# **BMJ Open** Diabetes-related behaviours among elderly people with pre-diabetes in rural communities of Hunan, China: a crosssectional study

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#### ABSTRACT

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Objective To explore diabetes-related behaviours and their influencing factors among elderly individuals with pre-diabetes in rural areas of China.

Design, setting and participants A cross-sectional survey was conducted among elderly individuals (≥60 years) in rural communities in Yiyang City of China. Multistaged cluster random sampling was carried out to select 42 areas, and interviews were conducted among 434 elderly individuals with pre-diabetes (fasting plasma glucose 6.1-7.0 mmol/L and/or 2-hour postglucose load of 7.8-11.1 mmol/L) using questionnaires on diabetes-related behaviours. The diabetes-related behaviours included eight categories: average daily sedentary time; frequency of physical activities per week; regular or irregular diet; whether paying attention to diet control or not; daily dietary preferences; frequency of physical examinations per year; current smoking status: and current consumption of alcohol. Each of the risky behaviours was scored -1 and each of the healthy behaviours was scored +1. Each individual's score of diabetes-related behaviours was the sum of the score for all behaviours.

Main outcome measures Participants were asked about general information (age, gender, marital status, history of hyperglycaemia, family history of diabetes mellitus, presence of other diseases, body mass index, waist-to-hip ratio and education) and their diabetes-related behaviours. Multivariate linear regression analysis was performed to identify the risk factors for diabetes-related behaviour among elderly individuals with pre-diabetes.

Results The average score of diabetes-related behaviours of elderly individuals with pre-diabetes in rural China was 2.7. The prevalences of risky diabetes-related behaviours were as follows: <1 physical examination per year (57.6%), insufficient physical activities (55.3%), lack of attention paid to diet control (51.4%), high-salt and highfat diets (41.0%), sedentary lifestyle (35.9%), smoking (22.8%), regular alcohol uptake (15.0%) and irregular diet (3.9%). Gender and a history of hyperglycaemia were found to be influencing factors of the diabetes-related behaviour score.

**Conclusions** The prevalence of risky diabetes-related behaviours was high among pre-diabetic elderly individuals in rural China. More effort should be made to promote the prevention and control of diabetes in rural

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A large number of studies have shown that lifestyle behaviour of patients with pre-diabetes plays an important role in the incidence and development of diabetes and other diseases. These behaviours can be collectively referred to as risky diabetes-related behaviours such as sedentary lifestyle, overeating and insufficient physical activity. Some studies have shown that healthy versions of these behaviours can delay or prevent the incidence and development of diabetes. For example, Ludwig et al found that high-fibre diets may have the effect of protecting against obesity and cardiovascular disease by lowering insulin levels in healthy black and white adults. Epidemiological studies have shown that the risk of developing T2DM among people who exercise actively is 30–50% lower than for sedentary persons.<sup>8</sup> Other studies have suggested that unhealthy behaviours of patients with pre-diabetes speed up the progress of their disease, including diabetes, microvascular and macrovascular diseases. The results of a large prospective cohort study conducted in the USA showed that there is an obvious association between higher consumption of sugar-sweetened beverages and an increased risk of developing T2DM in women.<sup>9</sup> Albright *et al* reported that regular physical activity is necessary for maintaining glucose-lowering effects and improving insulin sensitivity.

The Chinese Guidelines for T2DM Prevention and Treatment (2013 Edition) show that both old age ( $\geq 60$ years) and pre-diabetes are important risk factors for diabetes.<sup>11</sup> Patients with pre-diabetes who are aged  $\geq 60$ years have a very high possibility of developing diabetes. A study published by Yang *et al* showed that the development of diabetes in rural areas of China developed rapidly with a higher incidence of pre-diabetes than in urban areas.<sup>6</sup> Considering the large population and the ageing process in rural China, delayed and ineffective interventions will cause the development of diabetes to proliferate in rural areas. However, few reports have addressed diabetes-related behaviours of elderly people with pre-diabetes in rural China, and no epidemiological information is available on diabetes-related behaviours among rural pre-diabetic elderly people. Our study was performed, using

a questionnaire covering diabetes-related behaviours for pre-diabetic elderly individuals, to provide scientific recommendations for diabetes prevention in the future.

#### **MATERIALS AND METHODS** Study population and procedures

This study is a population-based cross-sectional study of Chinese individuals in Yiyang City, Hunan Province. Sample size calculation was done using the formula for  $\neg$ cross-sectional studies:  $n=u_{\alpha/2}^{2}P(1P)/d^{2}$ , where u was 1.96 when  $\alpha$  is 0.05, P is the prevalence of pre-diabetes (which is 20% in this study), and d is the admissible error (which was 4%). The theoretical sample was 423, which includes an extra 10% to allow for dropout of 8 subjects during the study. By using a multistage cluster randomised sampling method, we selected a representative sample of the rural pre-diabetic population aged  $\geq 60$ years in Yiyang City of Hunan Province between April and July 2015; 'cluster' here refers to the village. In the first stage, sampling was stratified according to geographical characteristic status and two counties (Yuanjiang and Nanxian) were selected. In the second stage, four townships (Yangluozhou, Yinfengqiao, Qingshuzui, and Maocaojie) were randomly selected within each chosen county. In the third stage, 25% of the rural villages were randomly selected in each chosen township. In the final stage, all households with elderly individuals within each village were listed.

All elderly individuals who had lived in these selected villages for  $\geq 3$  years were allowed to take part in the pre-diabetes sreening. Elderly individuals with diabetes or with severe mental or physical diseases were excluded from the pre-diabetes screening. In brief, a total of 2144 elderly individuals participated in the screening and 461 were found to have pre-diabetes; 27 pre-diabetic elderly subjects were not investigated or refused to take part in the subsequent study for various reasons. Thus, 434 pre-diabetic elderly individuals with complete data were included in the study. The design and procedure have been described in detail in a previous study.<sup>12</sup>

| Table 1 Outline of the diabetes-related behaviour questionnaire |  |   |  |  |  |  |
|---|--|---|--|--|--|--|
|   | Behaviour (score)  |   |  |  |  |  |
| Categories  | Risky behaviour(-1) Healthy behavio                      |   |  |  |  |  |
| Average daily sedentary time (hours)                            | ≥6   | <6  |  |  |  |  |
| Frequency of physical activities per week                       | <3   | ≥3  |  |  |  |  |
| Regularity of daily diet  | No   | Yes   |  |  |  |  |
| Paying attention to diet control                                | No   | Yes   |  |  |  |  |
| Daily dietary preferences                                       | High-salt/fat/sugar diet                                 | Bland diet  |  |  |  |  |
| Frequency of physical examinations per year                     | <1   | ≥1  |  |  |  |  |
| Current smoking status  | Smoking currently  | Have quit smoking or never smoked   |  |  |  |  |
| Current consumption of alcohol                                  | Frequent alcohol consumption<br>(drinking ≥3 times/week) | Occasional alcohol consumption<br>(drinking <3 times/week) or never<br>consumed alcohol |  |  |  |  |

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| Table 2    | Diabetes-related | behaviour | among | the | survey |
|------------|------------------|-----------|-------|-----|--------|
| participar | nts (n=434)      |           |       |     |        |

| Behaviour                                       | n   | Prevaler | nce (%) |
|---|-----|----------|---------|
| Average daily sedentary time<br>(hours/day)     |     |          |         |
| <2  | 73  | 16.8     |         |
| 3–5.9   | 205 | 47.2     |         |
| ≥6  | 156 | 35.9     |         |
| Frequency of physical activities per week       |     |          |         |
| Never   | 185 | 42.6     |         |
| <2  | 55  | 12.7     |         |
| 3–5   | 86  | 19.8     |         |
| Every day                                       | 108 | 24.9     |         |
| Regular daily diet                              |     |          |         |
| Yes   | 417 | 96.1     |         |
| No  | 17  | 3.9      |         |
| Paying attention to diet control                |     |          |         |
| Yes   | 211 | 48.6     |         |
| No  | 223 | 51.4     |         |
| Daily dietary preferences                       |     |          |         |
| Bland diet                                      | 256 | 59.0     |         |
| High-salt/fat/sugar diet                        | 178 | 41.0     |         |
| Frequency of physical examinations (times/year) |     |          |         |
| <1  | 250 | 57.6     |         |
| ≥1  | 184 | 42.4     |         |
| Current smoking status                          |     |          |         |
| Smoking currently                               | 99  | 22.8     |         |
| Quit smoking                                    | 41  | 9.4      |         |
| Never smoked                                    | 294 | 67.7     |         |
| Frequency of alcohol consumption                | n   |          |         |
| Frequently                                      | 65  | 15.0     |         |
| Occasionally                                    | 37  | 8.5      |         |
| Never   | 332 | 76.5     |         |

### **Data collection and measurements**

#### Pre-diabetes screening

Participants were diagnosed with pre-diabetes using oral glucose tolerance tests (OGTT). During screening they were instructed to maintain their usual physical activity and diet for a minimum of 3 days before the OGTT. The diagnostic standards for pre-diabetes as stated in the 1999 WHO criteria were categorised into three groups<sup>1</sup>: (1) IFG group: fasting plasma glucose 6.1–7.0 mmol/L (110–126 mg/dL) and 2-hour post-glucose load of <7.8 mmol/L (140 mg/dL); (2) IGT group: fasting plasma glucose 6.1 mmol/L (110 mg/dL) and 2-hour post-glucose load of 7.8–11.1 mmol/L (140–200 mg/dL); (3) IFG + IGT group.

#### Sociodemographic information

Sociodemographic information collected included age, gender, marital status, education, presence of other diseases, family history of diabetes and a history of hyperglycaemia. Education was assessed by asking the participants to select their highest level of education from the following choices: <1 year, 1–6 years and  $\geq$ 6 years.

#### Anthropometric measurements

Anthropometric measurements included blood pressure, height, weight and waist circumference; the measuring of blood pressure, BMI and waist-to-hip ratio (WHR) were described in a previous study.<sup>12</sup> Blood pressure was assessed twice (2min apart) with an electronic blood 2 pressure monitor (A&D Medical, Life Source UA-767PV) 8 after the participant had been seated for at least 5 min in Z a quiet room. The two blood pressure readings were averaged to obtain a mean resting blood pressure value for each participant. Hypertension is defined as systolic blood pressure  $\geq 140 \text{ mm}$  Hg and/or diastolic pressure  $\geq 90 \text{ mm}$ Hg.<sup>13</sup> Hypotension is defined as systolic blood pressure <90 mm Hg and/or diastolic pressure <60 mm Hg.<sup>13</sup> Both hypertension and hypotension are abnormal blood pressure. Height was measured to the nearest 0.1 cm using a stadiometer, and weight was measured without shoes and light indoor clothing to the nearest 0.1 kg. BMI was computed using the following formula:  $BMI=kg/m^2$ . Participants were defined as lean (BMI <18.5), normal (18.5<BMI<24.0), overweight (24.0<BMI<28.0) and te obese (BMI  $\geq$ 28.0), according to Chinese standards.<sup>14</sup> Waist circumference was measured to the nearest 0.1 cm by placing a non-stretching measuring tape horizontally around a participant's abdomen at the top of the iliac crest. The reading was taken after expiration while ensuring the tape was secure but not too tight. Hip measurement was taken at the point of maximum circumference over the ≥ buttocks, with the measuring tape held horizontally and touching the surface of the light clothing. The WHR was raining calculated by dividing the waist measurement by the hip measurement, and WHR >0.9 in men and WHR >0.8 in and women was defined as abnormal.<sup>15</sup>

#### **Diabetes-related behaviours**

Diabetes-related behaviours were assessed using the **Public** in China (QHLDP), which was designed by the Chinese Centre of Health Education and had a high reliability and validity with Cronbach's  $\alpha$  of 0.866.<sup>16</sup> The questionnaire included eight categories (table 1): average daily sedentary time; frequency of physical activities per week; regular or irregular diet; whether paying attention to diet control or not; daily dietary preferences (eg, bland diets, high-salt diets, high-fat diets); frequency of physical examinations per year; current smoking status; and current consumption of alcohol. Among the eight categories, the question regarding dietary preferences was given in multiple choice format while the other seven questions were single selections. Sedentary lifestyle

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|                                 | lifestyle, n (%) | activities, n (%) | (%)      | paid to diet, n (%) | sugar diet, n (%) | year, n (%) | currently, n (%) | (%)       |
|---------------------------------|------------------|-------------------|----------|---------------------|-------------------|-------------|------------------|-----------|
| Age (years)                     |                  |                   |          |                     |                   |             |                  |           |
| 60-69                           | 56 (26.5)        | 129 (56.1)        | 10 (4.3) | 118 (51.3)          | 98 (42.6)         | 133 (57.8)  | 44 (10.1)        | 38 (8.8)  |
| 70-79                           | 82 (46.8)        | 92 (53.2)         | 5 (2.9)  | 92 (53.2)           | 65 (37.6)         | 97 (56.1)   | 48 (27.7)        | 25 (14.5) |
| ≥80                             | 18 (45.2)        | 19 (61.3)         | 2 (6.5)  | 13 (41.9)           | 15 (48.4)         | 20 (64.5)   | 7 (22.6)         | 2 (6.5)   |
| X <sup>2</sup>                  | 18.901           | 0.822             | 1.127    | 1.332               | 1.785             | 0.778       | 4.163            | 2.238     |
| P value                         | <0.001*          | 0.663             | 0.569    | 0.514               | 0.410             | 0.678       | 0.125            | 0.327     |
| Gender                          |                  |                   |          |                     |                   |             |                  |           |
| Men                             | 75 (41.7)        | 94 (52.2)         | 9 (5.0)  | 101 (56.1)          | 77 (42.8)         | 109 (60.6)  | 83 (46.1)        | 50 (27.8) |
| Women                           | 81 (31.9)        | 146 (57.5)        | 8 (3.1)  | 122 (28.1)          | 101 (39.8)        | 141 (55.5)  | 16 (6.3)         | 15 (5.9)  |
| $\chi^{2}$                      | 4.374            | 1.178             | 0.958    | 2.753               | 0.396             | 1.097       | 94.829           | 39.577    |
| P value                         | 0.037†           | 0.278             | 0.328    | 0.097               | 0.529             | 0.295       | <0.001*          | <0.001*   |
| Marital status                  |                  |                   |          |                     |                   |             |                  |           |
| Stable                          | 113 (36.1)       | 175 (55.9)        | 10 (3.2) | 159 (50.8)          | 139 (44.4)        | 179 (57.2)  | 61 (19.5)        | 43 (13.7) |
| Unstable                        | 43 (27.6)        | 65 (53.7)         | 7 (5.8)  | 64 (52.9)           | 39 (32.2)         | 72 (58.7)   | 38 (31.4)        | 22 (18.2) |
| $\chi^{2}$                      | 0.222            | 0.170             | 1.556    | 0.153               | 5.349             | 0.079       | 7.037            | 1.353     |
| P value                         | 0.637            | 0.681             | 0.212    | 0.696               | 0.021†            | 0.778       | 0.008*           | 0.245     |
| History of hypergl              | ycaemia          |                   |          |                     |                   |             |                  |           |
| Yes                             | 14 (50.0)        | 13 (46.4)         | 1 (3.6)  | 10 (35.7)           | 159 (39.2)        | 12 (42.9)   | 5 (17.9)         | 1 (3.6)   |
| No                              | 142 (35.0)       | 227 (55.9)        | 16 (3.9) | 213 (52.5)          | 19 (67.9)         | 238 (58.6)  | 94 (23.2)        | 64 (15.8) |
| $\chi^{2}$                      | 2.568            | 0.953             | 0.009    | 2.941               | 8.915             | 2.665       | 0.417            | 2.175     |
| P value                         | 0.109            | 0.329             | 0.922    | 0.086               | 0.003*            | 0.103       | 0.518            | 0.140     |
| <sup>-</sup> amily history of c | liabetes         |                   |          |                     |                   |             |                  |           |
| Yes                             | 21 (58.3)        | 27 (75.0)         | 1 (2.8)  | 17 (47.2)           | 13 (36.1)         | 16 (44.4)   | 9 (25.0)         | 4 (11.1)  |
| No                              | 135 (33.9)       | 213 (53.5)        | 16 (4.0) | 206 (51.8)          | 165 (41.5)        | 234 (58.8)  | 90 (22.6)        | 61 (15.3) |
| $\chi^{2}$                      | 8.546            | 6.164             | 0.135    | 0.272               | 0.390             | 2784        | 0.107            | 0.461     |
| P value                         | 0.003*           | 0.013†            | 0.713    | 0.602               | 0.532             | 0.095       | 0.744            | 0.497     |
| Other chronic dise              | sases            |                   |          |                     |                   |             |                  |           |
| Yes                             | 73 (41.5)        | 91 (51.7)         | 7 (4.0)  | 91 (51.7)           | 64 (36.4)         | 113 (64.2)  | 47 (26.7)        | 34 (19.3) |
| No                              | 83 (32.2)        | 149 (57.8)        | 10 (3.9) | 132 (51.2)          | 114 (44.2)        | 137 (53.1)  | 52 (20.2)        | 31 (12.0) |
| $\chi^{2}$                      | 3.936            | 1.548             | 0.003    | 0.012               | 2.646             | 5.282       | 2.549            | 4.382     |
| P value                         | 0.047†           | 0.213             | 0.957    | 0.912               | 0.104             | 0.022†      | 0.110            | 0.036†    |

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| Table 4 Multiple linear regression analysis of diabetes-related behaviour |        |                   |        |        |         |                    |  |
|---|--------|-------------------|--------|--------|---------|--------------------|--|
| Variables   | В      | Standard<br>error | β′     | t      | P Value | 95% CI for B       |  |
| Constant  | 1.132  | 1.779             | -      | 0.636  | 0.525   | (-2.364 to 4.629)  |  |
| Gender  | 1.392  | 0.257             | 0.253  | 5.415  | 0.000   | (0.887 to 1.897)   |  |
| History of hyperglycaemia   | -0.600 | 0.247             | -0.114 | -2.425 | 0.016   | (-1.086 to -0.144) |  |

(average daily sedentary time  $\geq 6$  hours), insufficient physical activity (engaging in physical activity <3 times per week), irregular diet, lack of attention paid to diet, highsalt diet, high-fat diet, <1 physical examination per year, frequent alcohol consumption (drinking  $\geq$ 3 times/week) and currently smoking were defined as risky behaviours, and the rest of the behaviours were defined as healthy behaviours. Each of the risky behaviours was scored -1 and each of the healthy behaviours was scored +1. Each individual's score for the diabetes-related behaviours was the sum of the scores for all the behaviours. The sum of the diabetes-related behaviours scores ranged from -8 to 8 in the questionnaire. The higher the sum of the scores, the better the diabetes-related behaviours were.

#### **Statistical analysis**

Epidata 3.1 software was used to build the database and SPSS 20.0 software (SPSS, Chicago, Illinois, USA) was used for the statistical analysis. All questionnaires were doubly input into the database by two independent professional data processors. Data were presented as the prevalence and mean±SD. The  $\chi^2$  test was used for categorical variables and the Cochran-Mantel-Haenszel test was used for ranked variables. Multivariate linear regression was performed to explore factors influencing diabetes-related behaviours. The sum of the scores for all behaviours was selected as the dependent variable. Age (actual value), gender (1=male, 2=female), marital status (1=stable marital status, 2=unstable), education  $(1 = < 1 \text{ year}, 2 = 1 - 6 \text{ years}, 3 = \ge 6 \text{ years})$ , history of hyperglycaemia (1=yes, 2=no), family history of diabetes (1=yes, 2=no), other chronic disease status (1=yes, 2=no), BMI (1=lean, 2=normal, 3=overweight, 4=obese), WHR (1=normal, 2=abnormal) and blood pressure (1=normal, 2=abnormal) were entered as independent variables. All hypothesis tests used two-sided tests and a P value <0.05 was considered to be statistically significant.

#### RESULTS

### **Characteristics of participants**

A total of 2114 non-diabetic patients aged ≥60 years were screened. The prevalence of pre-diabetes was 21.5% (461/2144) and 434 participants with pre-diabetes completed the questionnaire. The effective response rate was 97.8%.

Among the 434 survey respondents there were 180 men (41.5%) and 254 women (58.5%). Participants had a mean±SD age of 69.4±6.45 years; 313 (72.1%) had a

stable marriage status (married and living with spouse) and 353 (81.3%) had a low level of education (<6 years). Only 28 participants (6.5%) had a history of hyperglycaemia and 36 patients (8.3%) had a family history of diabetes; 82.3% of the patients had abnormal WHR and 45.9% had abnormal blood pressure. More individuals had IGT (n=190, 43.8%) than IFG (n=186, 42.9%) or IGT+IFG (n=58, 13.4%). The characteristics of the pre-diabetic elderly individuals were not significantly different , including for uses from those without pre-diabetes (p>0.05; see details in previously published paper<sup>12</sup>).

#### Prevalence of diabetes-related behaviours among elderly individuals with pre-diabetes

Among the 434 survey respondents the reporting rates of risky diabetes-related behaviours included sedentary lifestyle (35.9%), insufficient physical activities (55.3%), irregular diet (3.9%), lack of attention paid to diet (51.4%), high-salt/fat/sugar diet (41.0%), <1 phystext ical examination per year (57.6%), smoking currently (22.8%) and frequent alcohol consumption (15.0%)(table 2). data mining

#### Comparison of risky diabetes-related behaviours between different characteristics of rural pre-diabetic elderly individuals

There were statistically significant differences in the  $\geq$ tra prevalences of risky diabetes-related behaviours among people of different ages, genders, marital statuses, history of hyperglyacemia, other chronic diseases situation and a family history of diabetes in elderly individuals with pre-di-ല abetes in rural China (P<0.05, see table 3 for details). There were no significant differences in the prevalences of risky diabetes-related behaviours between those with different levels of education, BMI, WHR, blood pressure technologies and type of pre-diabetes in the elderly individuals with pre-diabetes surveyed (p>0.05).

### Risk factors for diabetes-related behaviours among the rural pre-diabetic elderly population

The average score of diabetes-related behaviours of the survey respondents was 2.7, with the lowest score -8 and the highest 8. Multiple linear regression analysis showed that being female was a beneficial factor for diabetes-related behaviours among elderly people with pre-diabetes in rural areas ( $\beta = 0.253$ , P<0.001), and no history of hyperglycaemia was a risk factor for diabetes-related behaviours in this population ( $\beta = -0.114$ , p=0.016) (table 4).

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#### DISCUSSION

Elderly individuals with pre-diabetes in rural China have a high prevalence of risky diabetes-related behaviours and a low score for diabetes-related behaviours.

In this study the average score of diabetes-related behaviours in elderly individuals with pre-diabetes in the rural areas was 2.7, which was relatively low compared with the urban population in China.<sup>17</sup> Except for eating and alcohol consumption habits, the prevalences of risky diabetes-related behaviours such as sedentary lifestyle, insufficient physical activity, lack of attention paid to diet, high-salt and high-fat diet, <1 physical examination per year and smoking were relatively high, which were consistent with the findings of other studies from China.<sup>17</sup>

The prevalences of not paying attention to diet control and consuming high-salt/fat/sugar diets in elderly people with pre-diabetes in the rural areas were relatively high at 51.4% and 41.0%, respectively. Mounting evidence indicates that diet is an important factor in the development of diabetes. Liu et al found an association between a high diet of green leafy or dark yellow vegetables and a reduced risk of T2DM among overweight women.<sup>18</sup> Large cohort studies have shown that there is an inverse relationship between whole grain intake in diets and the risk of T2DM.<sup>19 20</sup> Cooper et al found that a diet characterised by a high intake of vegetables and fruit may be beneficial for the prevention of pre-diabetes and diabetes.<sup>21 22</sup> It has been proved that sugar intake is associated with an increased risk of diabetes,<sup>23</sup> and too much fat has also been shown to be an important contributor to the development of obesity, insulin resistance and diabetes.<sup>24</sup> Thus, dietary modification is crucial for the prevention and management of pre-existing T2DM. It is therefore necessary for individuals with pre-diabetes who pay no attention to diet and eat high-fat and salty food to change their lifestyle.

The rates of sedentary lifestyle and insufficient physical activity recorded in the current survey population were relatively high compared with a survey of urban residents by Wei *et al.*<sup>17</sup> Sedentary behaviour, defined by low-energy expenditure in a sitting or reclining position during waking hours,<sup>25</sup> has emerged as an additional concern regarding physical activity and health.<sup>26 27</sup> There is evidence to show that spending excessive time in sedentary behaviours is related to an increased risk of diabetes. Physical inactivity has been associated with some potential risk factors of diabetes.<sup>8</sup> Some large-sample studies have reported that habitual physical activity (such as moderate exercise) may significantly reduce the risk for T2DM.<sup>10</sup> Regular participation in moderate exercise such as walking is a cornerstone of the prevention and management of diabetes.<sup>28</sup> Henson *et al* found that breaking up prolonged sitting with 5 min bouts of standing or walking improved the glucose (standing and walking) and insulin (walking only) responses, which were maintained into the next day.<sup>29</sup> Another study reported that short and frequent periods of exercise have the effect of attenuating glucose excursions and insulin concentrations

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found that risky alcohol consumption was a risk factor for pre-diabetes in men.<sup>41</sup>

The prevalence of a high-salt/fat/sugar diet in pre-diabetic elderly people with a stable marital status was higher than in those without a stable marital status. There may be two reasons for this. On the one hand, persons with an unstable marital status may have a low income. On the other hand, Yang et al found that an unstable marital status had a bad effect on diet among the elderly population in rural China.<sup>42</sup> The prevalence of a high-salt/fat/ sugar diet in pre-diabetic elderly people without a history of hyperglycaemia was higher than in those with a history of hyperglycaemia. As we reported previously, hyperglycaemia influenced diabetes health literacy.<sup>12</sup> People with a history of hyperglycaemia are concerned about developing diabetes and actively keep healthy behaviours to prevent diabetes.

The prevalences of a sedentary lifestyle and insufficient physical activity in pre-diabetic elderly people with a family history of diabetes were high, which indicates that family history is associated with the development of diabetes. Bianco et al showed that there were correlations between a family history of T2DM and body weight, fat mass and alterations in basal glycaemia values.43 Aravindalochanan et al found that increased sitting duration for ≥180 min/day was associated with elevated random capillary blood glucose, and there was a threefold higher risk of diabetes among these subjects with a positive family history of diabetes.<sup>44</sup> A healthy diet and active lifestyle may significantly decrease the risk of T2DM in spite of a family history of diabetes.45

It was not surprising that the prevalence of <1 physical examination per year in people with other chronic diseases was higher than in those without other chronic diseases. Yin et al found that elderly people in rural China did not actively seek health services because of poor economic conditions, high price of health services and bad quality medical services.<sup>46</sup> These findings suggest that there are some differences in different populations, which should be taken into account when we implement specific recommendations to prevent or delay the onset of diabetes in the rural pre-diabetic elderly population. Specific strategies to reduce modifiable risk factors for the prevention and control of diabetes may be warranted.

#### Gender and hyperglycaemia are influencing factors for diabetes-related behaviours in elderly individuals with prediabetes in rural areas

The results of our study showed that female gender was a favourable factor for diabetes-related behaviours among elderly people with pre-diabetes in rural areas. This is consistent with others. Being male is a risk factor for diabetes in the Chinese population aged <50 years.<sup>47</sup> In addition, many studies have shown that men have lower diabetes health literacy than women.<sup>48–50</sup> Health literacy is the degree to which individuals have the capacity to obtain, process and understand the basic health information and services needed to make appropriate health

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benefit from the application of the English version of the QHLDP with other scales in the same populations.

#### **CONCLUSIONS**

The current study has shown that there is a high prevalence of risky diabetes-related behaviours among elderly people with pre-diabetes in rural China. Being male and not having a history of hyperglycaemia were the main risk factors. Considering the high prevalence of pre-diabetes and diabetes among the elderly population in rural China and low health literacy, low income and high prevalence of behaviour associated with an increased risk of diabetes, future studies should evaluate diabetes prevention strategies tailored specially for this population.

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Patient consent Obtained.

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