping with noise and its health consequences. Groningen, The Netherlands: The University of Groningen 1990.
- 20 Kroesen M, Molin EJE, van Wee B. Testing a theory of aircraft noise annoyance: A structural equation analysis. *J Acoust Soc Am* 2008;123(6):4250–4260.
- 21 Schupp J. [The Socioeconomic Panel (SOEP)]. *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz* 2012;55:767–74.
- 22 Bethge M, Radoschewski FM, Muller-Fahrnow W. [Job insecurity as risk for adverse health effects amongst German workers: a cohort study]. *Gesundheitswesen* 2008;70:381–6.
- 23 Muenster E, Rueger H, Ochsmann E, et al. Association between overweight, obesity and self-perceived job insecurity in German employees. *BMC Public Health* 2011;11:162.
- 24 Loerbroks A, Bosch JA, Douwes J et al. Job insecurity is associated with adult asthma in Germany during Europe's recent economic crisis: a prospective cohort study. *J Epidemiol Community Health* 2014; 68:1196–1199.
- 25 Pollack CE, von dem Knesebeck O, Siegrist J. Housing and health in Germany. *J Epidemiol Community Health* 2004;58:216–222.
- 26 Riedel N, Scheiner J, Müller G, et al. Assessing the relationship between objective and subjective indicators of residential exposure to road traffic noise in the context of environmental justice. *J Env Planning Management* 2014;57(9):1398–1421.
- 27 Kohlhuber M, Mielck A, Weiland S, et al. Social inequality in perceived environmental exposures in relation to housing conditions in Germany. *Env Research* 2006; 101(2):246–255.
- 28 Zou G, Donner A. Extension of the modified Poisson regression model to prospective studies with correlated binary data. *SMM Research* 2011;22(6): 661–670.
- 29 Ferrie JE, Shipley MJ, Stansfeld SA, et al. Effects of chronic job insecurity and change in job security on self reported health, minor psychiatric morbidity, physiological measures, and health related behaviours in British civil servants: the Whitehall II study. *J Epidemiol Community Health* 2002;56:450–4.
- 30 Lazlo KD, Pikhart H, Kopp MS et al. Job insecurity and health: A study of 16 European countries. *Soc Sci Med* 2010;70:867–874.
- 31 Job RFS. The influence of subjective reactions to noise on health effects of the noise. *Environmental International* 1996;22(1):93–104.

32 Stallen PJM. A theoretical framework for environmental noise annoyance. *Noise Health* 1999; 1:69-79.

33 Kristenson M, Eriksen HR, Sluiter JK, Starke D, Ursin H. Psychobiological mechanisms of socioeconomic differences in health. *Soc Sci Med* 2004;58:1511-22.

34 Ree E, Odeen M, Eriksen HR, Indahl A, Ihlebaek C, Hetland J, Harris A. Subjective health complaints and self-rated health: are expectancies more important than socioeconomic status and workload? *IJBM* 2014;21:411-20.

35 Klæboe R. Noise and health - Annoyance and Interference. In: Nriagu JO, editor. *Encyclopedia of environmental health*. Amsterdam, London: Elsevier Science; 2011. p. 152-63.

36 Ursin H, Eriksen HR. The cognitive activation theory of stress. *Psychoneuroendocrinology* 2004;9:567-92.

37 Ursin H, Eriksen HR. Cognitive activation theory of stress (CATS). *Neurosci Biobehavioral R* 2010;34:877-81.

38 Shang L, Riedel N, Loerbroeks A et al. The association between effort-reward imbalance and depressive symptoms is modified by selection, optimization, and compensation strategy. *JOEM* 2015; 57(11):1222-1227.

39 Ward Thompson C, Roeb J, Aspinall P et al. More green space is linked to less stress in deprived communities: Evidence from salivary cortisol patterns. *Landscape and Urban Planning* 2012;105(3):221-229.

40 van Kamp I, Klæboe R, Brown AL, et al. Soundscapes, human restoration and quality of life. In: Kang J, Schulte-Fortkamp eds. *Soundscape and the Built Environment*. Abington, UK: CRC Press, Taylor & Francis Group: 43-68.

41 Brown AL, van Kamp I. Response to a change in transport noise exposure: Competing explanations of change effects. *J Acoust Soc Am* 2009;125(2):905-914.

42 Kålsch H, Hennig F, Moebus S, et al. Are air pollution and traffic noise independently associated with atherosclerosis: the Heinz Nixdorf Recall Study? *EHJ* 2014;35: 853-860.

43 Gee GC, Payne-Sturges DC. Environmental health disparities: A framework integrating psychosocial and environmental concepts. *EHP* 2004;112:1645-53.

44 Morello-Frosch R, Shenassa ED. The Environmental "Riskscape" and Social Inequality: Implications for Explaining Maternal and Child Health Disparities. *EHP* 2006;114:1150-53.

45 Baar J, Romppel M, Igel U, et al. The association between physical environment and health: indicating the direction of effects using German panel data. *Int J Occup Environ Health*. 2016 Jan 29:1-6. [Epub ahead of print]

46 Flindell IH, Stallen PM. Non-acoustical factors in environmental noise. *Noise Health* 1999;1(3):11-6.

47 Guski R. Personal and social variables as co-determinants of noise annoyance. *Noise Health* 1999; 1(3): 45-56.

STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

STROBE Statement		Checklist of items that should be included in reports of cohort studies	
	Item No	Recommendation	Check
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	done, p. 1 (title), p. 2 (abstract, indicating panel data and prospective analysis)
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	done, p. 2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	done, p. 4
Objectives	3	State specific objectives, including any prespecified hypotheses	done, pp. 4-5
Methods			
Study design	4	Present key elements of study design early in the paper	done, p. 5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	done, p. 5
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	done, p. 5
		(b) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	done, pp. 5-6
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	done, pp. 5-6
Bias	9	Describe any efforts to address potential sources of bias	n/a ¹
Study size	10	Explain how the study size was arrived at	done, p. 5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	done, p. 5
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	done, pp. 6-7
		(b) Describe any methods used to examine subgroups and interactions	n/a
		(c) Explain how missing data were addressed	done, p. 5
		(d) If applicable, explain how loss to follow-up was addressed	n/a ¹
		(e) Describe any sensitivity analyses	done, p. 6
Results			
Participants	13*	(a) Report numbers of individuals at each stage of	done, p. 5

		study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	
		(b) Give reasons for non-participation at each stage	n/a ¹
		(c) Consider use of a flow diagram	n/a ¹
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	done, pp. 7-8
		(b) Indicate number of participants with missing data for each variable of interest	done, p. 5
		(c) Summarise follow-up time (eg, average and total amount)	done, pp. 7-8
Outcome data	15*	Report numbers of outcome events or summary measures over time	done, p. 8
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	done, pp. 6, 8-9
		(b) Report category boundaries when continuous variables were categorized	done, pp. 5-6
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	done, p. 6
Discussion			
Key results	18	Summarise key results with reference to study objectives	done, p. 9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	done, p. 11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	done, pp. 10-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	done, p. 11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	n/a

*Give information separately for exposed and unexposed groups.

¹ Analysis of secondary data from a national representative cohort study

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.

For peer review only