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A QUESTIONNAIRE DESIGNED TO CAPTURE THE IMPACT OF WIND TURBINE NOISE ON HUMAN WELL-BEING

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Abstract

Wind farms are becoming a common feature of landscapes in many countries and more large-scale wind turbines are seen in cities, close to residential areas. The possible adverse impacts of wind turbine noise on human health and well-being has attracted substantial attention. Nevertheless, existing studies have provided limited statistical evidence for the link between wind turbine noise and adverse health problems other than annoyance, and have typically not accounted for the effects of socio-demographic and architectural factors. Furthermore, questionnaires that fail to mask the purpose of the study may lead respondents to pay more attention to wind turbine noise than they usually do, and thus be susceptible to a focusing bias.

This paper presents a detailed description of a questionnaire that is designed to take into account a wider range of factors and to minimise possible focusing bias. The aim of the questionnaire is to elicit: the respondent's evaluation of various environmental noise including wind turbine noise; their self-reported sleep disturbance, health symptoms, general health and subjective well-being; and key features of their residence. The inclusion of a large number of questions on socio-demographic and architectural factors provides a wide range of variables that may be associated with the effect of noise. Possible focusing effect is minimised by designing a questionnaire variant that does not draw attention to wind turbine noise, to be answered by a control group from the same population. The design of specific questions and the response items are presented with the relevant background literature. This questionnaire can be (and has been) used to investigate the impact of exposure to wind turbine noise and well-being, and to address the evidence gap in evaluating the impacts in urbanised settings.

A Questionnaire Designed to Capture the Impact of Wind Turbine Noise on Human Well-being

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1. Introduction

The development of renewable energy technology helps mitigate greenhouse gas (GHG) emissions and climate change, which is a global long-term mission, and wind turbines play an increasing role in this challenge (Ishugah et al. 2014). In the UK, the number of onshore wind farms has grown every year, and has nearly tripled in the past four years, reaching 1,217 operational sites across the UK in 2017 (RenewableUK 2017). As onshore wind farms are becoming a common feature of landscapes in many countries, there is a shift towards integrating large-scale wind turbines within the urban environment (Ishugah et al. 2014), some of which are close to residential areas.

At the same time, the possibility of adverse impacts of wind turbine noise on human health and wellbeing has also attracted substantial attention, and studies have found a positive association between wind turbine noise exposure and annoyance, sleep disturbance, and adverse health problems such as tension and stress (Pedersen & Waye 2004; Pedersen & Waye 2007; Pedersen et al. 2009; Bakker et al. 2012; Pawlaczyk-Łuszczyńska et al. 2014; Michaud et al. 2016; Shepherd et al. 2011). Other health-related effects such as psychological distress were found to be associated with wind turbine noise with noise annoyance as a mediator(Bakker et al. 2012).

However, these studies on wind turbine noise provide limited statistical evidence for the link between noise and adverse health problems other than annoyance, such as headache, cardiovascular diseases, tension, or stress. Shepherd et al. (2011) and Bakker et al. (2012) have argued that the lack of evidence might be due to the lack of main explanatory variables that moderate the effect of noise, both individual and social, such as existing illness, attitudes to the noise source and individual coping strategies. Compared to studies on traffic noise (Öhrström et al. 2006; Bluhm et al. 2004) the effects of architectural factors have been under-explored, such as housing type and orientation of the dwelling, although they have been found to affect the distribution of wind turbine noise in built-up areas (Qu & Kang 2017).

Furthermore, previous surveys have asked respondents living near wind turbines to assess the impact of wind turbine noise directly (Pedersen & Waye 2004; Pedersen & Waye 2007; Pedersen et al. 2009;

Pawlaczyk-Łuszczyńska et al. 2014). Therefore, it may have been clear to the respondents that the purpose of the questionnaire was to investigate potential adverse health effects of wind turbines (Nissenbaum et al. 2012), and if so, such questionnaires may be susceptible to a focusing bias (Ubel et al. 2011; Wilson et al. 2000), where the questions lead the respondents to pay more attention than they usually do to the noise, and thus answer differently. A related issue concerns attribution: surveys may ask respondents to specify the cause of any health problems, but perceived causes are not necessarily the actual causes of health problems.

Therefore, there is a need for questionnaires that are designed to take into account a wider range of factors and possible focusing bias and respondent attribution. This paper presents a detailed description of a questionnaire to measure the impact of exposure to wind turbine noise and well-being. The questionnaire was used in a research project that investigated the health and subjective well-being of people living in proximity to urban wind turbines.

Aims of the questionnaire

The aim of the questionnaire is to elicit the respondent's evaluation of various environmental noise including wind turbine noise; their self-reported sleep disturbance, health symptoms, general health and subjective well-being; and key features of their residence. The following sections of this paper report the final version of the questionnaire, which was based on a literature review, item design, piloting, and revision.

In the below, Section 2 outlines the two different variants of the questionnaire. Section 3 gives an overview of the themes and variables included in the questionnaire. Specific wording of the individual items are presented in Section 4. Section 5 concludes with a summary of the key features of this questionnaire design.

2. Questionnaire Variants

The survey is designed to measure the effects of wind turbine noise on human well-being among people who live near wind turbines. In order to minimise the potential bias caused by focusing effects, two variants of the questionnaire are designed, to be answered by different individuals from the same population. The main, "Questionnaire Variant 1", includes explicit questions on the impacts of the local wind turbines on the respondent's well-being, such as: rating their general health and well-being given wind turbine noise; reporting annoyance by environmental nuisances including wind turbine noise; identifying health problems they experience that may be caused by wind turbine noise; describing the sound of wind turbines; and indicating their attitudes to wind turbines. Some of the questions allow respondents to attribute well-being concerns they have to the presence of the local wind power project. A separate control group variant, "Questionnaire Variant 2", focuses on well-being and health, but without associations to wind turbines. There are no references to wind turbines, except in one question on noticeability of and annoyance with various environmental nuisances including wind turbine noise. All other questions that do not mention wind turbines are identical across the two Variants.

3. Questionnaire Themes and Variables

The design of the questions is guided by the relationships between well-being and wind turbine noise derived from a literature review (Qu 2017), as well as other non-acoustical factors related to noise evaluation and human well-being. The questions included in the survey are shown in Table 1, grouped by themes. As indicated, all the variables are included in Variant 1, but not necessarily in Variant 2.

Table 1 Questionnaire themes and variables

Themes	Variables	Question in *Variant 1*	Question in *Variant 2*
Outcome variables:			
1. Subjective evaluations on WTN	Notice and annoyance of environmental nuisances (e.g. Odour, neighbourhood noise, traffic noise, bugs, pollution, etc. including WTN)	Q5	Q5
	WTN annoyance (verbal scale)	Q9	Not included
	WTN annoyance (numeric scale)	Q10	Not included
	Response to WTN in different situations	Q13	Not included
	Perceived sound characteristics of WTN	Q14	Not included
2. Health problems	Sleep disturbance	Q4	Q4
	Perceived health impact of wind turbines	Q11	Not included
	Adverse health problems (physiological and psychological distress)	Q12 (with WTN as a possible cause)	Q9 (without reference to possible causes)
3. Subjective well-being	Happiness	Q1	Q1
	General health	Q2	Q2
	Satisfaction with life	Q3	Q3
Moderating variables:			
4. Demo-graphics	Age, gender, employment long standing illness, educational qualification, marital status, household income	Q17-23	Q10-16
5. Personal/ attitudinal factors	Sensitivity and coping with environmental noise	Q6	Q6
	Attitude to environmental sustainability	Q7	Q7
	Attitude to wind turbines	Q15	Not included
	Financial stake in the wind farm	Q16	Not included
	Evaluation of overall sound environment	Q8	Q8
6. Architectural factors	Number of bedrooms	Q24	Q17
	Type of dwelling	Q25	Q18
	Orientation of dwelling	Q26	Q19

Themes	Variables	Question in *Variant 1*	Question in *Variant 2*
7. Residential factors	Visibility of wind turbine	Q27	Not included
	Length of residency	Q28	Q20
	Time spent indoors and outdoors everyday	Q29	Q21
	Ownership of the accommodation	Q30	Q22
	Double-glazed or sound-proofed windows	Q31	Q23

WTN: Wind Turbine Noise

3.1. Outcome variables

To assess the potential impact of wind turbine noise on health and well-being, the questionnaire elicits the respondent's subjective evaluation of wind turbine noise, their self-reported health problems and subjective well-being. As shown in Table 1, the respondent's evaluation on wind turbine noise is explored across four questions focused on annoyance. There are no questions that allow the respondent to report positive perceptions associated with the noise (e.g. "soothing"). One question assesses how residents perceive and describe the sound characters of the noise, such as "swishing" and "pulsating".

The potential adverse health impacts of wind turbine noise are examined in four questions. These invite self-reports on the occurrence of sleep disturbance; perceived health impact of wind turbine noise; the prevalence of health-related problems; and general health. The question on perceived health impact includes both physiological and psychological problems, such as headache, nausea, and dizziness, as well as stress, mood swings and lack of concentration.

Furthermore, the questionnaire asks two questions on subjective well-being, namely, self-reported happiness and satisfaction with various aspects of life.

3.2. Moderating variables

It is well-known that human reactions to noise depend on not only acoustical factors, but also a series of non-acoustical moderating factors (Fields 1993). As shown in Table 1, moderating variables included in the questionnaire are categorised as demographic, personal/attitudinal, architectural, and residential factors.

Firstly, questions on demographical factors such as age, sex, and employment that are hypothesised to influence noise annoyance are asked. Variables such as longstanding illness, marital status and income are also added, which have been reported to be important determinants of subjective well-being (Dolan et al. 2008). The majority of questions are drawn from national surveys such as Understanding Society[1] and Health Survey for England[2].

In addition, questions addressing personal noise sensitivity and attitude to the noise source are included, which have been demonstrated as important confounders of human reaction to noise in various socio-

[1] https://www.understandingsociety.ac.uk
[2] https://data.gov.uk/dataset/health_survey_for_england

acoustic studies (Pedersen & Waye 2004; Job 1999). Noise sensitivity is measured in one question with two items drawn from the shortened version of the established 21-items noise sensitivity questionnaire (Weinstein 1978; Benfield et al. 2014). It has been observed that respondents who believed that the noise source is generally important were less being annoyed (Fields 1993). This is captured in this survey by a question on the respondent's attitude to environmental sustainability, adapted from two questions in the British Household Panel Survey (BHPS, Brice et al. 1993). Respondents' attitudes to wind turbines are assessed using four pairs of antonyms describing wind turbines taken from previous studies (Pedersen & Waye 2004). There is a question to identify respondents with a financial stake in the wind farm, as this has been shown to be significantly negatively associated with annoyance with wind turbine noise (Pedersen et al. 2009).

Furthermore, the questionnaire includes questions on architectural features of the respondent's residence, which have not been previously explored in the context of wind turbine noise. The effects of the architectural features of dwellings, such as having access to the quiet side of the dwelling, orientation of the dwelling, and housing types, in the context of exposure to traffic noise have been demonstrated in a number of earlier studies (Öhrström et al. 2006). In this questionnaire, three questions on architectural factors asked about the number of bedrooms in the dwelling, and the type and orientation of the dwelling to identify the morphology of the building, which have been found to have effects on resisting the wind turbine noise in a morphological study of wind turbine noise (Qu & Kang 2017).

Finally, residential variables measure other variables associated with the respondent's relationship with their home. Among these variables, visibility is the factor that has most frequently been demonstrated to increase annoyance with wind turbine noise. Length of residency establishes whether the respondent moved in before or after the wind turbine became operational. Time spent indoors and outdoors everyday collect information on the number of hours the respondent typically spent inside and around the house through their daily life.

4. Specific Question Wording and Response Items

Table 2 documents all the questions including their response items and scales. Where the question has been taken from other existing surveys, the source is given. Examples of the printed questionnaires are shown in the Appendix.

Among the 31 questions, 14 (45%) are drawn verbatim from established national surveys or previous studies so that the wording of the question and the response items and scales are kept identical to those in the original. Ten (32%) questions are derived or adapted from existing questionnaires with several modifications to fit this questionnaire. Seven (23%) questions are newly created based on the literature. The following section focuses on the 17 questions and items that are either adapted or newly created.

Table 2 List of questions

Domain	variant 1	variant 2	Variable	Question	Items/sub-questions	options/scales	Source/Reference
Well-being and Health	Q1	Q1	Happiness	Taking all things together, on a scale of 0 to 10, how happy would you say you are? Here 0 means you are very unhappy and 10 means you are very happy.		Very unhappy - Very happy, 11 scales (0-10)	HSE 2010
	Q2	Q2	General health	In general, would you say your health is...		Excellent, Very good, Good, Fair, Poor	Understanding Society (W4_individual questionnaire_general health module_SF1_SF12)
	Q3	Q3	Satisfaction of life	Here are some statements on how you feel about your life. Please tick the box which you feel best describes how dissatisfied or satisfied you are with the following aspects of your current situation.	a) Your life overall b) Your health c) Your household income d) Your social life e) Your living environment	Not satisfied at all - Completely satisfied, 7 scales	Understanding Society & BHPS a):Sclfsat0; b):Sclfsat1; c): Sclfsat2; d): BHPS_RLFSAT6; e): BHPS_RLFSAT3
	Q4	Q4	Sleep disturbance	Please choose ALL the statement(s) which describe your sleep.	a) My sleep is not disturbed at all. b) It's hard for me to fall asleep. c) I sleep less deeply than I would like. d) I occasionally wake up but I soon go back to sleep. e) I often lie awake for a while. f) I have to take sleeping pills to fall asleep.		Adapted from Heathrow Second Survey of aircraft noise annoyance around London Heathrow airport (McKennel, 1979) also similar to Understanding Society_PQSI: b)_cannot get to sleep within 30mins:Tslp_30m; d)_wake-up in the night: Tslp_wak; e):Tsta_awk; f): Med_slp,
Evaluation of Environment	Q5	Q5	Environmental nuisances	The following are several things that might exist in people's living environment. Please state for each thing of the below, whether you notice them and if so, whether you are annoyed by them when you spend time at home.	a) unpleasant odor from outside b) noise from neighbours c) traffic noise d) noise from wind turbines e) other noise sources (please specify) f) bugs, pests or vermin g) vibration of the building h) pollution, grime or dust	1: notice? No, Yes, Don't know 2: If you notice, do you find it annoying? Not at all - Extremely, 5 scales	b, c, h adapted from BHPS_w18_H44 a, d, f adapted rom Pedersen and Waye 2004
	Q6	Q6	Sensitivity	In terms of environmental noise, how much do you agree or disagree with the following statements?	a) I find it hard to relax in a place that's noisy. b) I get used to most noises without much difficulty.	Agree strongly - Disagree strongly, 6 scales	Adapted from "Testing noise in the field: a brief measure of individual noise sensitivity." (Benfield et al., 2012).
	Q7	Q7	Sustainability	What are your views on environmental sustainability?	a) The environmental sustainability is a low priority for me compared with a lot of other things in my life. b) I personally need to change my way of life so that future generations can continue to enjoy a good quality of life and environment.	Agree strongly - Disagree strongly, 6 scales	a: Adapted from BHPS_w18_RV108 (5-point scale) b: Adapted from BHPS_w18_questionnaire _Q7 (4-point-scale)
	Q8	Q8	Sound environment	How do you evaluate the overall sound environment at your dwelling?	quiet - loud interesting - boring pleasant - unpleasant continuous - discontinuous predictable - chaotic calming - agitating directional - everywhere natural - artificial	very, fairly, little, neutral, little, fairly, very	Adapted from soundscape evaluation form: "Semantic differential analysis of the soundscape in urban open public spaces" (Kang & Zhang, 2009)
Evaluation of WTN	Q9	Not included	WTN annoyance (verbal)	Thinking about the last 12 months, when you are at home, how much does noise from wind turbines bother, disturb or annoy you?		not at all slightly moderately very extremely	ISO/TS 15666 Acoustics - Assessment of noise annoyance by means of social and socio-acoustic surveys

	Q 10	Not included	WTN annoyance (scale)	Thinking about the last 12 months, what number from 0 to 10 best shows how much you are bothered, disturbed or annoyed by wind turbine noise when you spend time *outdoors* and *indoors* at your dwelling?	outdoors at your dwelling indoors in your dwelling	Not at all - Extremely, 11 scales (0-10)	Adapted from ISO/TS 15666 Acoustics - Assessment of noise annoyance by means of social and socio-acoustic surveys (add indoors and outdoors)
	Q 11	Not included	Perceived health impact	Would you say that the wind turbine noise has any effect on your health?		No, not at all Yes, some of the time Yes, most of the time I don't know	Adapted from "Second survey of aircraft noise annoyance around London (Heathrow) airport" (McKennel, 1979)
	Q 12	Q9 (symptoms/disease only)	Health problems	Did you experience any of the below during the past week? Please indicate whether you consider it to be caused by wind turbine noise.	Headache Nausea Dizziness Ear discomfort Cardiovascular disease Stress Tension and edginess Difficulty in intellectual activities Mood swings Lack of concentration Other (please specify)	1: experienced any? - not at all, some of the time, all the time 2: Feel like it's caused by wind turbine noise? - Yes, possibly, no, I don't know	Newly created. g) Tension and edginess (Tense and edgy): from Heathrow Second Survey of aircraft noise annoyance around London Heathrow airport (McKennel, 1979) Others: impact of low frequency noise and infrasound (Hansen, 2007)
	Q 13	Not included	WTN in different situations	When you are at home, do you notice the noise from wind turbine(s) in each of the following situations? If you do, how much does it annoy you?	a) When the wind is strong b) When you are inside your room with windows closed c) when these is heavy traffic flow outside your dwelling d) when at night	1: Notice? No, Yes, Don't know 2: Annoying? Not at all - Extremely, 5 scales	Newly created. a): Pedersen & Waye 2004; Pedersen et al., 2009; Pawlaczyk-Luszczynska et al., 2014. b): Pawlaczyk-Luszczynska et al., 2014. c): Pedersen & Persson Waye, 2004; Bakker et al., 2012. d): Pedersen & Persson Waye, 2004; Pedersen et al., 2009;
	Q 14	Not included	Sound characteristics	How would you describe the sound of the wind turbine(s)? Please choose ALL that apply.	noiseless / quiet swishing beating wooshing whistling pulsating throbbing other (please specify)		Newly created. Swishing related to 2k-4k Hz, correlated to annoyance: Pedersen & Persson Waye, 2004. Whistling, throbbing: Pedersen et al., 2009 Beating, pulsating being indicative of AM: Moorhouse et al., 2007; Beating, pulsating at night & more annoying: van den Berg, 2004
	Q 15	Not included	Attitude to WT	Please mark ALL the adjectives that you think are applicable to wind turbines:	*7 polarised items:* environment-friendly; not environment-friendly; efficient; inefficient; dangerous; harmless; unnecessary; necessary; ugly; pretty; attractive/inviting; threatening; natural/green; unnatural; other (please specify)		Adapted from Pedersen & Persson Waye (2004) - eight polarised items (developed by Karin Hammarlund)
	Q 16	Not included	Financial stake	Do you or your family have a financial stake in the wind farm?	a) joint owner / employee b) receive compensation / benefits c) other (please specify)	1: You yes, no 2: your family: - yes, no, I don't know	Adapted from Pedersen, 2011; Bakker et al., 2012.
Demographics	Q 17	Q 10	Age	Your age in years:			HSE
	Q 18	Q 11	Gender	Your gender	male female		HSE
	Q 19	Q 12	Employment Status	Please indicate which one best describes your current situation.	In full-time employment / self-employed In part-time employment / self-employed In full-time education On a training scheme Retired On maternity leave Looking after family or home Other (please specify)		Understanding Society
	Q 20	Q 13	Illness	Are you suffering from any long-standing illness, disability or infirmity?	Yes No		HSE/Understanding Society (with minor adaption)

	Q 21	Q 14	Educational qualification	What is the highest educational or school qualification have you obtained?	No qualification GCSE / CSE / O Level A Leave or equivalent Higher education below degree Degree level qualification Other (please specify)		Understanding Society (with minor adaption)
	Q 22	Q 15	Marital status	What is your current marital status?	Single Married / In civil partnership / Cohabiting Separated / Divorced Widowed		Understanding Society (with minor adaption)
	Q 23	Q 16	Household income	Which one represents the total annual income of your household before any deductions?	Up to £20,000 £20,000 to £29,999 £30,000 to £49,999 £50,000 to £79,999 More than £80,000 I don't know		Adapted based on UK annual household income distribution
Accommodation	Q 24	Q 17	Number of bedrooms	How many bedrooms are there at your dwelling?			Understanding Society (hhresp_pos113)
	Q 25	Q 18	Housing type	What type of accommodation does your household live in?	Detached house/bungalow Semi-detached house/bungalow Mid-terraced house/bungalow End-terraced house/bungalow Purpose built or converted flat/maisonette Other		BHPS_w18 (with minor adaption)
	Q 26	Q 19	Orientation	Please choose ONE from the following statements.	a) All our rooms are at the front of the building facing the street/front yard. b) All our rooms are at the back of the building facing the back yard/court. c) We have rooms at both sides of the building. d) We have rooms facing three sides of the building, or more.		Newly created.
	Q 27	Not included	Visibility of WT	Can you see any wind turbines from the place you live? Please choose ALL that apply.	a) I can see it/them from the window of my dwelling. b) I can see it/them from my garden/yard. c) I can't see any from my dwelling or garden/yard.		Newly created. based on Pedersen & Persson Waye, 2004; 2007, etc.
	Q 28	Q 20	Length of residency	How long have you lived at your current address?	Number of years (if less than a year please indicate number of months)		Understanding Society_Mvyr_year moved to current address
	Q 29	Q 21	Time at home	Please indicate the approximate number of hours PER DAY you spent (including sleeping) indoors or outdoors at your dwelling during the last week.	a) Time spent indoors at your dwelling: ( ) hours at average PER DAY b) Time spent ourdoors around your dwelling: ( ) hours at average PER DAY		Newly created.
	Q 30	Q 22	Ownership	Please choose ONE statement which best describes your household's ownership of the accommodation.	owned outright owned/being bought on mortgage shared ownership (part-owned part-rented) rented rent free other		HSE/Understanding Society (hhresp_Pos115)
	Q 31	Q 23	Double-glazed window	Is the window of your bedroom double-glazed or sound proofed?	Yes No I don't know		Newly created.

4.1. Evaluation on wind turbine noise

Annoyance to wind turbine noise has been assessed in a number of previous studies, and most commonly among a set of environmental nuisances (Pedersen & Waye, 2004; 2007). In this questionnaire, annoyance is assessed in four questions, as shown in Table 2. The first question (Q5) is adapted from Pedersen & Waye (2004) and the BHPS (Brice et al. 1993) and concerns a series of environmental nuisances including wind turbine noise. Respondents are asked to first indicate whether

they notice any of the listed nuisances, and if yes, to rate their degree of annoyance on a 5-point scale from “not at all” to “extremely”. Potential environmental nuisances unrelated to wind turbines are included to decrease the focusing effect on wind turbine noise, taken from previous studies. Noise from neighbours and traffic are included following Pedersen & Waye (2004), to examine how noise from wind turbines is perceived relative to other potentially annoying sound sources in a suburban context. Unpleasant odors from outside and pests are also adapted from Pedersen & Waye (2004). Pollution, grime or dust are taken from the BHPS to further decrease the focusing effect on wind turbine noise. Vibrations of the building is newly added to the questionnaire, because residents near wind turbines frequently complain about this (Harry 2007; Pierpont 2009; Phipps 2007), but has not been assessed in previous studies. Note that this question (Q5) is the only wind turbine related question that is included in both Variants 1 and 2, allowing a direct comparison between the two variants.

In questionnaire Variant 1, annoyance of wind turbine noise is further examined in two questions that have been standardised by ISO Acoustics for assessing noise annoyance in surveys (ISO 15666 2003). One question (Q9) uses a verbal 5-point category scale (“not at all, slightly, moderately, very, extremely”) and asks directly for annoyance with wind turbine noise. The later question (Q10) uses a numerical 0-10 scale (endpoints marked “not at all” and “extremely”) and assesses the respondent’s annoyance outdoors and indoors separately.

The last question addressing awareness of and annoyance with wind turbine noise in questionnaire Variant 1 (Q13) is newly created and involves several situations. These are: (a) when the wind is strong, (b) when indoors with windows closed, (c) when there is heavy traffic flow outside, and (d) when at night. Previous studies have found that strong winds (a) and night time (d) increase awareness and annoyance (e.g. Harry, 2007; Pedersen & Waye, 2004; Pedersen et al., 2009). Moreover, traffic noise studies (Öhrström 1991) have found that noise exposure at night (d) is better related to psychosocial well-being than day-time noise exposure. Fewer respondents have reported to be disturbed by wind turbine noise when indoors (b) (Pawlaczyk-Luszcynska et al., 2014) and the masking effect of heavy traffic (c) has been demonstrated in two studies (Pedersen & Waye, 2004; Bakker et al., 2012).

This study also investigates respondent’s evaluation of the overall sound environment using pairs of contrasting adjectives (Q8), such as “quiet – loud”, “interesting – boring”, “continuous – discontinuous”, and so on. The items are adapted from a previous study on the soundscape in urban public spaces using semantic differential analysis (Kang 2006). Eight soundscape indices are used, which are hypothesised to be related to wind turbine noise. The indices cover various aspects of soundscape, for example, strength: quiet-noisy; satisfaction: pleasant-unpleasant, calming-agitating; fluctuation: directional-everywhere.

4.2. Sleep disturbance

Sleep disturbance is measured without making reference to noise and is kept identical in questionnaire Variants 1 and 2 (shown as Q4 in Table 2). The question is adapted from the questions used in a survey of aircraft noise (McKennel 1979). Respondents are required to choose all the statements that describes their sleep including difficulty in falling asleep, lighter sleep, occasional and long-time awakening, and taking pills to sleep. Table 3 documents the items and the contexts in which each has been used. Most

of the sleep problems included have been reported to be affected by environmental noise, but have not been examined in existing studies of wind turbine noise.

Sleep disturbance assessed in most previous studies on wind turbine noise have been measured either with or without making reference to noise. Where noise is mentioned as a possible cause of sleep disturbance, it has typically been measured by a single question, which either asks whether or not sleep is disturbed by any noise source (yes/no) (Pedersen & Waye, 2004; 2007), or asks how often sleep is disturbed by environmental noise (5-point ordinal scale from "almost never" to "almost daily") (Bakker et al., 2012). It has been argued, however, that the number of respondents whose sleep is disturbed by noise is too small for meaningful statistical analysis (Pedersen & Waye, 2004). More recent studies have measured sleep outcomes without referring to noise by asking for the respondent's satisfaction with their sleep (Shepherd et al., 2011) or whether they have difficulty with falling asleep (Pawlaczyk-Luszcynska et al., 2014). One study has measured general sleep quality by a set of questions taken from the Pittsburgh Sleep Quality Index (PSQI), which assesses the occurrence of various sleep problems such as not being able to go to sleep within 30 minutes or taking pills to fall asleep (Nissenbaum et al., 2012).

Table 2 Items of sleep disturbance

Question items	*Used in wind turbine noise studies (irrespective of result):*	*Used and evidenced in other noise studies:*
a) My sleep is not disturbed at all.	Disturbed sleep: Pedersen & Waye, 2004; Bakker et al., 2012; (evidenced). Pedersen & Waye, 2007; (not evidenced)	Disturbed sleep: Muzet 2007; Basner et al. 2011; WHO 1999; etc.
b) It's hard for me to fall asleep.	- Assessed in PSQI_Cannot get to sleep within 30mins: Nissenbaum et al., 2012. (evidenced – related to distance) - Having difficulty with falling asleep: Pawlaczyk-Luszczynska et al., 2014. (evidenced)	Noise increased the time to fall asleep: Ohrstrom 1991; Muzet 2007; Basner et al. 2014; etc.
c) I sleep less deeply than I would like.		Sleep lighter: Basner et al. 2011
d) I occasionally wake up but I soon go back to sleep.		Noise induced awakening: Muzet 2007; Basner et al. 2014; (Passchier-Vermeer & Passchier 2000; Zaharna & Guilleminault 2010; Persson et al. 2003); etc.
e) I often lie awake for a while.		Noise induced awakening: Muzet 2007; Basner et al. 2014; Passchier-Vermeer & Passchier 2000; Zaharna & Guilleminault 2010; Persson et al. 2003; etc.
f) I have to take sleeping pills to fall asleep.	Assessed in PSQI: Nissenbaum et al., 2012. (evidenced – related to distance)	

Question items are adapted from McKennel (1979) - Second survey of aircraft noise annoyance around London (Heathrow) airport.

4.3. Adverse health impacts

The question addressing adverse health impact has been newly created for this questionnaire. There are ten physiological and psychological problems captured in Q12 for Variant 1 (and Q9 for Variant 2), as shown in Table 2. Each item has been reported to be associated with either wind turbine noise or other noise sources typically with a low-frequency component such as aircraft noise (Møller & Lydolf 2002; Stansfeld et al. 2000). Table 4 lists each of the health-related problems included in the questionnaire and the case series studies that have reported the problem as well as previous field studies that have examined the relationship between the problem and levels of noise exposure. Almost all symptoms (h) have been reported in case series studied on wind turbine communities. They are included although evidence has not always been found for some of the same symptoms in large field studies.

It can be seen from Table 4, most case series studies have reported headache, tinnitus (and/or ear discomfort), stress and tension (or irritability) as frequent symptoms (Harry 2007; Ontario 2009; Pierpont 2009; Thorne & Leader 2012). Headache, nausea, dizziness and concentration problems have been reported by Pierpont (2009) as symptoms of the so-called "wind turbine syndrome" in a study that tracked patients over time.

Amongst the reported health symptoms, headache, dizziness, tinnitus, cardiovascular disease, stress and tension have been examined in large field studies. A meta-analysis of three field studies has found tinnitus to be significantly related to noise levels, and headache, tension, stress and being irritable to be significantly related to annoyance (Pedersen et al., 2011). In addition, respondents often report headache, nausea, and dizziness in low-frequency noise studies (Møller & Lydolf 2002; Hansen 2007), and feeling tense and edgy in a number of aircraft noise studies (Stansfeld et al. 2000; Tarnopolsky et al. 1980; McKennel 1979).

The questionnaire includes four health-related problems not included in previous wind turbine noise field studies. Difficulty in intellectual activities (h) is included because it is a known effect of low-frequency noise and community noise (Hansen 2007; WHO 1995), as well as an after effect of disturbed sleep related to noise (Basner et al. 2010; Bonnet & Arand 2003). Nausea, mood swings and lack of concentration have been reported in case series studies on wind turbine communities (Ontario 2009; Pierpont 2009; Thorne & Leader 2012), and so are included as part of a cluster of symptoms related to low-frequency noise (Møller & Lydolf 2002; Hansen 2007). Lack of concentration and mood swings are also found as after effects of disturbed sleep (Muzet 2007).

The question asks how often each of the above health problems are experienced. In questionnaire Variant 1, respondents are then given the opportunity to indicate whether they feel wind turbine noise might be their cause using response options: "yes", "possibly", "no", and "I don't know". There is no corresponding question in Variant 2 on the possible cause of health problems.

Table 3 Items of health symptoms

Health Symptoms *1.*	
a)	HEADACHE
Reported in *case series* studies:	Harry 2007; Pierpont 2009; Ontario 2009; Thorne & Leader 2012.
Used in *wind turbine noise* studies:	Pedersen & Waye 2004; 2007; Pedersen 2009; Pawlaczyk-Luszczynska et al. 2014.
Used and evidenced in *other noise* studies:	- Low-frequency noise: Møller & Lydolf 2002; Hansen 2007. - Aircraft noise: Stansfeld et al. 2000; etc.
b)	NAUSEA
Reported in *case series* studies:	Pierpont 2009; Thorne & Leader 2012.
Used in *wind turbine noise* studies:	
Used and evidenced in *other noise* studies:	Low-frequency noise: Hansen 2007.
c)	DIZZINESS
Reported in *case series* studies:	Pierpont 2009; Farboud et al. 2013;
Used in *wind turbine noise* studies:	Pawlaczyk-Luszczynska et al. 2014
Used and evidenced in *other noise* studies:	Low-frequency noise: Møller & Lydolf 2002
d)	EAR DISCOMFORT
Reported in *case series* studies:	- Tinnitus: Harry 2007; Pierpont 2009; - Ear pressure: Ontario 2009; Thorne & Leader 2012.
Used in *wind turbine noise* studies:	Tinnitus: Pedersen & Waye 2004; (evidenced) Pedersen & Waye,2007; Pedersen 2009; (not evidenced)
Used and evidenced in *other noise* studies:	- Low-frequency noise: Møller & Lydolf 2002; - Community noise: WHO 1999.
e)	CARDIOVASCULAR DISEASE
Reported in *case series* studies:	High blood pressure: Thorne & Leader 2012.
Used in *wind turbine noise* studies:	Pedersen & Waye 2004; 2007; Pedersen 2009; Pawlaczyk-Luszczynska et al. 2014.
Used and evidenced in *other noise* studies:	- Traffic noise: Babisch et al. 1990; Babisch 2008; etc. - Aircraft noise: Katsouyanni et al. 2008. - Community noise: WHO 1999 - Interfere with sleep: Muzet et al. 1980
f)	STRESS
Reported in *case series* studies:	Harry 2007; Ontario 2009; Farboud et al. 2013;
Used in *wind turbine noise* studies:	Pedersen & Waye 2004; 2007; Pedersen 2009; Pawlaczyk-Luszczynska et al. 2014.
Used and evidenced in *other noise* studies:	WHO 1995; Persson et al. 2000; etc.
g)	TENSION and EDGINESS
Reported in *case series* studies:	Irritability: Pierpont 2009; Thorne & Leader 2012;
Used in *wind turbine noise* studies:	Feeling tense, irritable: Pedersen & Waye 2004; 2007; Pedersen 2009; Pawlaczyk-Luszczynska et al. 2014.

Table 3 Items of health symptoms

	Used and evidenced in *other noise* studies:	Aircraft noise: Stansfeld et al. 2000; (Tarnopolsky et al. 1980); Mckennel, 1979
h)	DIFFICULTY IN INTELLECTUAL ACTIVITIES	
	Reported in *case series* studies:	
	Used in *wind turbine noise* studies:	
	Used and evidenced in *other noise* studies:	- Low-frequency noise: Hansen 2007. - Community noise: WHO 1999. - After effect of disturbed sleep: Basner et al. 2010; Bonnet & Arand 2003; WHO 1995
i)	MOOD SWINGS	
	Reported in *case series* studies:	Ontario, 2009;
	Used in *wind turbine noise* studies:	
	Used and evidenced in *other noise* studies:	- Low-frequency noise: Møller & Lydolf 2002; Alves-Pereira & Castelo Branco 2007; - After-effect of disturbed sleep: Muzet 2007; WHO 1995.
j)	LACK OF CONCENTRATION	
	Reported in *case series* studies:	Pierpont, 2009;
	Used in *wind turbine noise* studies:	
	Used and evidenced in *other noise* studies:	- Low-frequency noise: Møller & Lydolf 2002; - After-effect of disturbed sleep: Muzet 2007;
k)	OTHER (please specify)	

4.4. Sound characteristics

Respondents of questionnaire Variant 1 are asked to describe the sound of the wind turbine (Q14), from a set of descriptors of sound characteristics, such as swishing, beating, and pulsating, taken from previous studies, as summarised in Table 5. All descriptors have been used in formal complaints by residents affected by wind turbine noise (Moorhouse et al. 2007).

Swishing, whistling, and throbbing have also been captured in large field studies on wind turbine noise (Pedersen & Waye 2004; Pedersen & Waye 2007; Pedersen et al. 2009; Pawlaczyk-Łuszczyńska et al. 2014). Of these, swishing is the most frequently reported by respondents across a number of studies (Moorhouse et al. 2007) and has been found to be related to annoyance (Pedersen & Waye, 2004). In addition, respondents' descriptors of sound have been linked to different components of wind turbine noise, so that swishing and whistling are associated with the sound at 2-4k Hz, while beating and pulsating are prominent at night and more annoying (van den Berg, 2004). Moreover, beating and pulsating are also indicative of amplitude modulation (AM) of the sound (Moorhouse et al., 2007), which is often considered to be the most annoying aspect of wind turbine noise that leads to complains. An option of noiseless or quiet is added for respondents who do not notice the noise.

Table 4 Items describing sound characteristics of wind turbines

Question items *(Choose ALL that apply)*	*Examined in wind turbine noise studies:*
a) NOISELESS/QUIET	
b) SWISHING	- Related to 2-4k Hz & correlated to annoyance: Pedersen & Waye 2004. - Most reported: Pedersen & Waye 2004, 2007; Pedersen et al. 2009; Pawlaczyk-Luszczynska et al. 2014.
c) BEATING	- Being indicative of AM: Moorhouse et al. 2007; - More at night & more annoying: (van den Berg 2004)
d) WOOSHING	- van den Berg et al. 2008
e) WHISTLING	- Reported in Pedersen & Waye 2004; Pedersen et al. 2009
f) PULSATING	- Being indicative of AM: Moorhouse et al. 2007; - More at night & more annoying: (van den Berg 2004)
g) THROBBING	- Reported in Pedersen & Waye 2004; Pedersen et al. 2009
h) OTHER (please specify)	

All descriptors from b) to g) have been reported in complains from Moorhouse et al. (2007) - Research into aerodynamic modulation of wind turbine noise: final report.

4.5. Order of questions

Considerable effort has gone into determining the order of the questions since this could influence the answers obtained. First of all, to control for possible self-reporting bias, the questionnaire is designed as a general survey on well-being and living environments, including some questions on the reactions to noise. In the case of questionnaire Variant 1, the final version consists of five sections in the following order: a section on well-being and health, a section related to the evaluation of the neighbouring environment, a section addressing the response to wind turbine noise, and last two sections on demographic and architectural variables (see Table 2). This structure starts by getting people engaged in an issue by making them aware of the issue, moving on to general feelings, and then to specific aspects of the issue. Furthermore, the questionnaire aims to reduce non-responses by starting with the section on subjective well-being, which is relatively easy to answer, and leaving the relatively sensitive topics such as income until the last. When determining the position of the key questions on noise impact, possible conditioning effects of the earlier questions have been considered. For instance, the annoyance questions are placed early on in the question sequence, prior to any mention of the potential adverse health impacts, so as to minimise these affecting self-reported annoyance. For the same reason, control variables such as attitudes to wind turbines are also placed later.

5. Conclusions

The questionnaire design was guided by a review of existing large-scale cross-sectional studies that provide the current best evidence on the effects of wind turbine noise on human health and well-being. The questionnaire presented in this paper can be (and has been) used to investigate such effects in

suburban-urban contexts, to address the evidence gap in evaluating wind turbine noise impacts in noisy and urbanised settings.

The inclusion of a large number of questions on socio-demographic and architectural factors provides a wide range of explanatory variables to examine the relationship between wind turbine noise and well-being. This also helps to understand the impact of personal, architectural, and residential factors that may interact in the process.

Most questions on subjective well-being and socio-demographic factors are taken verbatim from those in large national surveys, including the response items and scales. This enables direct comparisons of the results from communities living near wind turbines with those from the general population as controls.

Possible bias associated with asking people for their perceived causes of health problems is minimised by designing a questionnaire variant that does not draw special attention to wind turbine noise.

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Appendix

Variant 1 (side A) (Originally double sided printed on A3 sheet)

Are you the person this questionnaire is addressed to?

☐ 1 Yes ☐ 2 No *(family member / current occupant)*

Instructions

Please complete the questionnaire by ticking the box that best represents your answer or writing in the space provided in some cases. Some questions may look similar.

Q1. Taking all things together, on a scale of 0 to 10, how happy would you say you are? Here 0 means you are very unhappy and 10 means you are very happy.

Very unhappy … Very happy

0 1 2 3 4 5 6 7 8 9 10

Q2. In general, would you say your health is...

☐ 1 Excellent ☐ 2 Very good ☐ 3 Good ☐ 4 Fair ☐ 5 Poor

Q3. Here are some statements on how you feel about your life. Please tick the box which you feel best describes how dissatisfied or satisfied you are with the following aspects of your current situation.

	Not satisfied at all … Completely Satisfied
a) Your life overall	1 2 3 4 5 6 7
b) Your health	
c) Your household income	
d) Your social life	
e) Your living environment	

Q4. Please choose ALL the statement(s) which describe your sleep.

☐ 1 My sleep is not disturbed at all.
☐ 2 It's hard for me to fall asleep.
☐ 3 I sleep less deeply than I would like.
☐ 4 I occasionally wake up but I soon go back to sleep.
☐ 5 I often lie awake for a while.
☐ 6 I have to take sleeping pills to fall asleep.

Q5. The following are several things that might exist in people's living environment. Please state for each thing of the below, whether you notice them and if so, whether you are annoyed by them when you spend time at home.

	Notice? No	Yes	Don't know	If you notice, do you find it annoying? Not at all … Extremely
a) Unpleasant odor from outside	1	2	3	1 2 3 4 5
b) Noise from neighbours				
c) Traffic noise				
d) Noise from wind turbines				
e) Other noise sources _____(Please specify)				
f) Bugs, pests or vermin				
g) Vibration of the building				
h) Pollution, grime or dust				

Q6. In terms of environmental noise, how much do you agree or disagree with the following statements?

	Agree strongly … Disagree strongly
a) I find it hard to relax in a place that's noisy.	1 2 3 4 5 6
b) I get used to most noises without much difficulty.	

Q22. What is your current marital status?

☐ 1 Single ☐ 2 Married / In civil partnership / Cohabiting
☐ 3 Separated / Divorced ☐ 4 Widowed

Q23. Which one represents the total annual income of your household before any deductions?

☐ 1 Up to £20,000 ☐ 2 £20,000 to £29,999
☐ 3 £30,000 to £49,999 ☐ 4 £50,000 to £79,999
☐ 5 More than £80,000 ☐ 6 I don't know

Q24. How many bedrooms are there at your dwelling? _____

Q25. What type of accommodation does your household live in?

☐ 1 Detached house/bungalow ☐ 2 Semi-detached house/bungalow
☐ 3 Mid-terraced house/bungalow ☐ 4 End-terraced house/bungalow
☐ 5 Purpose built or converted flat/maisonette ☐ 6 Other

Q26. Please choose ONE from the following statements.

☐ 1 All our rooms are at the front of the building facing the street/front yard.
☐ 2 All our rooms are at the back of the building facing the back yard/court.
☐ 3 We have rooms at both sides of the building.
☐ 4 We have rooms facing three sides of the building, or more.

Q27. Can you see any wind turbines from the place you live? Please choose ALL that apply.

☐ 1 I can see it/them from the window of my dwelling. ☐ 2 I can see it/them from my garden/yard.
☐ 3 I can't see any from my dwelling or garden/yard.

Q28. How long have you lived at your current address?

_____ years (If less than a year please indicate _____ months)

Q29. Please indicate the approximate number of hours PER DAY you spent (including sleeping) indoors or outdoors at your dwelling during the last week.

a) Time spent indoors at your dwelling: _____ hours at average PER DAY
b) Time spent outdoors around your dwelling: _____ hours at average PER DAY

Q30. Please choose ONE statement which best describes your household's ownership of the accommodation.

☐ 1 Owned outright ☐ 2 Owned / being bought on mortgage ☐ 3 Shared ownership (Part-owned part-rented)
☐ 4 Rented ☐ 5 Rent free ☐ 6 Other

Q31. Is the window of your bedroom double-glazed or sound proofed?

☐ 1 Yes ☐ 2 No ☐ 3 I don't know

You have complete the questionnaire. Please return it using the pre-addressed return-prepaid envelope best within two weeks of receiving this. Thank you very much for your participation!

Q7. What are your views on environmental sustainability?

	Agree strongly 1	2	3	4	5	Disagree strongly 6
a) The environmental sustainability is a low priority for me compared with a lot of other things in my life.						
b) I personally need to change my way of life so that future generations can continue to enjoy a good quality of life and environment.						

Q8. How do you evaluate the overall sound environment at your dwelling?

	Very 3	Fairly 2	Little 1	Neutral 0	Little -1	Fairly -2	Very -3	
a)								*Loud*
b) *Interesting*								*Boring*
c) *Pleasant*								*Unpleasant*
d) *Continuous*								*Discontinuous*
e) *Predictable*								*Chaotic*
f) *Calming*								*Agitating*
g) *Directional*								*Everywhere*
h) *Natural*								*Artificial*

Q9. Thinking about the last 12 months, when you are at home, how much does noise from wind turbines bother, disturb or annoy you?

☐ 1 Not at all ☐ 2 Slightly ☐ 3 Moderately ☐ 4 Very ☐ 5 Extremely

Q10. Thinking about the last 12 months, what number from 0 to 10 best shows how much you are bothered, disturbed or annoyed by wind turbine noise when you spend time *outdoors* and *indoors* at your dwelling?

	Not at all 0	1	2	3	4	5	6	7	8	9	Extremely 10
Outdoors at your dwelling:											
Indoors in your dwelling:											

Q11. Would you say that the wind turbine noise has any effect on your health?

☐ 1 No, not at all ☐ 2 Yes, some of the time
☐ 3 Yes, most of the time ☐ 4 I don't know

Q12. Did you experience any of the below during the past week? Please indicate whether you consider it to be caused by wind turbine noise.

	Experienced any? Not at all 1	Some of the time 2	All the time 3	Feel like it's caused by wind turbine noise? Yes 1	Possibly 2	No 3	I don't know 4
Headache							
Nausea							
Dizziness							
Ear discomfort							
Cardiovascular disease							
Stress							
Tension and edginess							
Difficulty in intellectual activities							
Mood swings							
Lack of concentration							
Other_____(Please specify)							

Q13. When you are at home, do you notice the noise from wind turbine(s) in each of the following situations? If you do, how much does it annoy you?

	Notice No 1	Yes 2	Don't know 3	Annoying Not at all 1	2	3	4	Extremely 5
a) When the wind is strong								
b) When you are inside your room with windows closed								
c) When there is heavy traffic flow outside your dwelling								
d) When at night								

Q14. How would you describe the sound of the wind turbine(s)? Please choose ALL that apply.

☐ 1 Noiseless / Quiet ☐ 2 Swishing ☐ 3 Beating ☐ 4 Wooshing
☐ 5 Whistling ☐ 6 Pulsating ☐ 7 Throbbing ☐ 8 Other _____ (Please specify)

Q15. Please mark ALL the adjectives that you think are applicable to wind turbines:

☐ 1 Environment-friendly ☐ 2 Not environment-friendly
☐ 3 Efficient ☐ 4 Inefficient ☐ 5 Dangerous ☐ 6 Harmless
☐ 7 Unnecessary ☐ 8 Necessary ☐ 9 Ugly ☐ 10 Pretty
☐ 11 Attractive/inviting ☐ 12 Threatening ☐ 13 Natural/green ☐ 14 Unnatural
☐ 15 Other (Please specify)_____

Q16. Do you or your family have a financial stake in the wind farm?

	You Yes 1	You No 2	Your family Yes 1	Your family No 2	Your family I don't know 0
a) Joint Owner / Employee					
b) Receive compensation/benefits					
c) Other _____(Please specify)					

Now, to help us analyse your answers, would you mind to tell us something about yourself?

Q17. Your age in years: _____

Q18. Your gender: ☐ 1 Male ☐ 2 Female

Q19. Please indicate which one best describes your current situation.

☐ 1 In full-time employment/self-employed ☐ 2 In part-time employment/self-employed
☐ 3 In full-time education ☐ 4 On a training scheme
☐ 5 Retired ☐ 6 On maternity leave
☐ 7 Looking after family or home ☐ 8 Other _____ (Please specify)

Q20. Are you suffering from any long-standing illness, disability or infirmity?

☐ 1 Yes ☐ 2 No

Q21. What is the highest educational or school qualification have you obtained?

☐ 1 No qualification ☐ 2 GCSE / CSE / O Level
☐ 3 A Level or equivalent ☐ 4 Higher education below degree
☐ 5 Degree level qualification ☐ 6 Other _____ (Please specify)

Variant 1 (side B) (Originally double sided printed on A3 sheet)

Are you the person this questionnaire is addressed to?

☐ 1 Yes ☐ 2 No *(family / current occupant)*

Instructions

Please complete the questionnaire by ticking the box that best represents your answer or writing in the space provided in some cases.

Q1. Taking all things together, on a scale of 0 to 10, how happy would you say you are? Here 0 means you are very unhappy and 10 means you are very happy.

Very unhappy … Very happy

☐0 ☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7 ☐8 ☐9 ☐10

Q2. In general, would you say your health is...

☐ 1 Excellent ☐ 2 Very good ☐ 3 Good ☐ 4 Fair ☐ 5 Poor

Q3. Here are some statements on how you feel about your life. Please tick the box which you feel best describes how dissatisfied or satisfied you are with the following aspects of your current situation.

	Not satisfied at all … Completely Satisfied
a) Your life overall	☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7
b) Your health	☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7
c) Your household income	☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7
d) Your social life	☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7
e) Your living environment	☐1 ☐2 ☐3 ☐4 ☐5 ☐6 ☐7

Q4. Please choose ALL the statement(s) which describe your sleep.

☐ 1 My sleep is not disturbed at all.
☐ 2 It's hard for me to fall asleep.
☐ 3 I sleep less deeply than I would like.
☐ 4 I occasionally wake up but I soon go back to sleep.
☐ 5 I often lie awake for a while.
☐ 6 I have to take sleeping pills to fall asleep.

Q5. The following are several things that might exist in people's living environment. Please state for each thing of the below, whether you notice them and if so, whether you are annoyed by them when you spend time at home.

	Notice? No ☐1	Yes ☐2	Don't know ☐3	If you notice, do you find it annoying? Not at all ☐1 ☐2 ☐3 ☐4	Extremely ☐5
a) Unpleasant odor from outside					
b) Noise from neighbours					
c) Traffic noise					
d) Noise from wind turbines					
e) Other noise sources _____(Please specify)					
f) Bugs, pests or vermin					
g) Vibration of the building					
h) Pollution, grime or dust					

Q20. How long have you lived at your current address?

_____ years (If less than a year please indicate_____ months)

Q21. Please indicate the approximate number of hours PER DAY you spent (including sleeping) indoors or outdoors at your dwelling during the last week.

a) Time spent indoors at your dwelling: _____ hours at average PER DAY

b) Time spent outdoors around your dwelling: _____ hours at average PER DAY

Q22. Please choose ONE statement which best describes your household's ownership of the accommodation.

☐ 1 Owned outright ☐ 2 Owned / being bought on mortgage ☐ 3 Shared ownership (Part-owned part-rented)
☐ 4 Rented ☐ 5 Rent free ☐ 6 Other

Q23. Is the window of your bedroom double-glazed or sound proofed?

☐ 1 Yes ☐ 2 No ☐ 3 I don't know

You have complete the questionnaire. Please return it using the pre-addressed return-prepaid envelope best within 2 weeks.

Thank you very much for your participation!

Q6. In terms of environmental noise, how much do you agree or disagree with the following statements?

	Agree strongly 1	2	3	4	5	Disagree strongly 6
a) I find it hard to relax in a place that's noisy.	☐	☐	☐	☐	☐	☐
b) I get annoyed when my neighbours are noisy.	☐	☐	☐	☐	☐	☐

Q7. What are your views on environmental sustainability?

	Agree strongly 1	2	3	4	5	Disagree strongly 6
a) The environmental sustainability is a low priority for me compared with a lot of other things in my life.	☐	☐	☐	☐	☐	☐
b) I personally need to change my way of life so that future generations can continue to enjoy a good quality of life and environment.	☐	☐	☐	☐	☐	☐

Q8. How do you evaluate the overall sound environment at your dwelling?

	Very 3	Fairly 2	Little 1	Neutral 0	Little -1	Fairly -2	Very -3	
a) *Quiet*	☐	☐	☐	☐	☐	☐	☐	*Loud*
b) *Interesting*	☐	☐	☐	☐	☐	☐	☐	*Boring*
c) *Pleasant*	☐	☐	☐	☐	☐	☐	☐	*Unpleasant*
d) *Continuous*	☐	☐	☐	☐	☐	☐	☐	*Discontinuous*
e) *Predictable*	☐	☐	☐	☐	☐	☐	☐	*Chaotic*
f) *Calming*	☐	☐	☐	☐	☐	☐	☐	*Agitating*
g) *Directional*	☐	☐	☐	☐	☐	☐	☐	*Everywhere*
h) *Natural*	☐	☐	☐	☐	☐	☐	☐	*Artificial*

Q9. Did you experience any of the below during the past week?

	Not at all 1	Some of the time 2	All the time 3
Headache.	☐	☐	☐
Nausea.	☐	☐	☐
Dizziness.	☐	☐	☐
Ear discomfort.	☐	☐	☐
Cardiovascular disease.	☐	☐	☐
Stress.	☐	☐	☐
Tension and edginess.	☐	☐	☐
Difficulty in intellectual activities.	☐	☐	☐
Mood swings.	☐	☐	☐
Lack of concentration.	☐	☐	☐
Other_____ (Please specify)	☐	☐	☐

Now, to help us analyse your answers, would you mind to tell us something about yourself?

Q10. Your age in years: _____

Q11. Your gender: ☐ Male (1) ☐ Female (2)

Q12. Please indicate which one best describes your current situation.

- ☐ In full-time employment/self-employed (1)
- ☐ In part-time employment/self-employed (2)
- ☐ In full-time education (3)
- ☐ On a training scheme (4)
- ☐ Retired / Looking after family or home (5)
- ☐ Other _____ (Please specify) (6)

Q13. Are you suffering from any long-standing illness, disability or infirmity?

- ☐ Yes (1)
- ☐ No (2)

Q14. What is the highest educational or school qualification have you obtained?

- ☐ No qualification (1)
- ☐ GCSE / CSE / O Level (2)
- ☐ A Level or equivalent (3)
- ☐ Higher education below degree (4)
- ☐ Degree level qualification (5)
- ☐ Other _____ (Please specify) (6)

Q15. What is your current marital status?

- ☐ Single (1)
- ☐ Married / In civil partnership / Cohabiting (2)
- ☐ Separated / Divorced (3)
- ☐ Widowed (4)

Q16. Which one represents the total annual income of your household before any deductions?

- ☐ Up to £20,000 (1)
- ☐ £20,000 to £29,999 (2)
- ☐ £30,000 to £49,999 (3)
- ☐ £50,000 to £79,999 (4)
- ☐ More than £80,000 (5)
- ☐ I don't know (6)

Q17. How many bedrooms are there at your dwelling? _____

Q18. What type of accommodation does your household live in?

- ☐ Detached house/bungalow (1)
- ☐ Semi-detached house/bungalow (2)
- ☐ Mid-terraced house/bungalow (3)
- ☐ End-terraced house/bungalow (4)
- ☐ Purpose built or converted flat/maisonette (5)
- ☐ Other (6)

Q19. Please choose ONE from the following statements.

- ☐ All our rooms are at the front of the building facing the street/front yard. (1)
- ☐ All our rooms are at the back of the building facing the back yard/court. (2)
- ☐ We have rooms at both sides of the building. (3)
- ☐ We have rooms facing three sides of the building, or more. (4)

Variant 2 (side B) (Originally double sided printed on A3 sheet)