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NOISE CONTROL FOR QUALITY OF LIFE

Social survey on community response to wind turbine noise in Japan

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ABSTRACT

A committee of Research on the Evaluation of Human Impact of Low Frequency Noise from Wind Turbine Generators conducted a series of physical measurements, laboratory psychological experiments and social surveys of wind turbine noise under the auspice of the Ministry of the Environment of Japan. In this paper, a design of questionnaire used in the survey and a part of the results are introduced. The questionnaire is based on the proposal of the Acoustical Society of Japan, which was planned to make the results of social surveys conducted by various researchers comparable. Social surveys were conducted in 36 sites where wind turbine noise is audible and in 16 sites where wind turbine noise is inaudible. The number respondents were 747 and 332, respectively. The results of the survey are introduced from various viewpoints.

Keywords: Wind turbine noise, Social survey

1. INTRODUCTION

From the viewpoint of sustainability of the environment, it is desirable to use natural resources to generate electricity, such as wind, water, solar energy, etc. When wind turbine generators are made at the place far from residential areas where residents cannot hear the sound and see the generators, there would be no problem. Also, when wind turbine generators are accepted as a part of the scenery in a park, the wind turbine generators may be able to co-exist with residents. However, it sometimes happens that people who live close to the wind turbine generators claim that they are annoyed by the wind turbine noise and that they suffer from health problems due to wind turbine

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generators.

Under these circumstances, a committee of Research on the Evaluation of Human Impact of Low Frequency Noise from Wind Turbine Generators conducted a series of physical measurements, laboratory psychological experiments and social surveys of wind turbine noise under the auspice of the Ministry of the Environment of Japan. In this paper, a design of questionnaire used in the survey and a part of the results are introduced.

2. QUESTIONNAIRE

2.1 Design of questionnaire

Social survey is a useful tool to examine the responses of people in the situation where they spend daily life. Many social surveys have been conducted by many researchers in various places. It needs much effort and cost to conduct a social survey. Usually, the surveys are conducted independently for different purposes. Therefore, their results cannot be compared with each other. If the social surveys conducted in various places can be compared with each other, more useful information can be obtained. It is also necessary to compare the results with those of other surveys in order to examine the validity of the survey. For this purpose it is required that common items are included in the social surveys to be compared.

The committee of the social survey on noise problems was organized by the Acoustical Society of Japan (ASJ) in order to examine the comparability of social surveys. The Committee proposed fundamental items for a questionnaire that can be used commonly in social surveys in Japanese in 1992 [1] after preliminary surveys conducted in seven research organizations. The English version of the questionnaire was published in 1996 [2].

The Committee was organized again in 2001 by ASJ and started to prepare the manual and the code of ethics and conduct for the social survey as well as to re-examine the fundamental items for the questionnaire in the first version published in 1992. The committee had several meetings and published the revised version of the common items for the questionnaire [3], the manual and the code of ethics and conduct in 2006. The revised questionnaire is translated into English [4]. Similar ideas were proposed by ICBEN [5] and ISO [6].

In order to decide the Environmental Quality Standard in Japan, the dose-response relationship is needed on the basis of the social survey conducted in Japan. By the request of the Ministry of the Environment of Japan, a committee was organized by the Institute of Noise Control Engineering of Japan (INCE/Japan). The committee had discussion about the questionnaires proposed by ASJ, made a small revision and conducted preliminary surveys in various places in Japan [7].

The questionnaire used in the survey of wind turbine noise is prepared on the basis of the questionnaire of INCE/Japan since the reasonable data could be obtained by the preliminary surveys conducted by the committee of INCE/J. Some questions were added about wind turbine noise and also subjective health status was examined by including questions related to respiratory system, eye and skin, digestive organ, irregularity of daily life and emotional instability from Total Health Index (THI) developed in the University of Tokyo [8].

The questionnaire used in the present survey is introduced at the end of this paper as appendix.

2.2 Respondents

Social surveys were conducted in 36 sites where wind turbine noise was audible (abbreviated as wind turbine site) and in 16 control sites where wind turbine noise is inaudible (abbreviated as control site) from Hokkaido to Okinawa in Japan. Physical measurements were also conducted in these sites. The survey of control sites was conducted in 18 sites. However, since it was found that the wind turbine generators were visible in two sites, the data of these two sites were deleted from the final analyses. The effect of wind turbine noise would become clear by doing social survey in control sites where the environment is similar to that of wind turbine sites. A few days before the survey, a sheet asking cooperation with the survey was posted to each house. The total number respondents were 747 in the wind turbine sites and 332 in control sites. The interviewers visited to each house and read each question by showing the questionnaire sheets to the respondents. The answers were written by the interviewers. The responses could be obtained from 49 percent of the residents whom the interviewers visited in wind turbine sites and 45 percent in control sites.

3. RESULTS

In this paper, some of the results of social survey in wind turbine sites and control site are introduced.

3.1 Respondents

Sex and age distributions are shown in Figures 1 and 2. It can be seen that both females and males participated in the survey in both sites though the percentage of females was a little higher in control site than in wind turbine site. About 80 percent of the respondents were above fifties in both sites.

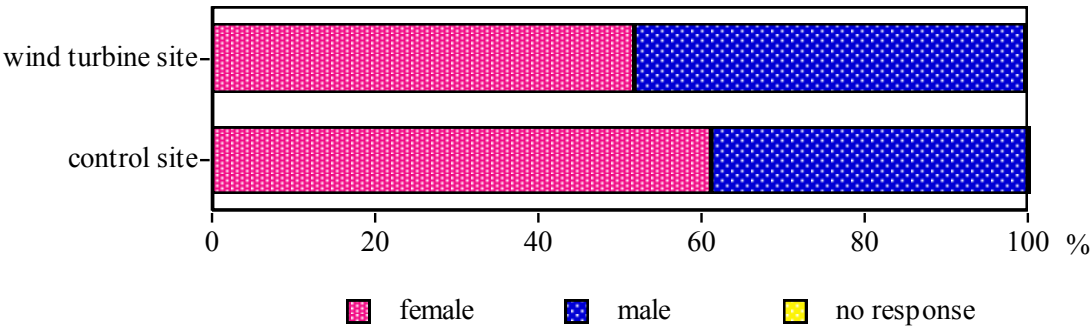


Figure1 Sex of the respondents

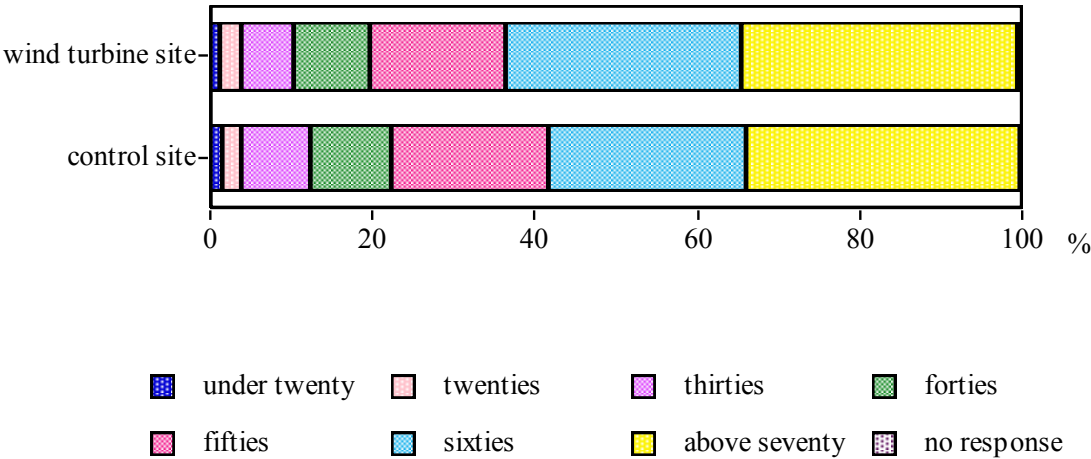


Figure 2 Age of the respondents

3.2 Satisfaction with living environment

In Q2 satisfaction with their living environment was asked. The results are shown in Figures 3 and 4. Both wind turbine site and control site were rural areas and many respondents were satisfied with the amount of greenery and clean air, and they were not always satisfied with the convenience of shopping and transportation and public facilities. Some difference can be seen in the satisfaction with quietness between wind turbine sites and control sites. About 10 percent of the respondents in wind turbine site were not satisfied with quietness. This may be due to wind turbine noise.

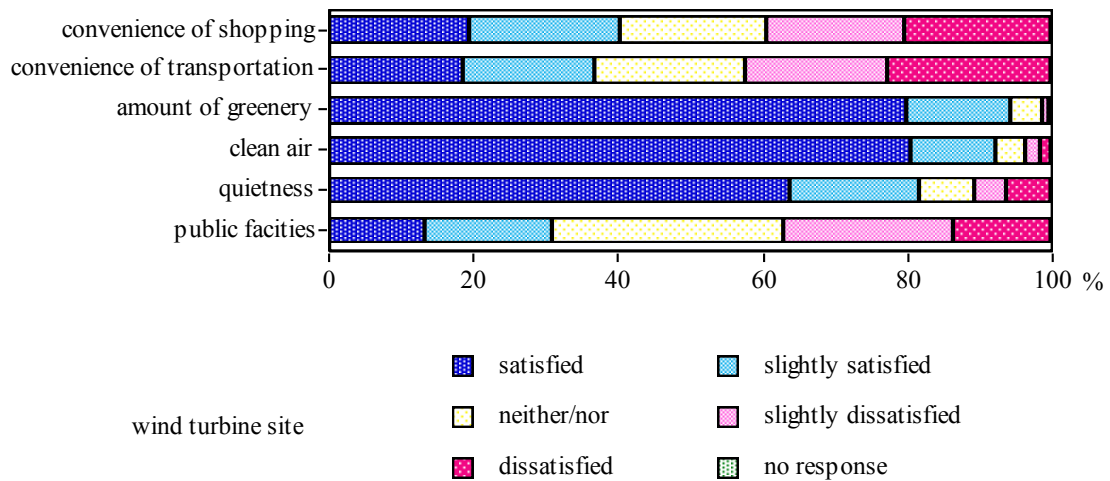


Figure 3 Satisfaction with their living environment in wind turbine site

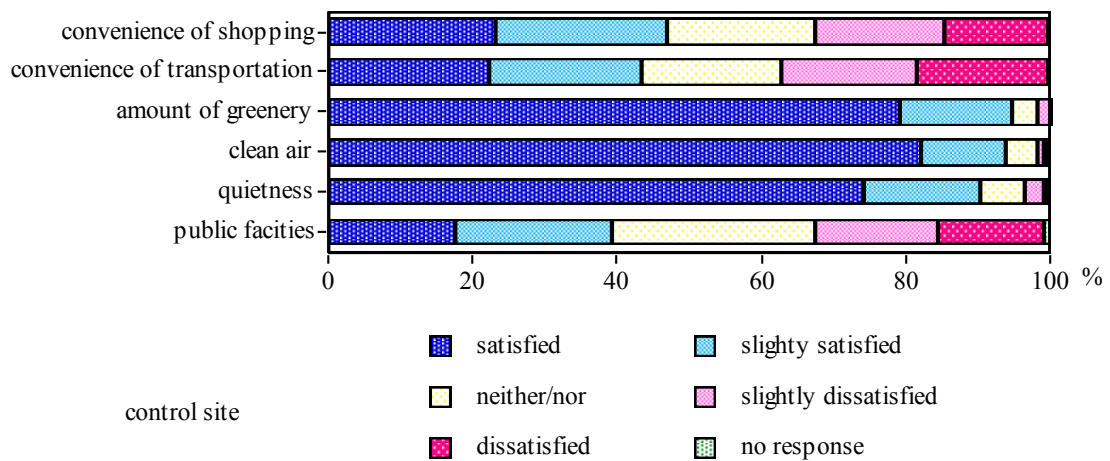


Figure 4 Satisfaction with their living environment in control site

3.3 Annoying sound

In Q3, the degrees of annoyance of road traffic noise, aircraft noise, shinkansen train noise, conventional train noise, noise from factories, construction noise and wind turbine noise were asked in 5-step categories. About 80 percent of the respondents of both sites answered that the noises were not annoying at all or they were slightly annoyed. When they were asked what was the most annoying sound in the list (Q4), about 16 percent of the respondents in wind turbine site answered that wind turbine noise was the most annoying sound as shown in Figure 5.

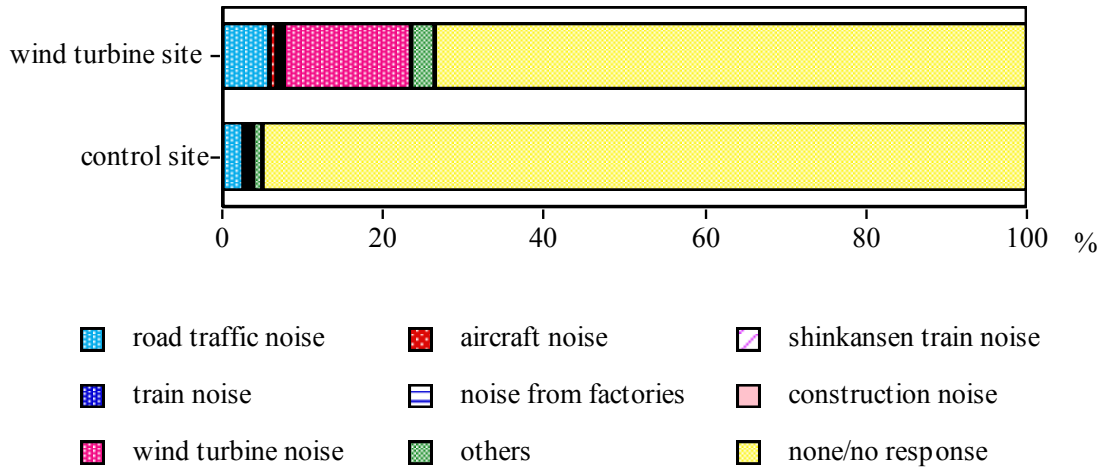


Figure 5 Most annoying sound

3.4 Trouble with sleep

There were not so many respondents who had trouble with sleep as shown in Figure 6. However, when the respondents who had trouble with sleep were asked the reason, more than half of the respondents in wind turbine site answered that it was due to the noise.

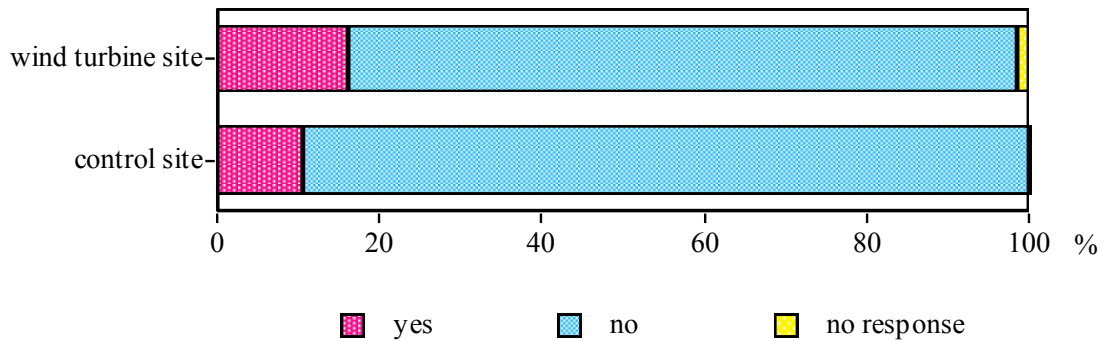


Figure 6 The percentage of the responses to the question whether they had a trouble with sleep.

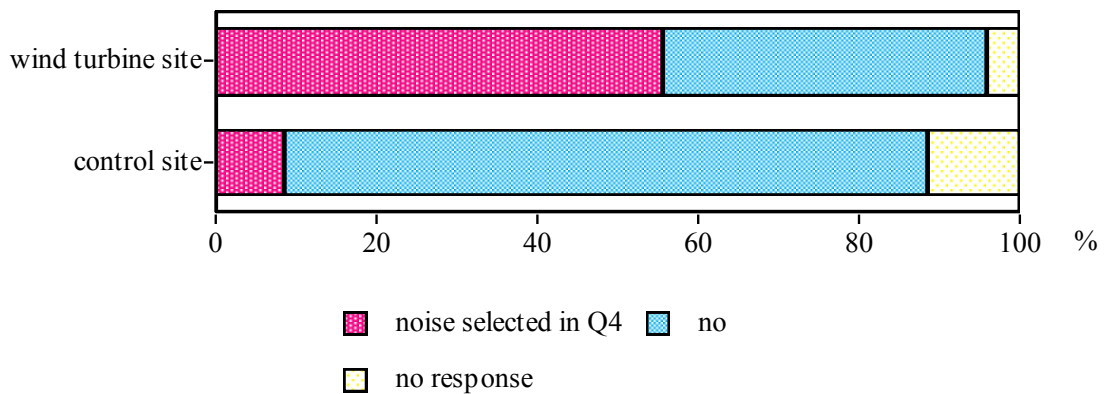


Figure 7 The reason of the trouble with sleep.

4. SUMMARY

Social surveys were conducted in 36 wind turbine sites and 16 control sites in Japan. The numbers of the respondents of each site were 747 and 332, respectively. There were not so big difference in the results between wind turbine site and control site except for the effect of wind turbine noise. It was suggested that wind turbine noise has an effect on annoyance and sleep disturbance when it was audible. The results of further analyses will be presented in another paper [9] and the results of the questions of subjective health status using THI will be presented in another congress. Since the surveys were conducted using a questionnaire that included the same questions proposed by ASJ and INCE/J, the results would be able to be compared with other surveys in future.

5. ACKNOWLEDGEMENT

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Appendix

Questionnaire on living environment

Q1 How many years have you lived in the present house?

1. shorter than one year
2. 1-3 years
3. 3- 5 years
4. 5- 10 years
5. longer than 10 years

Q2. To what degree are you satisfied with your surroundings? Please choose the appropriate number for each item.

Note: 1=satisfied, 2=slightly satisfied, 3=neither/nor, 4=slightly dissatisfied, 5=dissatisfied

1. convenience of shopping
1 2 3 4 5
2. convenience of transportation
1 2 3 4 5
3. amount of greenery
1 2 3 4 5
4. clean air
1 2 3 4 5
5. quietness
1 2 3 4 5
6. public facilities (such as park and school)
1 2 3 4 5

Q3. Thinking about the last one year or so, when you are here at home, how much does each noise listed below bother or annoy you? Please choose the appropriate number.

Note: 1=not at all, 2=slightly, 3=moderately, 4=very, 5=extremely, 9=in audible

1. road traffic noise
1 2 3 4 5 9
2. aircraft noise
1 2 3 4 5 9
3. shinkansen train noise
1 2 3 4 5 9

4. conventional train noise
1 2 3 4 5 9
5. noise from factories
1 2 3 4 5 9
6. construction noise
1 2 3 4 5 9
7. wind turbine noise
1 2 3 4 5 9
8. other: ()
1 2 3 4 5

Q4. What is the most annoying sound in the above list of sounds? Please choose the number of the sound. If you do not have any annoying sound, please answer none. ()

Those who did not find any annoying sound in Q4 should proceed to Q9.

Q5. In which way are you annoyed by the sound in Q4? Please choose the appropriate numbers. You can choose as many as you like.

1. The sound is a little annoying, but not so serious.
2. I cannot relax because of the sound.
3. The sound is irritating.
4. The sound makes me unhealthy.
5. The sound disturbs listening to telephone, television, or radio.
6. The sound disturbs working or reading.
7. The sound disturbs conversation.
8. Other: ()

Q6. At what time of day are you annoyed by the noise? Please choose the appropriate numbers. You can choose as many as you like.

1. early morning
2. during the day
3. evening
4. night
5. late at night
6. whole day
7. not fixed

Q7. In which season are you annoyed by the noise? Please choose the appropriate numbers. You can choose as many as you like.

1. spring 2. summer
3. autumn 4. winter

When awoken in midnight, it is difficult to sleep again.			
Awaken in early morning			
Do not feel having slept well in the next morning.			
Sleepy during daytime and cannot work well			
Others ()			

Q8. When you are annoyed by the noise, what would you like to do, or what did you do? Please choose the appropriate numbers.

Note: 1=I would like to do, 2=I have done
9=no response

1. Complain to the neighbor directly.
1 2 9
2. Complain to the neighbor by telephone or by letter.
1 2 9
3. Inform the city office or the police.
1 2 9
4. Inform residents' association
1 2 9
5. Inform public movement
1 2 9
6. Have my house sound-insulated.
1 2 9
7. Move house.
1 2 9
8. Other: ()
1 2

(3) If you have trouble with sleep, do you think that it is due to noise you pointed in Q4?

- 1 yes 2 no

Q10. Please answer about yourself.

(1) Sex:

1. female 2. male

(2) Age:

1. under twenty 2. twenties
3. thirties 4. forties
5. fifties 6. sixties
7. above seventy 9. no response

(3) Occupation

1. 1. self employed
2. 2. office worker
3. 3. liberal profession
4. housewife
5. temporary worker
6. student
7. unemployed
8. farmer/fisher/forestry worker
9. others ()

(4) Number of family members including yourself.

1. one 2. two
3. three 4. four
5. five 6 more than six
9. no response

(5) Are there any of the following in your family? Please choose as many as appropriate.

1. night worker

Q9. Please answer about your sleep.

(1) Do you have any trouble with sleep?

- 1 yes 2 no

(2) If you answer "yes" in the above question, please choose appropriate numbers for each item..

- 1=more than 3 times a week
2=once or twice a week
3=occasionally

item	1	2	3
Difficult to fall asleep			

2. examinee
3. the sick
4. the aged
5. baby
6. elementary school pupil
9. no response

(6) Are you sensitive to sound?

1. no
2. neither/nor
3. yes
9. no response

(7) Are you interested in the environmental problems such as noise?

1. no
2. neither/nor
3. yes
9. no response

(8) Do you think that wind turbine generator is a good method since it uses natural resources?

1. yes
2. no
3. others ()

(9) Is the wind turbine noise audible in your house?

1. yes
2. no

(10) Does the furniture vibrate in your house by the running of wind turbine generators?

1. yes
2. no

(11) Can you see the wind turbine generators from your house?

1. yes
2. no

(12) If you can see the wind turbine generators from your house, are they disturbing landscape?

1. no problem
2. disturbing
3. not interested

(13) Does the shadow flicker reflect in your house?

1. yes, in the garden
2. yes, in the house
3. no

(14) Do you have any benefit of wind turbine generators?

1. yes
2. no

2. (15) If "yes" in (14), please tell the concrete benefit.

()

Q11 Please answer the questions about your health conditions. Your answers will never be opened to others. Please answer frankly by choosing one of the three answer categories prepared.

note: Three categories were indicated with each question in the questionnaire. However, because of the limitation of the space, the categories are summarized in the following.

Categories for questions 1-5, 7-10, 12-18, 20-29, 32-35, 38-39, 45, 47

- 1=often
- 2=sometimes
- 3=hardly ever or never

Categories for questions 6, 11, 30, 41-44, 46, 48-54

- 1=yes
- 2= neither/nor
- 3=no

Categories for question 19

- 1=much
- 2=normal
- 3=no

Categories for questions 31

- 1=high
- 2=no
- 3=low

Categories for questions 36, 37

- 1=always
- 2=sometimes
- 3=no

1. Have you experienced coughing?
2. Do you sneeze?
3. Do you feel like there is something in your throat?
4. Do you have difficulty in coughing up phlegm?
5. Do you have a running nose?
6. Are you very sensitive to the cold?
7. Is your nose stuffy?
8. Do you have wheezing in your chest?
9. Do you feel irritation or pain in your throat?
10. Do you have phlegm or mucus in your throat?
11. Is your skin sensitive?
12. Do your eyes get tired?
13. Do you have skin eruptions or rashes?
14. Do you have inflamed or red eyes?
15. Do you have hives or urticaria?

16. Do you feel pain of itching in your eyes?
17. Do your eyelids feel heavy?
18. Do you get abscesses or rashes?
19. Do you have discharge from your eyes?
20. Do you have itchy skin?
21. Do you belch or burp?
22. Do you have indigestion?
23. Do you have stomach pain?
24. Do you suffer from diarrhea?
25. Do you feel queasy or nauseous when you brush your teeth in the morning?
26. Do you have stomach problems?
27. Do you have heartburn?
28. Do you have stomach pains after a meal?
29. Does your stomach hurt when it is empty?
30. Do you go to bed early and get up early?
31. Did a doctor ever say your blood pressure is ---?
32. Have you been told that your face looked pale?
33. Do you eat between meals?
34. Do you have a poor appetite?
35. Do you feel your work load is too much?
36. Do you feel languid or less energetic?
37. Do you find it hard to get up in the morning?
38. Do you skip breakfast?
39. Are your meals irregular?
40. Have you been sleeping less lately?
41. Do you worry about what people think of you?
42. Does your face flush?
43. Do you worry about the past?
44. Do you think your character is easily misunderstood by others?
45. Do you have cold sweats?
46. Are you nervous?
47. Do you perspire when you have to reply to your boss or superior or while taking on examination?
48. Do you feel uneasy when in a strange place?
49. Do you get nervous and shaky when approached by your boss or superior?
50. Do you tremble or feel weak whenever someone shouts at you?
51. Do you have periods of both mania and depression?
52. Do you become scared at sudden movement or noises at night?
53. Do you feel difficulty to continue in your work when your work is observed by others?
54. Do you worry about trivial or small things?

Q13. If you have any opinions about your living environment, please answer freely.

Thank you very much for your kind cooperation.

The following questions should be written by interviewers.

- (1) area
 1. residential
 2. commercial
 3. industrial
 4. agriculture/forestry/fishery
 5. others ()
- (2) house
 1. detached house
 2. apartment house
 3. high-rising apartment house
 4. house for farmer
 5. others ()
- (3) structure of the house
 1. wood
 2. steel frame
 3. ferro-concrete
 4. others ()
- (4) structure of the windows
 1. wood
 2. aluminum (single)
 3. aluminum (double)
 4. others ()
- (5) How many years have passed since the house was built?
 1. less than 5 years
 2. less than 10 years
 3. less than 20 years
 4. more than 20 years
- (6) If the respondent lives in an apartment house,

how many stories does the apartment have?
()

which floor does the respondent live on?
()
- (7) The respondent is
 1. owner of the house
 2. tenant
- (8) Are there any of the following in the vicinity of the house of the respondent?
 1. high way
 2. trunk road
 3. train
 4. Shinkansen
 5. railway bridge
 6. airport
 7. flyover of airplane or helicopter
 8. construction
 9. factory
 10. parking
 11. school, kindergarden or nursery school
 12. restaurant
 13. shop
 14. game center
 15. announcement using loudspeakers at the shop
 16. farm work
 17. wind turbine generator
 18. others ()