ORIGINAL RESEARCH

Prevalence of Diabetes and Prediabetes in Adults from a Third-Tier City in Eastern China: A Cross-Sectional Study

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ABSTRACT

Introduction: The aims of this study were to investigate the prevalence of adult diabetes and prediabetes in Bengbu (eastern China) in 2017, and to identify measures that can be taken to reduce the prevalence of diabetes and prediabetes in this region.

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Methods: A stratified cluster random sampling method was used in the study. Two sampling sites were randomly selected from each of the four districts of Bengbu City, and all permanent residents (resident for ≥ 5 years) at all eight sampling sites aged 18 years or above were cluster sampled, which led to the sampling of 3388 adults. After screening, a total of 3144 respondents were enrolled in the study. The t test was utilized to compare the mean parameter values of the males and the females, and variance analysis was employed to compare the mean values of the nondiabetic, prediabetic, and diabetic groups. The chi-squared test was used to compare rates. Logistic regression was used for multivariate analysis, and the statistical significance level α was set to 0.05.

Results: The mean ages of the male and female groups were 51.1 ± 15.7 and 49.4 ± 15.1 years, respectively ($p < 0.05$). The diabetes prevalence in adults was 11.5% (8.4% after standardization), while the prevalence of prediabetes in adults was 32.0% (27.6% after standardization). The prevalence of diabetes and that of prediabetes gradually increased with age (both $p < 0.05$). Older age, hypertension, overweight status, obesity, central obesity, current smoker status, low serum high-density lipoprotein level, and high serum low-density lipoprotein level were all significantly associated with a higher risk of diabetes ($p < 0.05$).

Conclusion: The prevalence of diabetes and that of prediabetes in adults in Bengbu City

remain high. Intervention aimed at reducing the occurrence of diabetic complications and preventing prediabetes from further development is urgently required.

Keywords: Diabetes; Epidemiology; Prediabetes; Prevalence rate; Risk factors

INTRODUCTION

Diabetes mellitus (DM) is one of most common metabolic disorders in the world, and the prevalence of diabetes in adults has been increasing globally over the last few decades [1, 2]. According to a report from the International Diabetes Federation, there were estimated to be 451 million people (aged 18–99 years) with diabetes worldwide in 2017 [3]. These figures are expected to increase to 693 million by 2045 [3]. Epidemiological investigations of diabetes in China began in the 1980s, and were conducted in 1980, 1994, 2007, 2010, and 2013. In 2010, the prevalence of diabetes was 11.6% in Chinese adults aged $\geq$ 18 years, and the prevalence of prediabetes was 50.1% [4]. In 2013, the estimated standardized prevalence of diagnosed and undiagnosed diabetes in the adult Chinese population was 10.9%, while the prevalence of prediabetes was 35.7% [5]. Diabetes and its chronic complications pose a great threat to the lives and the quality of life of patients, and impose direct, indirect, and intangible economic burdens on their families, the entire health system, and the country. In 2014, diabetes-related medical services consumed 80.33 billion yuan, representing 5% of the medical resources directed towards chronic diseases, and 33.99% of the medical expenses of diabetes were paid for by families [6]. Therefore, it is important to determine the prevalence of diabetes and prediabetes and to prevent and control diabetes and prediabetes.

While the prevalence of diabetes and that of prediabetes in the adult Chinese population have been reported, China is a large country, with the gap between rich and poor and the lifestyles adopted in different regions varying greatly. As a result, the prevalence of diabetes also varies widely between regions. Bengbu is a third-tier city in eastern China that has a developed economy. Our research group has conducted a series of studies on the prevention and treatment of diabetes in Bengbu [7–14]. In October 1979, we attended the First National Conference on Diabetes Research, held in Lanzhou. In 1980, a general survey of diabetes was carried out for the first time in Bengbu, and a tertiary diabetes prevention network was established. In 1994, we took part in the National Diabetes Prevention and Control of Cooperative Group [15], carried out a second diabetes census, and conducted a series of prevention and control studies and comparative analyses. Similarly, in 2005, we conducted a third diabetes status survey in Bengbu. That and the previous two surveys of residents diagnosed with diabetes and abnormal glucose tolerance were used to conduct a comprehensive study of diabetes prevention and treatment over the last 25 years. Over the last decade or more, the rapid development of the national economy, improvements in living standards, changes in diet, and a reduction in the amount of physical exercise performed by the general population have led to a rapid increase in the incidence of diabetes. By investigating the prevalence and risk factors of diabetes and prediabetes in Bengbu, we can not only improve the health of local residents but also provide guidance for local governments who are attempting to implement effective regional chronic disease prevention and control strategies.

Therefore, we conducted a population sampling survey of permanent residents ($\geq$ 5 years resident) of the Bengbu area aged 18 years or more in order to explore the characteristics of the adult diabetics and prediabetics in Bengbu and to pinpoint risk factors for diabetes. The results should facilitate work aimed at identifying measures that could be taken to prevent and control diabetes in adults.

METHODS

Subjects

Stratified cluster random sampling was used in the study. Prior to this sampling, a list of all the

sites at which sampling was to be performed was established, based on the distribution discussed in our previous study [7]. Two sampling sites were randomly selected from each of the four districts (Yuhui District, Bengshan District, Longzihu District, and Huaishang District) of Bengbu City. All permanent residents (only persons who had been living in Bengbu for at least 5 years) at the eight sampling sites (one hospital, one bank, one middle school, one university, two government institutions, and two factories) who were $\geq$ 18 years old were cluster sampled, resulting in the sampling of 3388 adults. The following subjects were removed: (1) those with severe liver and kidney diseases, acute diseases, infectious diseases, or trauma surgery; (2) those who did not answer the questionnaire in a consistent manner; and (3) those with incomplete data on physical or biochemical indicators. This led to the removal of 244 people from the study, leaving 3144 adults. The sampling efficiency was 92.8%. Among the respondents, 1655 were males and 1489 were females, and all respondents provided written informed consent. The protocol for the research project was approved by the Institutional Review Board and Ethics Committee of The First Affiliated Hospital of Bengbu Medical College (no. BYYFY-2017.KY04) and conforms to the Helsinki Declaration of 1964 and its later amendments. All subjects gave their informed consent and patient anonymity is preserved within the text of this manuscript.

Methods

A questionnaire focusing on demographic characteristics (age, sex, education, etc.), medical history, and lifestyle factors was administered by a trained medical worker. A current smoker was defined as someone who had smoked at least 100 cigarettes in their lifetime and still smoked cigarettes. Anthropometric measurements included height, weight, waist circumference (WC), and hip circumference. The body mass index (BMI) was also calculated.

The diagnostic criteria for diabetes and prediabetes were those proposed by the American Diabetes Association (ADA) in 2010 [16]. A

diabetic was defined as someone with (1) a self-reported previous diagnosis of diabetes, (2) a fasting plasma glucose (FPG) level of 7.0 mmol/L or higher, (3) a 2-h plasma glucose level of 11.1 mmol/L or higher, or (4) a glycosylated hemoglobin A1c (HbA1c) concentration of 6.5% or more (i.e., if one or more of these criteria were met, the individual was categorized as diabetic). A prediabetic and someone at an increased risk of diabetes were defined as individuals with (1) FPG $\geq$ 5.6 mmol/L and < 7.0 mmol/L, (2) 2-h plasma glucose levels of $\geq$ 7.8 mmol/L and < 11.1 mmol/L, respectively, or (3) a HbA1c concentration of $\geq$ 5.7% and < 6.5%, participants without a prior diagnosis of diabetes. If the individual met one or more of these criteria, they were categorized as prediabetic. In this study, FPG and HbA1c were used together to diagnose diabetes and prediabetes. Any individual who met the appropriate diagnostic criteria based on FPG and HbA1c was diagnosed accordingly as a diabetic or a prediabetic. BMI was used to classify individuals as overweight (BMI 24.0–27.9 kg/m^2) or obese (BMI $\geq$ 28.0 kg/m^2) [17]. The diagnostic criteria for dyslipidemia included serum total cholesterol (TC) $\geq$ 6.2 mmol/L, low-density lipoprotein (LDL) $\geq$ 4.1 mmol/L, high-density lipoprotein (HDL) < 1.0 mmol/L, and triglyceride (TG) $\geq$ 2.3 mmol/L [18]. Central obesity was defined as a male with WC $\geq$ 90 cm and a female with WC $\geq$ 80 cm [19]. The diagnostic criterion for hyperuricemia (HUA) was based on blood uric acid: > 420 μmol/L for males and > 360 μmol/L for females [20].

SPSS 24.0 (IBM, Chicago, IL, USA) was used for data processing and for all data analyses. Measurement data were expressed in terms of the mean and standard deviation. The t test was utilized to compare the mean values of the males to those of the females, and variance analysis was adopted to compare the means of the nondiabetic, prediabetic, and diabetic groups. The chi-squared test was used to compare rates. Logistic regression was used for multivariate analysis, and the statistical significance level (α) was set to 0.05. Additionally, prevalence was standardized according to the

age structure of the Sixth National Census in 2010.

RESULTS

The clinical characteristics of the participants are shown in Table 1. Among the 3144 participants, 1776 were nondiabetic individuals, 1007 had prediabetes, and 361 had diabetes. The mean ages of the nondiabetic, prediabetic, and diabetic participants were 45.9 ± 14.4, 54.3 ± 14.8, and 60.5 ± 14.0 years (mean $\pm$ SD values; $p < 0.001$), respectively. The prevalence rate of hypertension, proportion of males and current smokers, BMI, WC, hip circumference, TC, LDL, TG, uric acid (UA) increased with elevated blood glucose levels ($p < 0.001$) and HDL decreased with it ($p < 0.001$).

In this study, a total of 3388 people were investigated, but there were 244 with incomplete laboratory and demographic data, so the actual effective number of participants was 3144 (the effective sampling rate was 92.8%).

The prevalence of diabetes in adults was 11.5% (8.4% after standardization). The prevalence rate of prediabetes in adults was 32.0% (27.6% after standardization) (see Tables 2, 3).

The prevalence rates of diabetes in male and female adults were 13.7% and 9.1%, respectively (13.3% and 9.3%, respectively, after standardization). This difference was statistically significant ($\chi^2 = 16.241$, $p < 0.05$) (Tables 2, 3). There were a total of 1655 males with an average age of 51.1 ± 15.7 years, and 1489 females with an average age of 49.4 ± 15.1 years. The difference in the average ages of the males and females was statistically significant ($t = 3.106$, $p < 0.05$). The prevalence rates of diabetes and prediabetes gradually increased with age ($\chi^2 = 169.746$, $p < 0.05$ and $\chi^2 = 111.013$, $p < 0.05$, respectively). The prevalence of diabetes in males of all ages was consistently higher than it was in females of all ages. In addition, the prevalence of prediabetes in males under 50 years old was higher than that in females under 50 years old, and the prevalence of prediabetes in females over the

Table 1 General characteristics of the participants

Variable	Nondiabetic group $n = 1776$	Prediabetic group $n = 1007$	Diabetic group $n = 361$	p value
Male sex (%)	49.1%	55.3%	62.6%	< 0.001
Age (years)	45.9 ± 14.4	54.3 ± 14.8	60.5 ± 14.0	< 0.001
GLU (mmol/L)	5.00 ± 0.41	5.80 ± 0.47	8.82 ± 2.60	< 0.001
BMI (kg/m^2)	23.1 ± 2.9	24.6 ± 3.6	25.5 ± 3.7	< 0.001
Waist circumference (cm)	81.6 ± 9.8	86.6 ± 10.9	89.8 ± 10.2	< 0.001
Hip circumference (cm)	93.5 ± 10.3	96.5 ± 10.4	97.2 ± 11.0	< 0.001
TC (mmol/L)	4.79 ± 0.91	4.99 ± 0.95	5.04 ± 1.07	< 0.001
HDL (mmol/L)	1.41 ± 0.38	1.30 ± 0.37	1.25 ± 0.36	< 0.001
LDL (mmol/L)	2.53 ± 0.69	2.72 ± 0.75	2.73 ± 0.82	< 0.001
TG (mmol/L)	1.57 ± 1.15	1.76 ± 1.02	2.15 ± 1.93	< 0.001
UA (μmol/L)	316 ± 88	334 ± 83	322 ± 82	< 0.001
Hypertension (%)	17.5%	24.5%	31.3%	< 0.001
Current smoking (%)	23.3%	34.4%	39.9%	< 0.001

GLU glucose, *BMI* body mass index, *TC* serum total cholesterol, *HDL* high-density lipoprotein, *LDL* low-density lipoprotein, *TG* triglyceride, *UA* uric acid

Table 2 Risk factors for diabetes in the adult population of Bengbu

	Total number of participants	Total number with diabetes	Diabetes prevalence (%)	χ^2	p value
Overall	3144	361	11.5		
Sex				16.241	< 0.001
Men	1655	226	13.7		
Women	1489	135	9.1		
BMI (kg/cm^2)				105.911	< 0.001
< 24.0 (normal)	1731	125	7.2		
24.0–27.9 (overweight)	1078	149	13.8		
≥ 28 (obese)	335	87	26.0		
Waist circumference (cm)				60.336	< 0.001
< 90 in men < 80 in women	1792	137	7.6		
≥ 90 in men ≥ 80 in women	1352	224	16.6		
UA (μmol/L)				0.876	0.349
≤ 420 in men ≤ 360 in women	2615	294	11.2		
> 420 in men > 360 in women	529	67	12.7		
TC (mmol/L)				11.156	0.001
< 6.2	2851	310	10.9		
≥ 6.2	293	51	17.4		
TG (mmol/L)				22.761	< 0.001
< 2.3	2598	266	10.2		
≥ 2.3	546	95	17.4		
LDL (mmol/L)				15.670	< 0.001
< 4.1	2971	325	10.9		
≥ 4.1	173	36	20.8		
HDL (mmol/L)				28.746	< 0.001
≥ 1.0	2598	262	10.1		
< 1.0	546	99	18.1		

Table 2 continued

	Total number of participants	Total number with diabetes	Diabetes prevalence (%)	χ^2	p value
Level of education				55.578	< 0.001
None	191	35	18.3		
Primary school	208	44	21.2		
Junior high school	701	105	15.0		
Senior high school	720	74	10.3		
College/university	938	70	7.5		
$\geq$ Master	386	33	8.5		
Current smoker				24.688	< 0.001
No	2240	217	9.7		
Yes	904	144	15.9		
Hypertension				24.279	< 0.001
No	2474	248	10.0		
Yes	670	113	16.9		

BMI body mass index, *TC* serum total cholesterol, *HDL* high-density lipoprotein, *LDL* low-density lipoprotein, *TG* triglyceride, *UA* uric acid

age of 50 years was higher than that in males over the age of 50 years (Fig. 1).

In the single factor analysis, the prevalence rates of diabetes and prediabetes were found to increase significantly with increasing BMI ($\chi^2 = 105.911$, $p < 0.05$ and $\chi^2 = 56.451$, $p < 0.05$, respectively). The prevalence of diabetes in patients with central obesity (male WC $\geq$ 90 cm and female WC $\geq$ 80 cm) was 16.6%, which was significantly higher than that in the normal WC group (7.6%) ($\chi^2 = 60.336$, $p < 0.05$); the prediabetes prevalence was 40.5%, which was higher than the prediabetes prevalence observed in the normal WC group (25.6%), and this difference was statistically significant ($\chi^2 = 78.782$, $p < 0.05$). Among other factors affecting diabetes, people who differed in TC, TG, HDL, LDL, education level, history of hypertension, and smoking status had different prevalence rates of diabetes, and people who differed in TC, HDL, LDL, UA, education level, history of hypertension, and smoking status

had different prevalence rates of prediabetes ($p < 0.05$) (Tables 2, 3).

In a multinomial logistic regression model, older age, hypertension, overweight status, obesity, central obesity, current smoker status, low serum HDL level, and high serum LDL level were all significantly associated with a higher risk of diabetes ($p < 0.05$), and a higher level of education was inversely associated with diabetes. In addition, older age, hypertension, obesity, central obesity, current smoker status, low serum HDL level, and elevated serum LDL level were positively associated with a higher risk of prediabetes ($p < 0.05$), while a higher level of education was inversely associated with prediabetes (Table 4).

DISCUSSION

This epidemiological investigation of adult diabetes and prediabetes in Bengbu City showed that the prevalence of adult diabetes in Bengbu

Table 3 Risk factors for prediabetes in the adult population of Bengbu

	Total number of participants	Total number with prediabetes	Prediabetes prevalence (%)	χ^2	p value
Overall	3144	1007	32.0		
Sex				4.246	0.039
Men	1655	557	33.7		
Women	1489	450	30.2		
BMI (kg/cm$^{2)}$)				56.451	< 0.001
< 24.0 (normal)	1731	468	27.0		
24.0–27.9 (overweight)	1078	385	35.7		
≥ 28 (obese)	335	154	46.0		
Waist circumference (cm)				78.782	< 0.001
< 90 in men < 80 in women	1792	459	25.6		
≥ 90 in men ≥ 80 in women	1352	548	40.5		
UA (μmol/L)				5.316	0.021
≤ 420 in men ≤ 360 in women	2615	815	31.2		
> 420 in men > 360 in women	529	192	36.3		
TC (mmol/L)				12.747	< 0.001
< 6.2	2851	886	31.1		
≥ 6.2	293	121	41.3		
TG (mmol/L)				1.753	0.186
< 2.3	2598	819	31.5		
≥ 2.3	546	188	34.4		
LDL (mmol/L)				19.865	< 0.001
≤ 4.1	2971	925	31.1		
> 4.1	173	82	47.4		
HDL (mmol/L)				24.564	< 0.001
≥ 1.0	2598	783	30.1		
< 1.0	546	224	41.0		

Table 3 continued

	Total number of participants	Total number with prediabetes	Prediabetes prevalence (%)	χ^2	p value
Level of education				67.121	< 0.001
None	191	98	51.3		
Primary school	208	97	46.6		
Junior high school	701	234	33.4		
Senior high school	720	209	29.0		
College/university	938	263	28.0		
$\geq$ Master	386	106	27.5		
Current smoker				22.731	< 0.001
No	2240	661	29.5		
Yes	904	346	38.3		
Hypertension				9.148	0.002
No	2474	760	30.7		
Yes	670	247	36.9		

BMI body mass index, *TC* serum total cholesterol, *HDL* high-density lipoprotein, *LDL* low-density lipoprotein, *TG* triglyceride, *UA* uric acid

was 11.5% (8.4% after standardization), which was lower than the prevalence of 10.9% found during the National Adult Diabetes Investigation in 2013 [5]. This difference may be related to the geographical location of Bengbu (eastern China) and its developed economy. Furthermore, the sample comprised urban residents with a relatively high population quality. However, the prevalence of diabetes was significantly higher than those reported in the three previous epidemiological investigations of diabetes in Bengbu City conducted by our research group (the prevalence was 0.85% in 1980, 2.63% in 1994, and 7.5% in 2005–2006) [7], which may be closely related to the remarkable improvement in living standards and the changes in diet (more calories, fat, sugar, and sodium), lifestyle (decreased physical activity), and work pressure that have occurred over the past few decades.

This investigation showed that the prevalence rate of adult prediabetes was 32.0% (27.6% after standardization), which is similar to the prevalence of 35.7% noted in the 2013 Chinese survey [5] and the prevalence of 36.5% observed in an epidemiological investigation of prediabetes in the United States in 2011–2012 [21]. This finding shows that prediabetes has become an important hidden danger to human health and quality of life, and one in three of the population reach the diagnostic standard for prediabetes, which is an important risk factor for diabetes and systemic macrovascular and microvascular diseases as well as subsequent diseases of the kidney, heart, brain, and other organs. According to epidemiological investigations in China, diabetic nephropathy has surpassed glomerulonephritis to become the leading cause of hospitalization for patients with chronic kidney disease (CKD) [22], and diabetic retinopathy has also become the most common cause of adult blindness [23]. Therefore, it is necessary to strengthen the control of blood glucose in diabetic patients and to ensure that people with prediabetes and diabetes
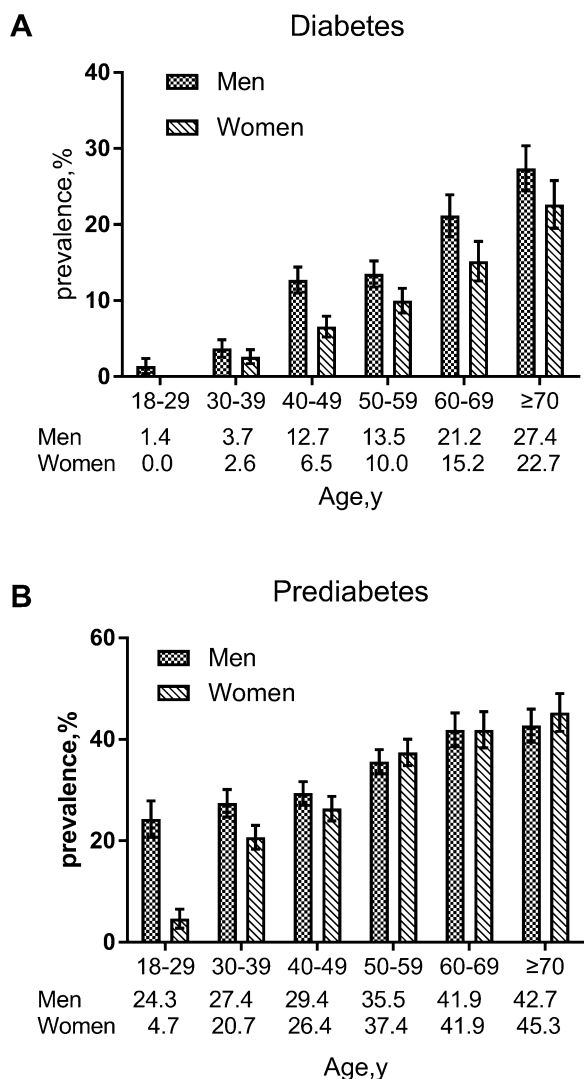
A

Diabetes

	18-29	30-39	40-49	50-59	60-69	≥70
Men	1.4	3.7	12.7	13.5	21.2	27.4
Women	0.0	2.6	6.5	10.0	15.2	22.7

Age,y

B

Prediabetes

	18-29	30-39	40-49	50-59	60-69	≥70
Men	24.3	27.4	29.4	35.5	41.9	42.7
Women	4.7	20.7	26.4	37.4	41.9	45.3

Age,y

Fig. 1 Age-specific and age-standardized prevalence rates of diabetes and prediabetes in Bengbu adults aged 18 years or older in 2017. Error bars indicate 95% confidence intervals

understand the important roles played by diet and sports in blood glucose control.

In addition, this investigation showed that the male proportion of the population, age, BMI, WC, hip circumference, TC, LDL, and TG, as well as the prevalence rates of hypertension and smoking are on the rise with elevated blood glucose levels ($p < 0.001$). In the single-factor study, BMI, central obesity, TC, TG, LDL, HDL, smoking status, hypertension, and level of education were significantly associated with the

prevalence rates of diabetes and prediabetes ($p < 0.05$). In a multinomial logistic regression model, older age, hypertension, overweight status, obesity, central obesity, current smoker status, lower serum HDL level, and elevated serum LDL and triglyceride levels were risk factors for diabetes, while a higher level of education was a protective factor against diabetes. Older age, hypertension, obesity, central obesity, current smoker status, lower serum HDL level, and elevated serum LDL level were risk factors for prediabetes, while a higher level of education was a protective factor against prediabetes, which is consistent with the findings of other studies on diabetes and obesity [24]. Additionally, the prevalence rates of diabetes and prediabetes in males were higher than those in females ($p < 0.05$), which may be related to the risk factors for diabetes, such as smoking, drinking, irregular work and rest, dyslipidemia, etc. This provides another reminder that maintaining a healthy lifestyle, increasing exercise levels, and eating a balanced diet are important ways to prevent and control diabetes. This study also found that the prevalence rates of diabetes and prediabetes decline with increasing education level ($p < 0.001$), which is a protective factor against diabetes. We expect that improvements in the average education level of the overall population will impact on the prevalence of diabetes, as this should coincide with a better understanding of various diseases (including diabetes) and a greater knowledge of preventive measures for diabetes among the general population.

The present study has several strengths. First, it was conducted on a large sample of the general population in Bengbu. This sample was larger than those studied in previous epidemiological investigations. Second, this study was a continuation of a series of studies we have already performed. We found how the prevalence rates of diabetes and prediabetes and the related risk factors changed over time, which could not only improve the health condition of local residents, but also provide theoretical guidance for local governments to plan effective regional chronic disease prevention and control strategies. Third, following the ADA 2010 criteria [16], HbA1c was added to the diagnostic

Table 4 Risk factors for diabetes and prediabetes in the participants

Risk factor	Diabetes, OR (95% CI)	p value	Prediabetes, OR (95% CI)	p value
Male sex	1.177 (0.890–1.557)	0.253	0.878 (0.714–1.079)	0.217
Age (years)				
46–60	3.046 (2.148–4.319)	< 0.001	1.885 (1.549–2.294)	< 0.001
> 60	6.287 (4.446–8.890)	< 0.001	3.802 (3.046–4.746)	< 0.001
Hypertension	1.629 (1.258–2.109)	< 0.001	1.471 (1.197–1.809)	< 0.001
≥ Senior high school education	0.619 (0.488–0.785)	< 0.001	0.597 (0.500–0.714)	< 0.001
BMI[a]				
Overweight status	1.397 (1.041–1.875)	0.026	1.187 (0.967–1.456)	0.101
Obesity	2.596 (1.774–3.798)	< 0.001	2.373 (1.701–3.309)	< 0.001
Central obesity[b]	1.433 (1.078–1.905)	0.013	1.802 (1.475–2.202)	< 0.001
Current smoking	1.422 (1.083–1.868)	0.011	1.788 (1.443–2.216)	< 0.001
TC ≥ 6.2 mmol/L	1.158 (0.795–1.685)	0.445	1.263 (0.923–1.728)	0.145
HDL < 1.0 mmol/L	1.594 (1.185–2.145)	0.002	2.125 (1.665–2.712)	< 0.001
LDL ≥ 4.1 mmol/L	1.606 (1.033–2.495)	0.035	2.058 (1.373–3.084)	< 0.001
TG ≥ 2.3 mmol/L	1.348 (0.989–1.838)	0.059	0.808 (0.626–1.042)	0.808
HUA[c]	0.844 (0.618–1.153)	0.287	1.106 (0.875–1.397)	0.401

BMI body mass index, *TC* serum total cholesterol, *HDL* high-density lipoprotein, *LDL* low-density lipoprotein, *TG* triglyceride, *HUA* hyperuricemia

[a] Overweight status was defined as a body mass index (BMI, calculated as weight in kilograms divided by height in meters squared) of 24.0–27.9; obesity was defined as a BMI of 28.0 or higher

[b] Central obesity was defined as a waist circumference of 90 cm or more in men and 80 cm or more in women

[c] Hyperuricemia (HUA) was defined as blood uric acid of > 420 μmol/L in men and > 360 μmol/L in women

criteria for diabetes and prediabetes in this study, which provided the basis for a comprehensive understanding of the prevalence and control of adult diabetes in Bengbu. In addition, a strict quality assurance and quality control program was implemented at every phase of the study to ensure the validity and reliability of the data.

This study also has several limitations. First, we used a stratified cluster sampling method in the study rather than a completely random sampling method. This will have resulted in biased estimates. Second, we did not distinguish type 1 from type 2 diabetes in our investigation of adult diabetics, and we did not investigate the incidence of type 1 diabetes, although this accounts for less than 5% of all diabetics

according to the Chinese Diabetes Clinical Guidelines [25]. Third, this study was a cross-sectional study, so we could not examine the cause-and-effect relationships between some risk factors and diabetes or prediabetes. Fourth, due to the low acceptance and limited coordination of the oral glucose tolerance test (OGTT) population, we did not conduct a glucose test 2 h after a meal, which may have led to an underestimation of the prevalence rates of diabetes and prediabetes. However, the HbA1c test in this study was carried out in the laboratory of the Endocrinology Department of the First Affiliated Hospital of Bengbu Medical College using an ion exchange HPLC, and the test system was a reliable reference method approved by the National Glycosylated Hemoglobin

Standardization Project (NGSP). A notable study of the Chinese population showed that the area under the receiver operating characteristic curve for detecting undiagnosed diabetes was 0.856 (95% confidence interval 0.828–0.883) for HbA1c alone and 0.920 (0.900–0.941) for fasting plasma glucose alone [26]. Furthermore, another study found that the utilization of a combination of fasting blood glucose with HbA1c to diagnose T2DM significantly improved the screening sensitivity [27]. Therefore, it is reasonable to suggest that the addition of HbA1c to the diagnostic criteria may have compensated for the abovementioned limitation of this study.

CONCLUSIONS

The prevalence of diabetes in adults in Bengbu was 11.5% (8.4% after standardization), while that of prediabetes was 32.0% (27.6% after standardization), and these are largely consistent with the corresponding values for the national population. Therefore, the trend of diabetes and pre-diabetes prevalence is still severe, and early diagnosis, early treatment, and early recovery from diabetes can provide a theoretical and practical platform for the effective prevention and treatment of chronic complications.

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