**ABSTRACT**

**Aims:** This study aimed to construct a standardized health risk assessment index system (HRAIS) under the guidance of general health and facilitate the family doctors to carry out chronic disease management. **Methods:** Available chronic disease surveillance systems and indexes were reviewed to identify potential indexes. The Delphi method was performed to establish the HRAIS, and the analytic hierarchy process was used to calculate the index weight. **Results:** HRAIS included four first-level indexes and 38 second-level indexes. The authority coefficient was 0.86. The Kendall's W for the two rounds of Delphi consultation were 0.202 and 0.210 ($p < 0.001$). The weights of the first-level indexes from high to low were physiological health (0.409), psychosocial health (0.290), health-related behaviors (0.205), and environment (0.097). Thus, HRAIS is a multi-dimensional and multi-index tool, which can be used as a guideline for family doctors in early screening, early intervention, and classified management of main chronic diseases.

**Keywords:** Chronic diseases, family doctors, general health, health risk assessment, index system
However, the uneven distribution of health resources, the low trust of residents in community medical institutions, and the imperfection of relevant policies also seriously restrict the development of community health management in China. Moreover, residents show great reluctance to sign with FDs. One major reason is that contract services lack appeal to residents. Therefore, with the development of family doctor contract services, more services should be provided to meet the growing health needs of residents.

In China, FDs mainly use health records for disease monitoring and health assessment. However, there still exist some problems in health records. For example, some records are either incomplete or untrue or non-standard. Especially, there is a lack of data on risk factors related to chronic diseases. Therefore, FDs lack a standardized assessment tool to monitor and evaluate the risk factors of chronic diseases, and it is difficult for them to develop personalized diagnosis and treatment plans for patients.

Although health risk assessment in foreign countries has been gradually improved, because of racial and geographical differences, the direct use of foreign research results may lead to large deviations in China. Therefore, this study aimed to construct a standardized health risk assessment index system (HRAIS) under the guidance of general health so as to provide a guideline for FDs to monitor and evaluate the risk factors related to chronic diseases. On one hand, personalized health risk assessment can enrich the service content and improve the service level of contracted services. On the other hand, it can provide the evidence for early screening, early intervention, and classified management of main chronic diseases among contracted residents.

**Methods**

In order to construct such a health risk assessment instrument, we undertook a literature review and sought expert consultations. The Delphi method and the analytical hierarchy process (AHP) method were used. The flowchart of the study process is shown in Figure 1.

**Literature source and retrieval method**

Available health indexes and chronic disease surveillance systems were reviewed to identify potential indexes and evaluation methods. We searched PubMed, MEDLINE, and China National Knowledge Infrastructure databases for eligible studies published from May 2010 to March 2019. Search terms included “chronic noncommunicable disease”, “chronic disease”, “health indexes”, “family doctor contract services”, “health assessment”, and “health risk assessment”. The index selection criteria were as follows: 1) the index was directly relevant to chronic disease prevention and control; 2) the index measuring and data collecting should be convenient and feasible; 3) the index must be consistent with the prioritized areas and priorities of government work.

**Delphi consultation process**

We performed the Delphi method and collected the experts’ opinions and suggestions for the index system. First, experts were asked to appraise each index according to the questionnaire, which included three parts: instructions, text content, and general information of experts. The instructions described the purpose and background of this study.

Then, we determined the indexes and their evaluation methods through two rounds of the Delphi method, from May to July 2019. Studies have shown that 10 to 18 experts can ensure adequate contributions. Therefore, we invited 15 experts as consultants from medical colleges, centers for disease control and prevention, and medical institutions. The selection criteria for experts were as follows: 1) they should be familiar with the connotation of family doctor contract services; 2) they should be engaged in the fields related to chronic diseases; 3) they should at least possess an intermediate professional title; 4) they should be interested in this study or active in supporting it.

We calculated the mean, standard deviation (SD), and coefficient of variation (CV) for each index. These indexes were screened and modified based on experts’ opinions and consensus on the importance of the index, and the index was removed if its CV was ≥0.3. The modified indexes after the first-round consultation were sent to the experts along with the second-round
questionnaire. The Delphi consultation was finished if the experts’ authority coefficient (Cr) and the Kendall coefficient of concordance (or Kendall’s W) met all the requirements. Cr represented the authority of experts, which was expressed by the mean of the familiarity degree coefficient (Cs) and the judgment basis coefficient (Ca). The formula for the expert authority coefficient was Cr = (Ca + CS)/2. Cr ≥0.7 indicated a high degree of authority among experts. The Kendall’s W was used to evaluate the concordance of the responses of experts. SPSS 20.0 (IBM, Armonk, New York, USA) was used for the statistical analysis.

AHP method

We adopted the AHP to determine the weight for each index. First of all, based on the results of the second round of Delphi consultation, the hierarchical structure model was constructed. Then, pairwise comparisons were performed to calculate the relative value of each index and to draw a judgment matrix. In calculating the weights, the elements of each column in a consistent paired comparison matrix were processed through normalization. Finally, the logic of judgment was checked by calculating the consistency of the judgment matrix. The eigenvalue method proposed by Saaty was used to evaluate the weight. Generally, if the random consistency ratio (CR) was less than 0.1, the judgment matrix was regarded as consistent, and the weight coefficient was thought to meet logic consistency. The results were analyzed using YAAHP software.

Results

Development of a framework for the index system

We established the HRAIS including four first-level indexes: physiological health, psychosocial health, health-related behaviors, and environment. We collected the data of the risk factors related to chronic diseases through questionnaire survey, physical measurements, and biochemical detection. Because of the fact that there were no recognized questionnaires for certain indexes, data collection was based on self-reports of residents. Finally, through literature reviews, we selected a total of 42 indexes including evaluation methods and initially developed a framework for the index system.

Delphi expert consultation

This study consulted 15 experts from medical colleges, medical institutions, and centers for disease control and prevention. Of the experts, 93.3% hold senior professional titles. The mean age of them was 50.6 ± 7.7 (range: 35–66) years; the mean working duration was 22.5 ± 8.1 (range: 3–33) years. The experts discussed the significance and feasibility of 42 indexes as well as the evaluation methods. At the end of the expert consultation, the recovery rate of the two rounds of questionnaires was 100%.

Based on the experts’ self-assessment scores, the expert authority coefficient of Delphi was 0.86 (CS for 0.825, CA for 0.89). It showed that the experts were familiar with these indexes. The value of Kendall’s W represented the degree of expert concordance. In this study, the Kendall’s W values of the two rounds were 0.202 and 0.210 [Table 1], indicating that the degree of concordance among the experts was acceptable.

Establishment of the index system

In the first round of Delphi consultation, a total of 42 indexes were assessed. The mean score of the importance of these indexes ranged from 3.60 to 4.73, and the CV ranged from 0.1 to 0.33 [Table 2 and S1]. Based on the results of the current round of consultation, we deleted the residence types. The reason was that there were not enough empirical studies on residence types and it was difficult to standardize the description of the evaluation criteria. We also combined the mental stress and psychological stress because they could affect human health to some extent. We categorized these two indexes into the dimension of health-related behaviors. After the panel discussion, we determined the occupational risks by assessing high-risk occupation protection criteria in residents’ self-reports. As a result, 40 indexes and their evaluation methods were retained in the second round.

In the second round of Delphi consultation, the mean score of the index importance ranged from 3.87 to 4.86, and the CV ranged from 0.08 to 0.28 [Table 2 and S1]. Based on the results of the current round of consultation, we deleted the residence types. The reason was that there were not enough empirical studies on residence types and it was difficult to standardize the description of the evaluation criteria. We also combined the mental stress and psychological stress into the subjective stress and used Perceived Stress Scale to measure it. The medication safety was evaluated from four aspects: medication types, storage methods, side effects, and medication adherence. The HRAIS was established after the second round of Delphi consultation. It comprised 38 indexes and their evaluation methods [Table 2 and S1].

AHP results

Based on the results of two rounds of Delphi consultation, we performed AHP to check the consistency of HRAIS and

| Table 1: Results of experts’ opinion coordination degree |
|-------|-------|-------|-------|
| Index importance | Kendall’s W | χ² | P |
| First round | 0.202 | 136.373 | <0.001 |
| Second round | 0.210 | 135.424 | <0.001 |

| Table 2: Results of two rounds of expert consultation |
|-------|-------|-------|-------|-------|-------|
| Index | First round | Second round |
| Mean | SD | CV | Mean | SD | CV |
| A Physiological health | 4.73 | 0.46 | 4.86 | 0.50 | 0.10 |
| B Psychosocial health | 4.60 | 0.63 | 0.14 | 4.80 | 0.40 | 0.08 |
| C Health-related behaviors | 4.60 | 0.63 | 0.14 | 4.73 | 0.68 | 0.14 |
| D Environment | 4.00 | 0.85 | 0.21 | 4.47 | 0.72 | 0.16 |

SD, standard deviation; CV, coefficient of variation.
determine the weight of each index. According to the results of consistency test, the CR values of the first-level indexes and second-level indexes were both less than 0.1, indicating that the judgment matrix met the consistency requirement. In the order of weights from high to low, the four first-level indexes were physiological health (0.409), psychosocial health (0.290), health-related behaviors (0.205), and environment (0.097). The weight for each index is listed in Table S2. Within physiological health, blood pressure (0.0455), blood glucose (0.0414), and heart rate (0.0352) accounted for a large proportion. Within psychosocial health, the weight coefficients of secondary indexes from high to low were cognition (0.0821), depression (0.0453), and anxiety (0.0453). Within health-related behaviors, smoking (0.0387), alcohol drinking (0.0387), and medication safety (0.0387) had a greater weight. Within environment, medical insurance (0.0381) had the greatest weight.

**Discussion**

This study constructed the HRAIS especially for FDs in primary care activity, which could standardize their behavior for health assessment and supply a publicly available code of conduct. In this study, the expert authority coefficient was more than 0.7, and the Kendall's W values were between 0.202 and 0.210, indicating that the degree of concordance between experts was acceptable. That is to say, the HRAIS constructed in this study is reliable and applicable for FDs’ health risk assessment.

According to the HRAIS, FDs should assess the residents from four dimensions: physiological health, psychosocial health, health-related behaviors, and environment. First, of the four first-level indexes, the highest weight one was physiological health (42%), indicating that its importance was approved by experts. It was also in consistence with the high demand of residents for regular physical examinations in China. In terms of physiological health, the weights of blood pressure (0.046), blood glucose (0.041), and glycosylated hemoglobin (0.027) were come out in front. These were the associated factors related to main chronic diseases, reflecting the epidemic trend of high incidence of hypertension, diabetes, and cardio-vascular diseases in China. In addition, obesity, as a chronic metabolic disease, is a risk factor for many chronic diseases. Body mass index (BMI) is usually used to judge the degree of obesity. Waist circumference was also used by the China-PAR risk assessment model as an important index for predicting cardio-vascular disease. Therefore, BMI and hip and waist circumference were all included in this study. Previously, obesity rate and abdominal obesity rate were used as metabolic indexes for evaluating cardio-vascular health of the Chinese population. This is in consistence with our study. In short, FDs could appraise the physiological items of residents, according to the HRAIS; thus, they were able to perform the risk assessment comprehensively.

Second, our system included the psychosocial index used to assess the psychological health and social adaptability. The mental health of residents could not be ignored, and FDs should become aware of the influence of psychosocial factors to the general health of residents. In this study, the weight of psychosocial health (0.290) ranked the second, indicating that experts had a high degree of recognition concerning its importance. In this dimension, the index with the highest weight was cognition (0.083). Chronic disease was one of the most important risk factors for cognitive impairment in the elderly. It could damage the blood vessels and nervous system and consequently affected cognitive functions. Cognitive impairment often occurred in the elderly with common chronic diseases such as diabetes and hypertension, which might lead to the decline of the quality of life, the aggravation of depressive symptoms, dementia, and premature death in the elderly. In addition, the weights of anxiety and depression were both 0.051. Previous studies indicated that anxiety and depression could affect the occurrence, prognosis, and development of chronic diseases. Meanwhile, chronic diseases could also lead to depression or anxiety. FDs are the initial point of contact for anxiety and depression. In this study, we put forward this dimension, which could help FDs identify the common psychological problems of residents.

Third, this system also focused on health-related behaviors. FDs should encourage people to adopt the healthy lifestyle and healthy environment, thus preventing chronic diseases in primary health care services. The results showed that the weight of health-related behaviors was 0.205. Within this dimension, the weight of alcohol drinking, smoking, and medication safety was 0.040, ranking the first, followed by activities of daily living (0.025), sleep and rest (0.025), dietary nutrition (0.018), and physical activity (0.013). Positive modification in habits (changes in diet and lifestyle) and treatment adherence are essential for the control of chronic diseases. Previous studies found that 80% of heart disease and type 2 diabetes could be avoided by four interventions: tobacco control, salt reduction, dietary intervention, and increased exercise. Besides, the International Olympic Committee consensus meeting pointed out that the prevention and management of chronic diseases required the new programs focusing on physical activity, diet, and lifestyle. It was consistent with our study design. In addition, the results in this dimension showed that the weight of medication safety was the highest. Medication safety includes a set of indexes to evaluate the drug-use process, including medication types, storage methods, side effects, and medication adherence. It is common for residents with chronic diseases to take the long-term medication at home. However, there were some problems, such as poor compliance, the occurrence of adverse drug reactions, and improper use of medication and polypharmacy, especially for the elderly. Especially, the poor medication compliance was a global problem, and medication compliance among patients with chronic disease in developed countries was only about 50%. Thus, to keep medication safety in the residents, it is a daily duty for FDs to encourage and supervise the rational medication.

Fourth, in the dimension of environment, the occupational exposure (weight 0.026), acoustic environment (weight 0.026), and indoor air environment (weight 0.016) were included. Similarly, we also put forward the housing conditions as an
important index to assess the health of the European population. The difference was that they focused on the dampness and water leakage of the living conditions rather than acoustic and indoor air environments. The possible cause was the diversity of study sites and civilization. Besides, medical insurance accounted for the highest weight (0.044) in the dimension of environment and investigated the medical behaviors of rural patients with diabetes and hypertension in Cambodia. In China, the medical insurance system would influence individuals’ health care-seeking behaviors. Therefore, it is vital for FDs to make an optimized treatment plan based on the patients’ medical insurance.

This study had three limitations. First, the value of Kendall’s W coefficient was not high (0.202–0.210), and it was statistically significant verified by a Chi-squared test. It indicated that the degree of concordance between experts was acceptable, and there was still some degree of inconsistent views on different indexes. Second, the questionnaires were sent to experts by e-mails, instead of a face-to-face consultation. Third, all the experts came from Hebei Province in this study. Thus, the HRAIS cannot be generalized in the whole country. In the future, we would recruit more experts from multiple regions in China to gather more comprehensive suggestions.

In summary, HRAIS is a comprehensive index system designed for FDs to carry out health risk assessment in the community. It contains 38 indexes in four dimensions, which can be used to evaluate chronic diseases and their risk factors from physiological health, psychosocial health, health-related behaviors, and environment. It would help FDs to monitor and assess risk factors associated with chronic diseases and to implement personalized interventions.

**Key points**

1. Based on the concept of general health, the HRAIS included four first levels: physiological health, psychosocial health, health-related behaviors, and environment.
2. We established the HRAIS through the Delphi method, and it contained 38 indexes and evaluation methods of the indexes.
3. We determined the index weights by the analytic hierarchy process, and the weights of the first-level indexes from high to low were physiological health (0.409), psychosocial health (0.290), health-related behaviors (0.205), and environment (0.097).
4. Our results would help family doctors monitor and assess risk factors associated with chronic diseases, collect health data in an all-round way, and implement personalized interventions.
5. It is recommended that HRAIS would be applied to put the general health into effect and establish the large-scale database of chronic diseases and risk factors.

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**Conflicts of interest**

There are no conflicts of interest.

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### Table S1: Results of two rounds of expert consultation

| Index | First round | | | Second round | | |
|-------|-------------|---|---|-------------|---|---|
|       | Mean   | SD  | CV  | Mean     | SD  | CV  |
| A1 Body temperature† | 4.00 | 1.20 | 0.30 | NA | NA | NA |
| A2 Pulse | 4.27 | 0.80 | 0.19 | 4.66 | 0.60 | 0.13 |
| A3 Respiration | 4.20 | 0.94 | 0.22 | 4.53 | 0.62 | 0.14 |
| A4 Blood Pressure | 4.73 | 0.46 | 0.10 | 4.80 | 0.54 | 0.11 |
| A5 Pain | 4.47 | 0.64 | 0.14 | 4.47 | 0.62 | 0.14 |
| A6 Heart rate | 4.47 | 0.64 | 0.14 | 4.67 | 0.60 | 0.13 |
| A7 Vital capacity | 4.00 | 1.07 | 0.27 | 4.07 | 1.12 | 0.28 |
| A8 BMI | 4.60 | 0.63 | 0.14 | 4.40 | 0.80 | 0.18 |
| A9 Waist | 4.47 | 0.64 | 0.14 | 4.13 | 0.72 | 0.17 |
| A10 Hip circumference | 4.33 | 0.72 | 0.17 | 3.87 | 0.88 | 0.23 |
| A11 Defecation | 4.20 | 1.01 | 0.24 | 4.40 | 0.61 | 0.14 |
| A12 Glycated hemoglobin | 4.60 | 0.51 | 0.11 | 4.60 | 0.61 | 0.13 |
| A13 Blood sugar | 4.73 | 0.46 | 0.10 | 4.73 | 0.57 | 0.12 |
| A14 Hyperuricemia | 4.40 | 0.51 | 0.12 | 4.47 | 0.72 | 0.16 |
| A15 Homocysteine | 4.40 | 0.63 | 0.14 | 4.40 | 0.71 | 0.16 |
| A16 Blood lipid | 4.67 | 0.49 | 0.10 | 4.60 | 0.61 | 0.13 |
| A17 Serum calcium | 4.13 | 0.83 | 0.20 | 4.13 | 0.72 | 0.17 |
| A18 Red blood cell count | 4.13 | 0.83 | 0.20 | 4.13 | 0.88 | 0.21 |
| A19 White blood cell count | 4.00 | 0.93 | 0.23 | 4.07 | 0.93 | 0.23 |
| A20 Bone density | 4.33 | 0.82 | 0.19 | 4.07 | 0.85 | 0.21 |
| A21 Skin† | 3.73 | 1.22 | 0.33 | NA | NA | NA |
| A22 Eyesight | 4.47 | 0.64 | 0.14 | 4.07 | 0.85 | 0.21 |
| B1 Cognition | 4.67 | 0.82 | 0.18 | 4.80 | 0.40 | 0.08 |
| B2 Depression | 4.53 | 0.83 | 0.18 | 4.67 | 0.47 | 0.10 |
| B3 Anxiety | 4.53 | 0.83 | 0.18 | 4.67 | 0.47 | 0.10 |
| B4 Life events | 4.40 | 0.99 | 0.23 | 4.60 | 0.49 | 0.11 |
| B5 Social support | 4.47 | 0.74 | 0.17 | 4.67 | 0.47 | 0.10 |
| B6 Mental stress‡ | NA | NA | NA | 4.67 | 0.47 | 0.10 |
| B7 Psychological stress‡ | NA | NA | NA | 4.67 | 0.47 | 0.10 |
| C1 Physical activity | 4.40 | 0.74 | 0.17 | 4.47 | 0.62 | 0.14 |
| C2 Dietary nutrition | 4.53 | 0.52 | 0.11 | 4.53 | 0.62 | 0.14 |
| C3 Alcohol drinking | 4.53 | 0.52 | 0.11 | 4.73 | 0.57 | 0.12 |
| C4 Smoking | 4.53 | 0.52 | 0.11 | 4.73 | 0.57 | 0.12 |
| C5 Sleep and rest | 4.47 | 0.64 | 0.14 | 4.67 | 0.60 | 0.13 |
| C6 Medication safety | 4.73 | 0.46 | 0.10 | 4.73 | 0.57 | 0.12 |
| C7 Gait and balance | 4.47 | 0.83 | 0.19 | 4.40 | 0.61 | 0.14 |
| C8 Activities of daily living | 4.60 | 0.83 | 0.19 | 4.67 | 0.60 | 0.13 |
| D1 Residence type¶ | 3.67 | 0.98 | 0.27 | 4.00 | 0.89 | 0.22 |
| D2 Residential floor¶ | 3.60 | 1.12 | 0.31 | NA | NA | NA |
| D3 Acoustic environment | 3.93 | 0.88 | 0.22 | 4.40 | 0.61 | 0.14 |
| D4 Light environment¶ | 3.93 | 0.88 | 0.22 | NA | NA | NA |
| D5 Indoor air environment | 3.87 | 0.83 | 0.21 | 4.33 | 0.70 | 0.16 |
| D6 Occupational Exposure | 3.93 | 1.03 | 0.26 | 4.40 | 0.71 | 0.16 |
| D7 Medical security | 4.27 | 0.88 | 0.20 | 4.47 | 0.62 | 0.14 |

NA, not assessed; SD, standard deviation; CV, coefficient of variation. † indexes deleted in the first round; ‡ indexes added in the first round; § indexes deleted in the second round.
### Table S2: Final indexes and weight of each index

| First-level index and weight | Second-level index | Assessment method or content | Weight |
|-----------------------------|-------------------|-----------------------------|--------|
| Physiological health (0.409) | Pulse             | Physical examination        | 0.035  |
|                             | Respiration       | Physical examination        | 0.023  |
|                             | Blood Pressure    | Physical examination        | 0.046  |
|                             | Pain              | Numeric rating scale        | 0.020  |
|                             | Heart rate        | Physical examination        | 0.035  |
|                             | Vital capacity    | Physical examination        | 0.007  |
|                             | BMI               | BMI=weight (kg)/height (m)^2| 0.013  |
|                             | Waist circumference| Physical examination        | 0.007  |
|                             | Hip circumference | Physical examination        | 0.013  |
|                             | Defecation        | Self-report whether you often find it difficult to defecate or defecate less than three times a week | 0.017  |
|                             | Glycated hemoglobin | Laboratory examination   | 0.027  |
|                             | Blood glucose     | Laboratory examination      | 0.041  |
|                             | Hyperuricemia     | Laboratory examination      | 0.020  |
|                             | Homocysteine      | Laboratory examination      | 0.017  |
|                             | Blood lipid       | Laboratory examination      | 0.027  |
|                             | Serum calcium     | Laboratory examination      | 0.010  |
|                             | Red blood cell count | Laboratory examination       | 0.010  |
|                             | White blood cell count | Laboratory examination       | 0.008  |
|                             | Bone density      | Laboratory examination      | 0.008  |
|                             | Eyesight          | Standard logarithmic visual acuity chart | 0.008  |
| Psychosocial health (0.290) | Cognition         | The Montreal Cognitive Assessment | 0.083  |
|                             | Depression        | Self-rating depression scale | 0.051  |
|                             | Anxiety           | Self-rating Anxiety Scale   | 0.051  |
|                             | Life events       | Life Event Scale            | 0.029  |
|                             | Social support    | Social support revalued scale | 0.051  |
|                             | Psychological stress | Perceived Stress Scale    | 0.029  |
| Health-related behaviors (0.205) | Physical activity | Chinese adult physical activity guidelines | 0.013  |
|                             | Dietary nutrition | Food frequency questionnaire | 0.018  |
|                             | Alcohol drinking^†| Self-reported behaviors of drinking types, drinking frequency, drinking volume and harmful drinking | 0.040  |
|                             | Smoking‡          | Self-reported behaviors of smoking history, current smoking status and passive smoking status | 0.040  |
|                             | Sleep and rest    | Pittsburgh sleep quality index | 0.025  |
|                             | Medication safety | Self-reported knowledge of medication types, storage, side effects, and the behavior of medication compliance | 0.040  |
|                             | Gait and balance  | Tinetti scale               | 0.010  |
| Environment (0.097)         | Activities of daily living | Activity of Daily Living Scale | 0.025  |
|                             | Acoustic environment | Self-reported degree of noise disturbance | 0.026  |
|                             | Indoor air environment | Self-reported status of room ventilation, household fuel and kitchen smoke exhaust equipment | 0.016  |
|                             | Occupational exposure | Self-report whether protective measures for high-risk occupations are adequate | 0.026  |
|                             | Medical security  | Self-reported types of participation in medicare, such as medical insurance, new rural cooperative medical care, free medical care, commercial insurance and not participating | 0.044  |

Physical examination and laboratory examination refer to the examination items carried out by hospitals or physical examination centers, with or without clinical diagnostic significance as the evaluation criteria. In the questionnaire survey, we preferred mature and effective measurement tools at home and abroad, which were expressed in italics text. For another part of the index, we used a self-designed questionnaire to describe the specific content of risk assessment. ^†Alcohol drinking was assessed in four ways: (1) frequency of drinking, (2) alcohol consumed, (3) drinking types and (4) harmful drinking. Harmful drinking refers to the number of days in which men drank more than 5 standard drinking units at a single time in the past 12 months, and women drank more than 4 standard drinking units at a single time. Smoking was assessed in three ways: (1) daily smokers report the number of cigarettes smoked every day, other smokers report the average amount of smoking in a week, (2) the age when one started smoking and the age when one started smoking every day and (3) days of exposure to secondhand smoke per week.