Internet survey of the influence of environmental factors on human health: environmental epidemiologic investigation using the web-based daily questionnaire for health

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With increasing Internet coverage, the use of a web-based survey for epidemiological study is a possibility. We performed an investigation in Japan in winter 2008 using the web-based daily questionnaire for health (WDQH). The WDQH is a web-based questionnaire survey formulated to obtain information about the daily physical condition of the general public on a real-time basis, in order to study correlations between changes in physical health and changes in environmental factors. Respondents were asked whether they felt ill and had specific symptoms including fever. We analysed the environmental factors along with the health conditions obtained from the WDQH. Four factors were found to influence health: minimum temperature, hours of sunlight, median humidity and weekday or holiday. The WDQH allowed a daily health survey in the general population in real time via the Internet.

Keywords: web-based survey; environmental factor; minimum temperature; general population

Background

With the rapid progression of Internet technology, a web-based epidemiological survey was developed and implemented for use with the general public (Ekman and Litton 2007). This allowed epidemiological studies to be conducted at lower cost, with greater speed and with higher data precision compared with paper-based or face-to-face surveys on a similar scale (Bennett et al. 2007; Ekman and Litton 2007). Although early web-based surveys were found to be problematic because of population bias, this has been mitigated with the marked increase in the proportion of the population using the Internet (Ekman et al. 2006).

Web-based epidemiological studies came to be implemented for cross-sectional studies as well as for follow-up investigations (Bennett et al. 2007). To date, web-based follow-up surveys have been conducted with patients with specific diseases, but
not with the general public. Specifically, no studies have been conducted to investigate the correlations between daily environmental changes and the daily physical condition of members of the general public. There is currently concern over human health with regard to air pollution (Huang et al. 2009) and global warming (McMichael et al. 2006). Accordingly, it would be useful to be able to determine the influence of environmental factors on the health of the general population on a daily basis. Therefore, we developed a follow-up survey system using the Internet to question citizens directly on a daily basis. We named this survey the web-based daily questionnaire for health (WDQH).

We then studied the correlations between changes in the daily physical condition of the subjects and changes in environmental factors that are considered to have an influence on health (minimum temperature, hours of sunlight, median humidity, weekday or holiday) using the WDQH.

Methods

Survey method

The WDQH is a prospective survey system designed to conduct a direct health-related questionnaire survey of individuals every day for a certain period to collect and analyse information on a real-time basis. The WDQH has already been put into operation in part, and its usefulness has been established (Sugiura et al. 2010).

Participants

Participants were persons already registered with an existing internet survey company, who noticed the request to participate in the questionnaire survey on the company website, and voluntarily decided to participate. They understood the purpose of the survey, and that it also included information on their families. In this survey, the residential area of the participants was limited to Izumo, a regional city in Japan. We only included those who understood the details of our request and agreed to cooperate in the survey. The population of Izumo is approximately 150,000, with approximately 50,000 households. The study included 702 subjects (333 males, 369 females; mean age 37.4 years; range 16–72 years) from 181 households. We collected information describing the survey participants including their residential district, age, gender, occupation, marital status, number of children and annual income. The survey was performed for 78 days from January 10, 2008 to March 28, 2008.

Questionnaire

The survey required participants to answer questions regarding subjective symptoms every day. The internet survey company sent a reminder email to each subject daily requesting completion of the questionnaire survey. The subject opened the email, accessed his/her personal password and then answered the questionnaire about himself/herself and his/her family. Respondents were asked whether they felt ill. If not, they closed the survey on that day. Those who answered in the affirmative were then asked detailed questions about whether they had any of the following symptoms: fever, coughing, diarrhoea, vomiting, rash, convulsion and others. Remuneration (approximately 60 yen/answer: US$ 0.75; US$1.00 = 80 yen at the time of writing) was given to the registered monitors. The survey was repeated every
day over the study period. We analysed and studied the correlations between changes in the daily physical condition of the participants and changes in environmental factors.

**Environmental factors**

Data describing the following 12 environmental factors are monitored and published by The Japan Meteorological Agency: mean temperature, maximum temperature, minimum temperature, hours of sunlight, cloud cover (the percentage or fraction of the sky obscured by clouds represented by an 11-point scale), median humidity, atmospheric pressure, vapour pressure, precipitation, wind direction, wind speed and weekday or holiday. Data describing these environmental factors in the survey area were collected. Mondays to Fridays were considered weekdays, while Saturdays, Sundays and public holidays were considered to be holidays.

In addition, three individual factors (sex, age and annual income) were included. The 15 variables were first subjected to principal component analysis. As a result, five principal components were identified. The first component was temperature; the second component was hours of sunlight; the third components were sex and age; the fourth component was wind direction; and the fifth component was median humidity.

Then, the correlation coefficients of all 15 variables were examined. Eight variables (sex, age, annual income, median humidity, precipitation, wind direction, wind speed and weekday or holiday) were included because of no correlations between them. Cloud cover, vapour pressure and atmospheric pressure, which were not extracted as main components and showed strong correlations (correlation coefficient >0.5), were excluded from the variables. Mean temperature was strongly correlated with maximum temperature \( (r = 0.924) \) and minimum temperature \( (r = 0.722) \). Hence, a single variable could be selected from mean temperature, maximum temperature and minimum temperature. Minimum temperature, which was not correlated with hours of sunlight \( (r = -0.097) \), was selected as a variable to negate interaction with hours of sunlight, which was selected as the second component for principal component analysis. Thus, 10 variables were selected: sex, age, annual income, minimum temperature, hours of sunlight, median humidity, precipitation, wind direction, wind speed and weekday or holiday.

Additionally, the 10 selected variables were analysed using generalized estimating equations (GEE). Three variables (precipitation, wind direction and wind speed) showed no significant correlation with any independent variable (ill or healthy and details of symptoms) and were excluded from covariates by a stepwise method. The variables remaining in the final analysis included four environmental factors (minimum temperature, hours of sunlight, median humidity and weekday or holiday).

**Statistical analysis**

Statistical analysis was conducted using IBM SPSS 20. A \( p \)-value <0.05 was considered to indicate significance. Adjusted odds ratios and standard deviations were determined with 95% confidence intervals.

The data used in this study were answers repeatedly collected from the same subject to the same question. We selected the GEE useful for the analysis of repeated
measurements of health results. The repeated measurements included individuals and households as subject variables and days as an intra-subject variable.

Generalized estimating equations was conducted using “ill or healthy” as a dependent variable and three individual factors (sex, age and annual income) and four environmental factors (minimum temperature, hours of sunlight, median humidity and weekday and holiday) as independent variables. The GEE was also performed using presence/absence of specific symptoms (fever, coughing, diarrhoea, vomiting, rash and others) as a dependent variable, and the seven aforementioned independent variables.

Ethics and consent
This research was conducted with the approval of the Ethics Committee of Nara Medical University (Authorization code: 220).

Results
The largest age group of the enrolled subjects was between 35 and 39 years old (37 years old on average) for both males and females. The ratio of males to females of the participants was approximately 1:1. The male and female participants were similar in age distribution. Approximately, 500 completed questionnaires were received each day during the survey period, giving a daily response rate of 35% to 51% (47% on average) (Figure 1). The mean response rate was 48.7% on weekdays and 44.4% on holidays. The everyday responder rate throughout the survey period was 3.2%. Although 34.5% of persons registered to show his/her willingness to answer the survey, they did not respond. As shown in Figure 2, the proportion of respondents who reported that they felt ill during the survey period ranged from 3% to 10% on a daily basis during the survey period.

Table 1 illustrates the outcome of the questionnaire according to gender. There were more female respondents than male respondents who suffered changes in their

![Figure 1. Daily response rate to the questionnaire.](image-url)
physical condition. Coughing accounted for the highest proportion (3%) of an individual symptom suffered by respondents during the survey period.

From principal component analysis, the first principal components were mean temperature, maximum temperature and minimum temperature. The second principal component was hours of sunlight. The third principal components were sex and age. The fourth principal component was wind direction. The fifth principal component was median humidity.

Pearson’s correlation coefficients were calculated. Variables strongly correlated were as follows: mean temperature and maximum temperature ($r = 0.924; p < 0.001$), mean temperature and minimum temperature ($r = 0.722; p < 0.001$), mean temperature and atmospheric pressure ($r = -0.547; p < 0.001$), mean temperature and vapour pressure ($r = 0.880; p < 0.001$), maximum temperature

Table 1. Questionnaire outcomes.

|              | Male     |           | Female   |           | Total     |           |
|--------------|----------|-----------|----------|-----------|-----------|-----------|
| Presence of symptoms (%) |          |           |          |           |          |           |
| Absence of symptoms (%) |          |           |          |           |          |           |
| Ill          | 1746 (5.7) | 28,830 (94.3) | 2246 (6.9) | 30,274 (93.1) | 3992 (6.3) | 59,104 (93.7) |
| Fever        | 247 (0.8)  | 30,329 (99.2) | 249 (0.8)  | 32,271 (99.2) | 496 (0.8)  | 62,600 (99.2) |
| Coughing     | 944 (3.1)  | 29,632 (96.9) | 958 (2.9)  | 31,562 (97.1) | 1902 (3)   | 61,194 (97)  |
| Diarrhoea    | 117 (0.4)  | 30,459 (99.6) | 181 (0.6)  | 32,339 (99.4) | 298 (0.5)  | 62,798 (99.5) |
| Vomiting     | 94 (0.3)   | 30,482 (99.7) | 116 (0.4)  | 32,404 (99.6) | 210 (0.3)  | 62,886 (99.7) |
| Rash         | 28 (0.1)   | 30,548 (99.9) | 34 (0.1)   | 32,486 (99.9) | 62 (0.1)   | 63,034 (99.9) |
| Convulsion   | 19 (0.1)   | 30,557 (99.9) | 2 (0)      | 32,518 (100)  | 21 (0)     | 63,075 (100)  |
| Others       | 768 (2.5)  | 29,808 (97.5) | 1602 (4.9) | 30,918 (95.1) | 2370 (3.8) | 60,726 (96.2) |
| Sum total    | 30,576     | 32,520     | 63,096    |           |           |           |
and hours of sunlight \((r = 0.566; p < 0.001)\), maximum temperature and cloud cover \((r = -0.579; p < 0.001)\), maximum temperature and vapour pressure \((r = 0.779; p < 0.001)\), minimum temperature and atmospheric pressure \((r = -0.520; p < 0.001)\), minimum temperature and vapour pressure \((r = 0.760; p < 0.001)\), atmospheric pressure and vapour pressure \((r = -0.521; p < 0.001)\).

Table 2 shows the results of the GEE of ill participants. The number of ill subjects was inversely proportional to individual factors (age and annual income) and environmental factors (minimum temperature and hours of sunlight). In addition, fewer people were found to be ill on holidays.

Table 3 shows the results of GEE of individual symptoms. The results revealed that the number with fever, cough, diarrhoea, vomiting and rash decreased with age. Others (unidentified complaints) decreased as annual income increased. Fever and rash decreased as the minimum temperature increased. Additionally, fever and vomiting decreased as hours of sunlight increased. On holidays, cough and others decreased and rash increased.

### Discussion

In the present study, the relationship between environmental factors and health conditions, which changed on a daily basis, were analysed from health results in the daily web questionnaire survey. Case control designs, generalized linear models (GLIM), and GEE are useful for such repeated epidemiological analyses. The GEE was established by modifying GLIM, and has been found to be useful for repeated measurements and longitudinal data analysis. The GEE allows unbiased estimation and bias correction for individual confounding factors that may be generated from Internet survey results. They are commonly used in large epidemiological studies, especially multi-site cohort studies as they can handle many types of unmeasured dependence between outcomes (Nitta et al. 2010). Thus, we employed GEE for analysis of the repeated measurements of health results in our web survey to analyse the changes in environmental and health conditions.

Correlations between environmental changes and changes in daily symptoms have been reported for particular diseases (Vocks et al. 2001; Srinivasan et al. 2007; Pantavou et al. 2008). A decrease in temperature is associated with an increase in ischemic cardiac events such as angina pectoris and a rise in blood pressure, while an

### Table 2. Generalized estimating equations of ill subjects.

|                  | Ill   | Healthy | GEE     |
|------------------|-------|---------|---------|
|                  | Mean  | SD      | Mean    | SD      | B      | SE     | p-value | Exp(B) |
| Sex              | 0.099 | 0.240   | 0.686   | 1.104   |
| Age              | 36.15 | 6.460   | 37.90   | 9.000   | -0.023 | 0.0111 | 0.035** | 0.977  |
| Annual income    | 3.07  | 1.499   | 3.53    | 1.609   | -0.197 | 0.0893 | 0.027** | 0.821  |
| Minimum temperature | 5.078 | 2.8328  | 5.359   | 2.9440  | -0.029 | 0.0128 | 0.024** | 0.972  |
| Hours of sunlight | 2.873 | 3.1088  | 3.163   | 3.2276  | -0.030 | 0.0111 | 0.007** | 0.971  |
| Median humidity  | 76.47 | 7.411   | 76.08   | 7.353   | 0.002  | 0.0035 | 0.563   | 1.002  |
| Weekday or holiday| 0.122 | 0.0474  | 0.010** | 1.130   |

Notes: **\(p < 0.05\); *\(p < 0.1\). The table shows the mean and standard deviation (SD) based on the presence/absence of symptoms for comparison. GEE: generalized estimating equations; SE: standard error.
Table 3. Generalized estimating equations for each symptom.

| Symptom         | Sex   | Age      | Annual income | Minimum temperature | Hours of sunlight | Median humidity | Weekday or holiday | Mean (SD) | Mean (SD) | Mean (SD) | B       | SE     | p-value | Exp(B) |
|-----------------|-------|----------|---------------|--------------------|-------------------|-----------------|--------------------|-----------|-----------|-----------|---------|--------|---------|--------|
| Fever           |       |          |               |                    |                   |                 |                    |           |           |           |         |        |         |        |
|                  | Mean  | SD       | Mean          | SD                 |                   |                 |                    |           |           |           |         |        |         |        |
| Fever           | B     | SE       | p-value       | Exp(B)             |                   |                 |                    |           |           |           |         |        |         |        |
| Coughing        |       |          |               |                    |                   |                 |                    |           |           |           |         |        |         |        |
|                  | Sex   | 0.384    | 0.2593        | 0.138              |                   |                 |                    |           |           |           |         |        |         |        |
|                  | Age   | 36.06    | 5.545          | 37.85              | 8.954             |                   |                    |           |           |           |         |        |         |        |
|                  | Annual income | 3.51    | 1.359          | 3.50              | 1.613             |                   |                    |           |           |           |         |        |         |        |
|                  | Minimum temperature | 5.015  | 2.8145         | 5.352             | 2.9413            |                   |                    |           |           |           |         |        |         |        |
|                  | Hours of sunlight | 2.772  | 3.0623         | 3.157             | 3.2254            |                   |                    |           |           |           |         |        |         |        |
|                  | Median humidity | 76.85  | 7.592          | 76.08             | 7.349             |                   |                    |           |           |           |         |        |         |        |
|                  | Weekday or holiday | 0.222  | 0.697         | 0.001**           | 1.248             |                   |                    |           |           |           |         |        |         |        |
| Diarrhoea        |       |          |               |                    |                   |                 |                    |           |           |           |         |        |         |        |
|                  | Sex   | −0.113   | 0.3287         | 0.732              |                   |                 |                    |           |           |           |         |        |         |        |
|                  | Age   | 35.49    | 6.418          | 37.81              | 8.893             |                   |                    |           |           |           |         |        |         |        |
|                  | Annual income | 3.55    | 1.664          | 3.50              | 1.607             |                   |                    |           |           |           |         |        |         |        |
|                  | Minimum temperature | 5.112  | 2.9279         | 5.344             | 2.9386            |                   |                    |           |           |           |         |        |         |        |
|                  | Hours of sunlight | 2.794  | 3.2217         | 3.148             | 3.2217            |                   |                    |           |           |           |         |        |         |        |
|                  | Median humidity | 76.55  | 7.174          | 76.10             | 7.357             |                   |                    |           |           |           |         |        |         |        |
|                  | Weekday or holiday | 0.156  | 0.1906        | 0.414             | 0.856             |                   |                    |           |           |           |         |        |         |        |
| Vomiting         |       |          |               |                    |                   |                 |                    |           |           |           |         |        |         |        |
|                  | Sex   | −0.109   | 0.3291         | 0.741              |                   |                 |                    |           |           |           |         |        |         |        |
|                  | Age   | 34.26    | 7.620          | 37.81              | 8.887             |                   |                    |           |           |           |         |        |         |        |
|                  | Annual income | 2.97    | 1.632          | 3.50              | 1.607             |                   |                    |           |           |           |         |        |         |        |
|                  | Minimum temperature | 4.371  | 2.5365         | 5.346             | 2.9391            |                   |                    |           |           |           |         |        |         |        |
|                  | Hours of sunlight | 2.050  | 2.5977         | 3.150             | 3.2228            |                   |                    |           |           |           |         |        |         |        |
|                  | Median humidity | 77.35  | 6.879          | 76.10             | 7.358             |                   |                    |           |           |           |         |        |         |        |
|                  | Weekday or holiday | 0.034  | 0.2165        | 0.874             | 0.966             |                   |                    |           |           |           |         |        |         |        |
| Rash             |       |          |               |                    |                   |                 |                    |           |           |           |         |        |         |        |
|                  | Sex   | 1.185    | 1.0015         | 0.237              |                   |                 |                    |           |           |           |         |        |         |        |
|                  | Age   | 28.43    | 3.664          | 37.81              | 8.885             |                   |                    |           |           |           |         |        |         |        |
|                  | Annual income | 3.69    | 1.814          | 3.50              | 1.607             |                   |                    |           |           |           |         |        |         |        |
|                  | Minimum temperature | 4.786  | 2.9974         | 5.344             | 2.9385            |                   |                    |           |           |           |         |        |         |        |
|                  | Hours of sunlight | 3.017  | 3.0967         | 3.147             | 3.2220            |                   |                    |           |           |           |         |        |         |        |
|                  | Median humidity | 76.12  | 7.510          | 76.10             | 7.357             |                   |                    |           |           |           |         |        |         |        |
|                  | Weekday or holiday | 0.483  | 0.2155        | 0.025**           | 0.617             |                   |                    |           |           |           |         |        |         |        |
| Others           |       |          |               |                    |                   |                 |                    |           |           |           |         |        |         |        |
|                  | Sex   | −0.440   | 0.3542         | 0.214              |                   |                 |                    |           |           |           |         |        |         |        |
|                  | Age   | 36.55    | 6.917          | 37.84              | 8.938             |                   |                    |           |           |           |         |        |         |        |
|                  | Annual income | 2.43    | 1.222          | 3.53              | 1.606             |                   |                    |           |           |           |         |        |         |        |
|                  | Minimum temperature | 5.214  | 2.8481         | 5.347             | 2.9413            |                   |                    |           |           |           |         |        |         |        |
|                  | Hours of sunlight | 3.041  | 3.1820         | 3.151             | 3.2230            |                   |                    |           |           |           |         |        |         |        |
|                  | Median humidity | 76.08  | 7.301          | 76.10             | 7.359             |                   |                    |           |           |           |         |        |         |        |
|                  | Weekday or holiday | 0.147  | 0.0609        | 0.016**           | 1.159             |                   |                    |           |           |           |         |        |         |        |

Notes: **p < 0.05; *p < 0.1.
increase in minimum temperature, especially during the warm season, is associated with a decrease in the onset of cardiovascular or respiratory events (Pantavou et al. 2008). It has also been reported that a decrease in humidity at a temperature of less than 15°C resulted in an increase in the rate of torsion of the testes (Srinivasan et al. 2007). A sharp decrease in temperature has been reported to exacerbate symptoms such as itching sensations in patients with atopic dermatitis (Vocks et al. 2001). Moreover, an increase in maximum temperature of 1°C was found to increase overall mortality by 0.9%, and a mean temperature of 32°C or above has been reported to increase overall mortality by 7.3% (Hu et al. 2008). An article about the relationship between climate and hospitalization in children with asthma demonstrated that children aged 0–4 years were the most vulnerable to climatic changes. More children were hospitalized on cold and dry days with low absolute humidity (Nastos et al. 2008). An article on the relationship between climate and respiratory infection demonstrated that temperature and humidity were strongly associated with the development and aggravation of respiratory infection. Of note, there was an increase in death rate about two weeks after cold days with low humidity (Nastos et al. 2006). An article on the relationship between climatic changes and death rates demonstrated that rapid climatic changes were a critical risk factor for death. Of note, the physical conditions are influenced at three days in winter and at one day in summer after rapid climatic changes (Nastos et al. 2011).

However, few studies have been conducted to investigate the correlation between changes in the daily physical condition of a general population not suffering from any particular disease, and changes in environmental factors.

When ambient temperature decreases during winter, symptoms such as runny nose, sneeze, cough or fever commonly appear. Moreover, bacterial infections, common cold and influenza are frequently reported to increase during winter in clinical practice (Heikkinen and Järvinen 2003; Tanaka 1998). These correspond to the result that when the minimum ambient temperature decreases, it is likely that many people will experience symptoms of poor health, especially fever. Conversely, when the minimum ambient temperature increases, the overall health conditions of the general population tend to improve. The web-based questionnaire collects data regarding changes in the respondents’ daily physical condition on a real-time basis, which allowed investigation of the correlation between environmental factors and the physical condition of the general population.

The results also revealed that the physical condition of the respondents improved as the hours of sunlight increased. Additionally, more people were ill on weekdays than on holidays. It is possible that the latter finding was related to stress. Indeed, an increase in the prevalence of disease caused by psychosocial stress in recent times has been reported (Schmidt et al. 2008), and attending school or work on a weekday may result in psychosocial stress, which could have an effect on the physical condition. In contrast, a more relaxing time on holiday is likely to relieve stress (Butler et al. 2009) and improve the physical condition.

The “presence/absence of specific symptoms” was found to be significantly correlated with hours of sunlight. Hours of sunlight has been reported to be correlated with the secretion of serotonin in the brain; therefore, mental disorders such as depression and anxiety, which are associated with decreased serotonin secretion, may be improved by sunlight exposure (Lambert et al. 2002). In addition, ultraviolet exposure increases the synthesis of vitamin D, and appropriate quantities of vitamin D may be a preventative factor against immune-related disorders, such as
multiple sclerosis and type 1 diabetes mellitus, infections and cancer (Norval et al. 2007). It has also been reported that the risk of human papillomavirus (HPV) infection decreases as the amount of sunlight exposure increases. Despite the reported effects of increased sunlight, the increase in ultraviolet radiation resulting from depletion of the ozone layer could have adverse effects on the body such as acute damage to the eyes and skin. Additionally, sunlight exposure is associated with an increased risk of skin squamous cell carcinoma, epidermodysplasia verruciformis-HPV infection and decreased skin or systemic immunoreactivity (Termorshuizen et al. 2004).

The results of this study revealed that the appearance of symptoms decreased with increased hours of sunlight. These findings were in accordance with the positive effects of sunlight exposure on the human body observed in previous reports. Although it has been reported that intra-individual variability, amount of sunlight exposure and individual background significantly influenced the effects of sunlight exposure on intracellular DNA, and that ultraviolet-induced DNA damage accumulated over three to six days (Moller et al. 2002), this was not relevant at the time of year our survey was conducted.

An article about the relationship between health conditions and individual factors indicated that health conditions varied with sex, age and income. Men were more vulnerable than women. Younger persons were more vulnerable. Those with higher incomes had better health conditions (Belloc et al. 1970). The present survey also demonstrated that individual factors influenced health conditions.

It should be noted that there are some limitations to this study. In the questionnaire, the severity and specificity of symptoms in the questions could not be determined by the researcher. This survey was also limited in terms of the assessment of the reliability of respondents’ answers due a self-reporting system being used.

The cost of the three-month survey in Izumo was 8.28 million yen (US$ 103,500). It would be ideal to conduct surveys about changes in the environment and health conditions of the general population in major cities in Japan all year long. Although a web-based survey is cheaper than paper-based or face-to-face surveys, if the survey was expanded to main cities in Japan or carried out over a full year, the expense would be massive. Thus, because of the excessive cost of such surveys, the target area and period in this survey were limited. January to March was selected because we assumed that changes in health conditions caused by environmental changes would be most common during the period from winter to spring (specifically January to March). The results of this study demonstrated that changes in body conditions caused by environmental changes would be associated with environmental changes. However, as described above, health conditions and climatic changes have time trends. Thus, a survey should be conducted throughout the year in different seasons and months. In the future, we hope to expand the survey area and study period. In addition, given that sunlight exposure may have an impact on the human body not only on the day of exposure, but three to six days later (Moller et al. 2002), it may be necessary to perform a more detailed analysis using lag times to investigate the correlation of sunlight with physical condition.

Conclusions

The WDQH enabled monitoring of changes in physical condition on a real-time basis by daily collection of data. Changes in the daily physical condition of the
general population were found to be correlated with changes in certain environmental factors. In particular, it was revealed that the following factors in winter/spring were associated with physical condition: fever, cough, diarrhoea, vomiting and rash decreased with age. Others decreased as household income increased. An increase in minimum temperature was associated with a reduction in fever and rash; an increase in hours of sunlight was associated with a reduction in fever, and vomiting; holidays were associated with better physical condition and less coughing and others, while rash increased.

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