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Prevalence of overweight and obesity and associated risk factors among adult residents of northwest China: A cross- sectional study

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Abstract

Objective: Overweight and obesity have been shown to be related to multiple chronic conditions and lead to a heavy economic burden on society throughout the world. This study aims to estimate the prevalence of overweight and obesity and determine potential influencing factors among adults in Xinjiang，northwest China.

Design: A community-based observational study.

Setting: The First Affiliated Hospital of Xinjiang Medical University.

Methods: In total, 14,618 adult participants (7,799 males; 6,819 females), aged over 35 years old, were recruited from the Cardiovascular Risk Survey conducted in 2010. Data were obtained from face-to-face interview and physical examination. The sample was used to estimate the prevalence of overweight (body mass index (BMI) 24-27.9 kg/m^2) and obesity (BMI>28 kg/m^2) in Xinjiang Province, and the influencing factors were analyzed based on statistical methods.

Results: The overall prevalence of overweight was 36.52% (male 40.1%; female; 33.4%), and the prevalence of obesity was 26.47% (male 27.2%; female 25.8%) in Xinjiang Province. The prevalence of both overweight and obesity were higher in women than men (P<0.001). The main influencing factors for overweight and obesity are sex, age, race, marriage status, education level, occupation, smoking, drinking, hypertension, diabetes and dyslipidemia (P<0.05).

Conclusions: This study estimated that the prevalence of overweight and obesity among adult residents of Xinjiang Province, northwest China, was high. These data suggest that efforts toward prevention and control of overweight and obesity should be a public health priority in the northwest of China.

Keywords: cross-sectional survey, overweight, obesity, risk factors

Strengths and limitations of this study

- The survey sample was demographically representative of Uygur obese adults aged 35–80 years in Xinjiang.
- The main strengths of our study are its large sample size and precise physical measurements, which increase the validity of our results.
- This is the first study to date that investigate the association of overweight and obesity and races in adults.
- However, the present study has several limitations. First, self-reported data and the nature of

cross-sectional data may lead to recall and reporting biases, which may be the reason for the insignificant difference in the effect of obesity on reasons.

- Moreover, other indicators of adiposity, such as body fat percentage and waist circumference which plenty of studies reported to reflect the prevalence of overweight and obesity and body fat distribution, were not obtained in our study.

Introduction

Obesity is a complex chronic global disease affecting people worldwide across all ages, sexes, ethnicities, and nationalities, which is the fifth leading cause of mortality globally [1, 2]. According to the World Health Organization (WHO), the prevalence of worldwide obesity has doubled in more than 70 countries since 1980 [3]; this trend has continuously increased in most other countries. In 2013, in order to make physicians pay more attention to the condition, the American Medical Association classified obesity as a disease [4].

Body mass index (BMI), which is calculated as weight/height squared (kg/m^2), is a common and accepted measure that is used to report obesity rates. While BMI is not a true measure of adiposity, it is simple to use in health screenings and epidemiological surveys [5]. According to the WHO, obesity is defined as a BMI≥30 kg/m^2, and overweight as a BMI of 25-9.9 kg/m^2 [6]. For Chinese people, obesity suggests a BMI≥28 kg/m^2 and overweight indicates a BMI of 24-27.9 kg/m^2 [7].

China is the largest developing country and has the largest population in the world. With the rapid economic growth and changes in lifestyle such as dietary habits and physical activity [8], the epidemiological data indicated that individuals with overweight and obesity had a higher prevalence of traditional diseases including dyslipidemia, hypertension, cardiovascular disease, insulin resistance or diabetes, fatty liver disease, and psychosocial complications and some cancers [5, 9]. Located in the northwest China, Xinjiang not only is an autonomous minority ethnic region of the People's Republic of China, but also is one of the developing regions in China. It is the largest Chinese administrative division and spans over 1.66 million km^2 which takes up about one sixth of the country's territory. A few of studies had reported the prevalence of overweight among adults in Xinjiang [10]. Nevertheless, the samples in above mentioned studies were small, those results cannot represent accurately the status of overweight and obesity in the whole region of Xinjiang.

In the present study, we estimate the prevalence of overweight and obesity in Xinjiang. Meanwhile, the potential influencing factors in adult residents of northwest China were explored. The results of this study will be considered as a reference for policy makers in making informed decisions.

Materials and Methods

Ethics approval

This study was conducted according to the standards of the Declaration of Helsinki. Written informed consent was acquired from each participant prior to enrollment. Ethics approval was from the Ethics Committee of the First Affiliated Hospital of Xinjiang Medical University.

Study design and population

This population-based cross-sectional survey is part of the Project on Present Situation and the Cardiovascular Risk Survey (CRS) study in Xinjiang Province of China in 2010.The CRS was a prospective, multiple ethnicity and community-based observational study designed to investigate the prevalence and risk factors for cardiovascular disease (CVD) in the Han, Uygur and Kazakh populations in Xinjiang Province [11]. All the subjects included had lived in Xinjiang Province for more than 1 year. Briefly, the CRS consisted of 16,460 adults aged≥35 years old, of whom 14,618 subjects (5,757 Han, 4,767 Uygur and 4,094 Kazakh Chinese) completed the survey, yielding a response rate of 88.8%. We used a multistage stratified sampling method to select the study sample from 6 different administrative regions including Urumqi, Yili, Hetian, Kelamayi, Fukang, and Turpan. Finally, each participant was selected randomly from each household in the sites mentioned above.

Data collection

The formal survey was made up of two parts: face-to-face interview and physical examination. Before the formal survey, we conducted a pre-survey to explore the feasibility of the questionnaire. During the investigation, each completed questionnaire was examined by two investigators to ensure validity and consistency. After the fieldwork, data were manipulated by parallel double entry, and we also performed three verifications to check for incomplete and inconsistent responses. The questionnaire provided demographics, general personal information and medical histories [12]. Height and weight were measured using a standard protocol. Height was measured to the nearest 0.1 cm, and weight was measured with a standard scale in the upright position to the nearest 0.1 kg.

Smoking and drinking conditions were self-reported.

Blood samples collection was conducted in examination centers at local hospital in the participants' residential area. At the time of the in-person interview, a 5 mL of venous blood was collected into EDTA tubes and processed to obtain plasma within 4h. All samples were stored at -80℃ immediately after processing. We measured the concentration of fasting glucose using equipment for chemical analysis (Dimension AR/AVL Clinical Chemistry System, Newark, NJ, USA) employed by the Clinical Laboratory Department of the First Affiliated Hospital of Xinjiang Medical University. Biochemical markers in plasma including total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C) were measured.

Definition of variables

Overweight and obesity were defined by Chinese standards mentioned above. Obesity was defined as BMI≥28 kg/m^2, and overweight was defined as a BMI of 25-29.9 kg/m^2.

Education was classified into four levels: Primary school and below (including never attended school and elementary schooling only); Junior middle school; Senior middle school (including secondary vocational schooling); undergraduate and above (including post-secondary vocational schooling, Master and doctor). Manual labor included farmers, production and service workers. White collar occupations included office and other technical employment. Other occupations included unemployed, retiree, student and full-time housewife [13]. Smoking status classifications were current smokers (which had smoked at least one cigarette a day over the past 30 days), and never-smokers. Drinking status classifications were current drinkers (which had consumed more than one alcoholic drink a week), and never-drinkers. Hypertension was defined as mean systolic BP≥140 mmHg, and/or mean diastolic BP≥90 mmHg, and/or current use of antihypertensive medications [14]. Diabetes was defined as fasting plasma glucose≥126 mg/dL (≥7.0mmol/L) and/or self- reported history of diabetes and/or current use of insulin or antidiabetic medications [15]. Hypercholesterolemia was defined as serum total cholesterol level>6.22 mmol/L (240 mg/dL), and hypertriglyceridemia was defined as serum triglyceride level>2.26 mmol/L (200 mg/dL). A serum LDL-C level of>4.14 mmol/L (160 mg/dL) was defined as high LDL-C, and a serum HDL-C level of<1.04 mmol/L (40 mg/dL) was defined as low HDL-C. In total, dyslipidemia was defined as the existence of at least one of the four abnormal lipid concentrations mentioned above, or self-reported

use of lipid-lowing drugs [16].

Statistical analysis

Data was verified and corrected using EpiData3.02 software (EpiData, Association, Odense, Denmark) by 2 staff members. Frequency distribution was used to present characteristics of the subjects, and data presented as percentages were used to report the prevalence ratio. Continuous variables were expressed as mean ± standard deviation (SD) and or numerical data were expressed as rates, and a Chi-square test ($\chi 2$) was used to compare the prevalence of overweight and obesity in different groups.

To analyze the factors for obesity and adjust for potential confounding effects, a multivariate logistic regression analyses were carried out to explore independent factors associated with overweight and obesity. OR with 95% CI was used for the risk analysis. All statistical analyses were conducted using the complex sampling function of Social Sciences SPSS for Windows version 22.0 (SPSS, Inc, Chicago, IL, USA), and a $p<0.05$ level of significance was selected.

Patient and public involvement

This population-based cross-sectional survey is part of the Project on Present Situation and the Cardiovascular Risk Survey (CRS) study in Xinjiang Province of China in 2010. The study was designed to investigate the prevalence of overweight and obesity among adult residents in Xinjiang, the northwest China. However, no patients or members of the public were included in the design, recruitment or conduct of the study. The results of measurements would be disseminated to participants after the study which was completed by the study team. The burden of the intervention will not be assessed by patients themselves.

Results

In this survey, we interviewed 14618 residents aged 35 to 101 years (mean age: 50.82±12.62 years), comprised of 6,819 (46.6%) men and 7,799 (53.4%) women. Among these participants, 5,757 (39.4%) were Han ethnicities with a mean age of 52.47±12.71 years, 4,767 (32.6%) were Uygur ethnicities with a mean age of 50.70±12.98 years, and 4,094 (28.0%) were Kazakh ethnicities with a mean age of 48.63±11.69 years. According to the BMI classification for Chinese people, the overall prevalence of overweight was 36.52% (male 40.1%; female 33.4%), and the prevalence of obesity was 26.47% (male 27.2%; female 25.8%) in Xinjiang Province **(Table 1)**. There were differences in age, area, race, occupation, education, marriage, drinking, hypertension history and

plasma levels of TG, TC among the overweight and obesity groups, while there was no significant difference in sex, smoking, diabetes history and the level of LDL-c and HDL-C among the 2 groups.

From the age-stratified and gender-stratified results in **Table 2**, for men, the prevalence of both overweight and obesity all peaked at 45-54 years, while no significant trend was illustrated in the prevalence of overweight increased with age. For women, the prevalence of overweight and obesity increased with age, peaking at 55-64 years, though there has a slight decrease at ≥65 years. In addition, a higher proportion of enrolled males were overweight than females. Interestingly, the proportions of females who were obese were higher than those of males.

From the age-stratified and race-stratified results in **Table 3**, as a whole, obesity prevalence in the different ethnicities was found to be the highest in Kazakh and the lowest in Han participants, and there was a statistical significance among the three ethnic groups ($p<0.001$). Further, overweight prevalence also showed an interesting significant difference among the three ethnicities, the highest in Han and the lowest in Kazakh participants.

We divided the participants into two groups: normal weight; overweight and obese. **Table 1** has showed that the following factors all had a significant effect: age, area, race, education, marriage status, occupation, drinking, hypertension and dyslipidemia ($p<0.05$). We applied multivariate unconditional logistic regression analysis model on all identified risk factors and attempted to identify any existing difference in these risk factors which may explain the difference in overweight and obesity prevalence. **Table 4** shows the results of logistic regression models comparing the prevalence of the potential risk factors: sex, age, area, marriage status, occupation, smoking, drinking, hypertension, diabetes and the level of dyslipidemia, including hypercholesterolemia, hypertriglyceridemia and low HDL-C. The multivariate logistic regression results reveal that female adults are more likely to become overweight and obese than male adults (OR 0.77, 95% CI 0.71 to 0.84). We categorized age into four groups, which clearly showed that increasing age is a risk factor for overweight/obesity, especially age 45-54 years (OR 1.46, 95% CI 1.33 to 1.61). Among the three races, Kazak population (OR 1.66, 95% CI 1.49 to 1.84) and Uygur population (OR 1.44, 95% CI 1.30 to 1.59) are the risky people to become overweight and obese comparing with Han population. Participants who have married (OR 1.83, 95% CI 1.36 to 2.47) or widowed (OR 1.81, 95% CI 1.30 to 2.51) are more likely to be overweight/obese than those who have unmarried. In addition, smokers (OR 0.86, 95% CI 0.78 to 0.95) are less likely to become overweight and obese than nonsmokers.

Participants who drink are more likely to become overweight or obese than those who never or rarely drink (OR 1.45, 95% CI 1.28 to 1.64). Overweight and obesity are more common among those who had hypertension (OR 2.14, 95% CI 1.97 to 2.32) and diabetes (OR 1.32, 95% CI 1.12 to 1.57) compared with those who had no hypertension and diabetes hisrory. In the overweight and obese population, hypertriglyceridemia (OR 2.43, 95% CI 2.22 to 2.66), hypercholesterolemia (OR 1.23, 95% CI 1.13 to 1.34) and low HDL-C (OR 1.11, 95% CI 1.02 to 1.20) remained as risk factors.

Discussion

The epidemic of obesity is one of the most important health problems worldwide and is estimated to be the second leading cause of preventable death in developed countries, behind cigarette smoking [3, 17]. The prevalence of overweight and obesity continues to increase around the world, as have associated comorbidities and healthcare costs [18]. In the US, the prevalence of obesity accounts for one-third of the general population, and another one-third is overweight [19]. Data from the China Chronic Disease Survey conducted by the Chinese Center for Disease Control and Prevention demonstrated that the prevalence of overweight among Chinese adults (age 18–64 years) for 2007 and 2010 was 26.6% and 30.6%, respectively (male 27.4% and 32.1%; female 25.7% and 29.1%), and the prevalence of obesity was 7.7% and 12.1%, respectively (male 6.7% and 12.5%; female 8.7% and 11.1%). No doubt, we found that the prevalence of both overweight and obesity was high. Our cross-sectional study indicates that the prevalence of overweight and obesity among adults in northwest China was 36.52% (male 40.1%; female 33.4%), and 26.47% (male 27.2%; female 25.8%). This implies that overweight and obesity have a higher prevalence in both sexes and are more common in northwest China than in other areas, although effective actions might have been taken to control the upward trend [20].

In this study, we found that the prevalence of both overweight and obesity is high in middle age (45-64 years). Chinese people are more likely to have positive perceptions of obesity because it is considered good fortune to become fat during middle age in traditional Chinese culture [21]. Through the present study, we found a very high prevalence of overweight and obesity in three ethnicities in Xinjiang, and there is no doubt that the result is similar to the previous study in Xinjiang [10]. In addition, the prevalence rate of obesity was significantly different among Han, Uygur and Kazak groups and the prevalence in Kazak group was significantly higher compared with Han and Uygur. Overall, our findings indicate that 16.28% of Han, 11.18% of Uygur, and 9.05%

of Kazak people more than 35 years of age in Xinjiang have overweight, as with 7.40% of Han, 9.31% of Uygur, and 9.76% of Kazak people have obesity. Xinjiang is a multi-ethnic co-populated area in China. The national census showed that lives 47 ethnicities in Xinjiang, and 13 of them are confirmed to be native ethnicities, such as the Uygur and Kazak. The explanations for this increase of prevalence as follows: firstly, Kazak live in the grassland and forests, whose dietary habits were characterized by eating more animal and consuming fewer fresh vegetables; Secondly, Kazak is a nomadic ethnic who usually lives in hypoxia area and high altitude where the climate is cold and dry; Thirdly, different genetic backgrounds may also an important factor underlying the different prevalence of obesity [22].

Multivariate logistic regression analysis suggested that several factors are associated with the prevalence of overweight and obesity. A previous review revealed that various marital transitions are related with changes in body weight: transition into marriage appears to be associated with weight gain, whereas transition out of marriage is associated with weight loss [23]. Our study found a similar result that, transition into marriage including married, divorce and widowed are risk factors for becoming overweight and obese. Plausible explanations are behaviors and lifestyle which differ among married individuals, however, the exact mechanism is not clear to illustrate this apparent association with marriage status. In our study, it is also found that different educational levels, occupations and area of residence are closely related to body weight. We have observed that low education level is a risk factor because of insufficient level of cognition. Urban population, especially unemployed, retiree, student and full-time housewife, are more risky among overweight and obese, which contribute to urban working conditions, for example sitting in the office, fast-paced life and supermarket or fast food restaurant availability [24].

The 2015 Global Burden of Disease Study, representing 195 countries and territories, estimated that 25% of men and 5.4% of women worldwide smoked daily, which is the leading preventable cause of death worldwide [25]. In this study, we found a lower prevalence of overweight and obesity in smokers than non-smokers, which is consistent with studies conducted in Switzerland, India and Jilin, China [26-28]. In addition, reasonable explanations to illustrated the issue according to two different criteria. In terms of tobacco use, using tobacco is connected with multiple system functions, especially cardiovascular and digestive systems [29]. In terms of the organism itself, smoking has been considered as methods of pressure and energy relief. Affected by the traditional culture of

drinking alcohol, especially in northwest China, it is generally believed that, the more you drink, the more weight you get. Wang et al [28] showed the consisted results.

To the best of our knowledge, obesity is an independent risk factor both of CVD and death [30-32]. We explore that the prevalence of overweight and obesity are higher if subjects are with hypertension or diabetes or dyslipidemia. The results provide a compelling reason why the occurrence of obesity is combined with cardiovascular risk factors such as hypertension, diabetes or dyslipidemia. Previous studies reported that the benefits of weight loss are well established, with a 5–10% reduction in weight associated with improvement in health and quality of life, and a 3% reduction being positive for health improvement where it is maintained [33].

These departments should heed the high prevalence of overweight and obesity in Xinjiang Province and provide effective guidelines to help to reverse the trend. The main strengths of our study are its large sample size and precise physical measurements, which increase the validity of our results. However, the present study has several limitations. First, self-reported data and the nature of cross-sectional data may lead to recall and reporting biases, which may be the reason for the insignificant difference in the effect of obesity on reasons. Moreover, other indicators of adiposity, such as body fat percentage and waist circumference which plenty of studies reported to reflect the prevalence of overweight and obesity and body fat distribution, were not obtained in our study [34, 35].

Conclusions

In conclusion, the present study indicates that the prevalence of overweight and obesity among adult residents in Xinjiang, the northwest China, is very high during the past years. Furthermore, the main influencing factors for overweight and obesity are sex, age, race, marriage status, education level, occupation, smoking, drinking, hypertension, diabetes and dyslipidemia. These data suggest that efforts toward prevention and control of overweight and obesity should be a public health priority in the northwest of China, which will be submitted to relevant departments as a reference to reverse the trends.

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Conflicts of Interest: The authors declare no conflict of interest.

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Table 1 Prevalence of overweight and obesity according to demographic characteristics

Characteristic	N	Overweight			Obesity		
		n（%）	χ2	*P*	n（%）	χ2	*P*
Sex							
Male	6819	2735(40.1)	71.13	<0.001	1856（27.2）	3.70	0.054
Female	7799	2603(33.4)			2013(25.8)		
Age(years)							
35-44	5425	1866(34.4)	20.27	<0.001	1146(21.1)	149.82	<0.001
45-54	3759	1441(38.3)			1153(30.7)		
55-64	2932	1067(36.4)			919(31.3)		
≥65	2502	964(38.5)			651(26.0)		
Area							
Urban	7974	3163(39.7)	75.08	<0.001	1956(24.5)	33.85	<0.001
Rural	6644	2175(32.7)			1913(28.8)		
Ethnicity							
Han	5757	2380(16.28)	99.09	<0.001	1082(7.40)	331.94	<0.001
Uyghur	4767	1635(11.18)			1361(9.31)		
Kazak	4094	1323(9.05)			1426(9.76)		
Occupation							
Manual	4583	1760(12.04)	12.11	0.002	1095(7.49)	32.08	<0.001
White collar	7751	2736(18.72)			2086(14.27)		
Other	2284	842(5.76)			688(4.71)		
Education							

Primary school and below	5805	1993(13.63)	26.85	<0.001	1589(10.87)	21.17	<0.001
Junior middle school	3094	1196(8.18)			844(5.77)		
Senior middle school	4556	1676(11.46)			1191(8.15)		
Undergraduate and above	1163	473(3.24)			245(1.68)		
Marriage							
Unmarried	192	59(0.40)	14.11	<0.001	27(0.18)	23.05	<0.001
Married	12988	4795(32.80)			3427(23.44)		
divorced	201	53(0.36)			47(0.32)		
widowed	1237	431(2.95)			368(2.52)		
Drinking							
Yes	4169	923(6.31)	44.48	<0.001	663(4.54)	24.58	<0.001
No	10449	4415(30.20)			3206(21.93)		
Smoking							
Yes	2151	1688(11.55)	39.71	<0.001	1101(7.53)	0.01	0.92
No	12467	3650(24.97)			2768(18.94)		
Hypertension							
Yes	5701	2138(14.63)	3.92	0.048	2155(14.74)	616.77	<0.001
No	8917	3200(21.89)			1714(11.73)		
Diabetes							
Yes	859	335(2.29)	2.43	0.119	317(2.17)	51.02	<0.001
No	13759	5003(34.22)			3552(24.30)		
Dyslipidemia							
hypertriglyceridemia							
Yes	4113	1724(11.79)	71.97	<0.001	1497(10.24)	289.94	<0.001
No	10505	3614(24.72)			2372(16.23)		
hypercholesterolemia							
Yes	3787	1469(10.05)	11.40	0.001	1267(8.67)	128.29	<0.001

No	10831	3869(26.47)			2602(17.80)		
High LDL-C							
Yes	5251	1921(13.14)	0.016	0.90	1334(9.13)	4.76	0.029
No	9367	3417(23.38)			2535(17.34)		
Low HDL-C							
Yes	4437	1704(11.66)	9.79	0.002	1215(8.31)	2.75	0.097
No	10831	3634(24.86)			2654(18.16)		

Categorical variables are presented as counts and percentages. HDL-c, high density lipoprotein-cholesterol; LDL-c, low density lipoprotein-cholesterol.

Table 2 Prevalence of overweight and obesity in men and women according to age group

Age	Overweight		*P*	Obesity		*P*
(years)	Male(%)	female(%)		male(%)	female(%)	
35-44	994(40.2)	872(29.5)	<0.001	631(25.5)	515(17.4)	<0.001
45-54	735(43.1)	706(34.4)		517(30.3)	636(31.0)	
55-64	476(35.8)	591(36.8)		389(29.3)	531(33.0)	
≥65	530(40.3)	434(36.5)		319(24.3)	332(27.9)	

Table 3 Prevalence of overweight and obesity in Han, Uyghur and Kazak according to age group

Age	Overweight			*P*	Obesity			*P*
(years)	Han(%)	Uyghur(%)	Kazak(%)		Han(%)	Uyghur(%)	Kazak(%)	
35-44	712(35.0)	573(34.6)	581(33.6)	<0.001	273(13.4)	422(25.5)	451(26.1)	<0.001
45-54	599(43.9)	481(38.1)	361(31.9)		246(18.0)	436(34.5)	471(41.6)	
55-64	497(45.9)	354(32.6)	216(28.3)		268(24.7)	318(29.3)	333(43.6)	
≥65	572(45.0)	227(29.9)	165(35.1)		295(23.2)	185(24.3)	171(36.4)	

Table 4 Multivariate regression analysis of correlates of overweight and obesity in residents of Xinjiang Province

Characteristic	**B**	**S.E.**	**Wald**	**df**	**P**	**OR**	**95%CI**

Area	-0.14	0.04	10.42	1	0.001	0.87	0.80-0.95
Sex	-0.26	0.05	32.52	1	<0.001	0.77	0.71-0.84
Ethnic			94.43	2	<0.001		
Han	-	-	-	-	-	1	-
Uygur	0.36	0.05	49.95	1	<0.001	1.44	1.30-1.59
Kazakh	0.50	0.05	86.21	1	<0.001	1.66	1.49-1.84
Age(years)			71.20	3	<0.001		
35-44	-	-	-	-	-	1	-
45-54	0.38	0.05	62.79	1	<0.001	1.46	1.33-1.61
55-64	0.27	0.05	24.63	1	<0.001	1.31	1.18-1.46
≥65	0.11	0.06	3.05	1	0.081	1.11	0.99-1.26
Education			17.87	3	<0.001		
Primary school and below	-	-	-	-	-	1	-
Junior middle school	0.20	0.05	15.61	1	<0.001	1.22	1.11-1.35
Senior middle school	0.15	0.06	7.02	1	0.008	1.16	1.04-1.29
Undergraduate and above	0.22	0.08	6.84	1	0.009	1.25	1.06-1.47
Occupation			10.36	2	0.006		
Manual	-	-	-	-	-	1	-
White collar	0.01	0.05	0.04	1	0.833	1.01	0.91-1.12
Other	0.18	0.06	7.90	1	0.005	1.20	1.06-1.36
Marriage			26.50	3	<0.001		
Unmarried	-	-	-	-	-	1	-
Married	0.60	0.15	15.54	1	<0.001	1.83	1.36-2.47
Divorced	0.10	0.21	0.20	1	0.656	1.10	0.72-1.67
widowed	0.59	0.17	12.44	1	<0.001	1.81	1.30-2.51
Smoking	-0.15	0.05	8.95	1	0.003	0.86	0.78-0.95
Drinking	0.37	0.06	34.83	1	<0.001	1.45	1.28-1.64
Hypertension	0.76	0.04	340.43	1	<0.001	2.14	1.97-2.32
Diabetes	0.28	0.09	10.41	1	0.001	1.32	1.12-1.57

Dyslipidemia							
hypertriglyceridemia	0.89	0.05	371.44	1	<0.001	2.43	2.22-2.66
hypercholesterolemia	0.21	0.05	20.94	1	<0.001	1.23	1.13-1.34
Low HDL-C	0.10	0.04	6.44	1	0.011	1.11	1.02-1.20
High LDL-C	0.015	0.038	0.156	1	0.693	1.015	0.94-1.09
Constant	-1.01	0.17	35.28	1	<0.001	-	-

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Prevalence of overweight and obesity and associated risk factors among adult residents of northwest China: A cross- sectional study

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Abstract

Objective: Overweight and obesity have been shown to be related to multiple chronic conditions and lead to a heavy economic burden on society throughout the world. This study aims to estimate the prevalence of overweight and obesity and determine potential influencing factors among adults in Xinjiang, northwest China.

Design: A community-based observational study.

Setting: The First Affiliated Hospital of Xinjiang Medical University.

Methods: In total, 14,618 adult participants (7,799 males; 6,819 females), aged over 35 years old, were recruited from the Cardiovascular Risk Survey conducted in 2010. Data were obtained from face-to-face interview and physical examination. The sample was used to estimate the prevalence of overweight (body mass index (BMI) [24-28) kg/m^2) and obesity (BMI≥28 kg/m^2) in Xinjiang Province, and the influencing factors were analyzed based on statistical methods.

Results: The overall prevalence of overweight was 36.5% (male 40.1%; female 33.4%), and the prevalence of obesity was 26.5% (male 27.2%; female 25.8%) in Xinjiang Province. The prevalence of both overweight and obesity were higher in women than men (P<0.001). The main influencing factors for overweight and obesity are sex, age, race, marriage status, education level, occupation, smoking, drinking, hypertension, diabetes and dyslipidemia (P<0.05).

Conclusions: This study estimated that the prevalence of overweight and obesity among adult residents of Xinjiang Province, northwest China, was high. These data suggest that efforts toward prevention and control of overweight and obesity should be a public health priority in the northwest of China.

Keywords: cross-sectional survey, overweight, obesity, risk factors

Strengths and limitations of this study

- The survey sample was demographically representative of Uygur adults with obesity aged 35–80 years in Xinjiang.
- The main strengths of our study are its large sample size and precise physical measurements,

which increase the validity of our results.

- Due to the cross-sectional nature and self-designed questionnaire, indicators and experience could have been affected by bias.
- Moreover, other indicators of adiposity, such as body fat percentage and waist circumference were not obtained in our study.
- The results were from Xinjiang only and therefore cannot be generalised to the whole China.

Introduction

Obesity is a complex chronic global disease affecting people worldwide across all ages, sexes, ethnicities, and nationalities, which is the fifth leading cause of mortality globally [1 2]. According to the World Health Organization (WHO), the prevalence of worldwide obesity has doubled in more than 70 countries since 1980 [3]; this trend has continuously increased in most other countries. In 2013, in order to make physicians pay more attention to the condition, the American Medical Association classified obesity as a disease [4].

Body mass index (BMI), which is calculated as weight/height squared (kg/m^2), is a common and accepted measure that is used to report obesity rates. While BMI is not a true measure of adiposity, it is simple to use in health screenings and epidemiological surveys [5]. According to the WHO, obesity is defined as a BMI≥30 kg/m^2, and overweight as a BMI of [25-30) kg/m^2 [6]. For Chinese people, a BMI≥28 kg/m2 suggests obesity and a BMI of [24-28) kg/m2 indicates overweight [7].

China is the largest developing country and has the largest population in the world. With the rapid economic growth and changes in lifestyle such as dietary habits and physical activity [8], the epidemiological data indicated that individuals with overweight and obesity had a higher prevalence of traditional diseases including dyslipidemia, hypertension, cardiovascular disease, insulin resistance or diabetes, fatty liver disease, and psychosocial complications and some cancers [5 9]. Located in the northwest China, Xinjiang not only is an autonomous minority ethnic region of the People's Republic of China, but also is one of the developing regions in China. It is the largest Chinese administrative division and spans over 1.66 million km^2 which takes up about one sixth of the country's territory. A few of studies had reported the prevalence of overweight among adults in

Xinjiang [10]. Nevertheless, the samples in above mentioned studies were small, those results cannot represent accurately the status of overweight and obesity in the whole region of Xinjiang.

In the present study, we estimated the prevalence of overweight and obesity in Xinjiang. Meanwhile, the potential influencing factors in adult residents of northwest China were explored. The results of this study will be considered as a reference for policy makers in making informed decisions.

Materials and Methods

Ethics approval

This study was conducted according to the standards of the Declaration of Helsinki. Written informed consent was acquired from each participant prior to enrollment. Ethics approval was from the Ethics Committee of the First Affiliated Hospital of Xinjiang Medical University (the approval ID: 20100116-01).

Study design and population

This population-based cross-sectional survey is part of the Project on Present Situation and the Cardiovascular Risk Survey (CRS) study in Xinjiang Province of China in 2010.The CRS was a prospective, multiple ethnicity and community-based observational study designed to investigate the prevalence and risk factors for cardiovascular disease (CVD) in the Han, Uygur and Kazakh populations in Xinjiang Province [11]. All the subjects included had lived in Xinjiang Province for more than 1 year. Briefly, the CRS consisted of 16,460 adults aged≥35 years old, of whom 14,618 subjects (5,757 Han, 4,767 Uygur and 4,094 Kazakh Chinese) completed the survey, yielding a response rate of 88.8%. We used a multistage stratified sampling method to select the study sample from 6 different administrative regions including Urumqi, Yili, Hetian, Kelamayi, Fukang, and Turpan. Finally, each participant was selected randomly from each household in the sites mentioned above.

Data collection

The formal survey was made up of two parts: face-to-face interview and physical examination. Before the formal survey, we conducted a pre-survey to explore the feasibility of the questionnaire. During the investigation, each completed questionnaire was examined by two investigators to ensure validity and consistency. After the fieldwork, data were manipulated by parallel double entry, and

we also performed three verifications to check for incomplete and inconsistent responses. The questionnaire provided demographics, general personal information and medical histories [12]. Height and weight were measured using a standard protocol. Height was measured to the nearest 0.1 cm, and weight was measured with a standard scale in the upright position to the nearest 0.1 kg. Smoking and drinking conditions were self-reported.

Blood samples collection was conducted in examination centers at local hospital in the participants' residential area. At the time of the in-person interview, a 5mL of venous blood was collected into EDTA tubes and processed to obtain plasma within 4h. All samples were stored at -80℃ immediately after processing. We measured the concentration of fasting glucose using equipment for chemical analysis (Dimension AR/AVL Clinical Chemistry System, Newark, NJ, USA) employed by the Clinical Laboratory Department of the First Affiliated Hospital of Xinjiang Medical University. Biochemical markers in plasma including total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C) were measured.

Definition of variables

Overweight and obesity were defined by Chinese standards mentioned above. Obesity was defined as BMI≥28 kg/m^2, and overweight was defined as a BMI of [24-28) kg/m^2.

Education was classified into four levels: Primary school and below (including never attended school and elementary schooling only); Junior middle school; Senior middle school (including secondary vocational schooling); undergraduate and above (including post-secondary vocational schooling, master's degree and doctoral degree). Manual labor included farmers, production and service workers. White collar occupations included office and other technical employment. Other occupations included unemployed, retiree, student and full-time housewife [13]. Smoking status classifications were current smokers (which had smoked at least one cigarette a day over the past 30 days), and never-smokers. Drinking status classifications were current drinkers (which had consumed more than one alcoholic drink a week), and never-drinkers. Hypertension was defined as mean systolic BP≥140mmHg, and/or mean diastolic BP≥90mmHg, and/or current use of antihypertensive medications [14]. Diabetes was defined as fasting plasma glucose≥126mg/dL (≥7.0 mmol/L) and/or self- reported history of diabetes and/or current use of insulin or antidiabetic

medications [15]. Hypercholesterolemia was defined as serum total cholesterol level>6.22 mmol/L (240 mg/dL), and hypertriglyceridemia was defined as serum triglyceride level>2.26 mmol/L (200 mg/dL). A serum LDL-C level of >4.14 mmol/L (160 mg/dL) was defined as high LDL-C, and a serum HDL-C level of <1.04 mmol/L (40 mg/dL) was defined as low HDL-C. In total, dyslipidemia was defined as the existence of at least one of the four abnormal lipid concentrations mentioned above, or self-reported use of lipid-lowing drugs [16].

Statistical analysis

Data was verified and corrected using EpiData 3.02 software (EpiData, Association, Odense, Denmark) by 2 staff members. Frequency distribution was used to present characteristics of the subjects, and data presented as percentages were used to report the prevalence ratio. Continuous variables were expressed as mean±standard deviation (SD) and numerical data were expressed as rates, and a Chi-square test ($\chi 2$) was used to compare the prevalence of overweight and obesity in different groups.

To analyze the factors for obesity and adjust for potential confounding effects, a multivariable logistic regression analyses were carried out to explore independent factors associated with overweight and obesity. OR with 95% CI was used for the risk analysis. All statistical analyses were conducted using the complex sampling function of Social Sciences SPSS for Windows version 22.0 (SPSS, Inc, Chicago, IL, USA), and a $P<0.05$ level of significance was selected.

Patient and public involvement

This population-based cross-sectional survey is part of the Project on Present Situation and the Cardiovascular Risk Survey (CRS) study in Xinjiang Province of China in 2010. The study was designed to investigate the prevalence of overweight and obesity among adult residents in Xinjiang, the northwest China. However, no patients or members of the public were included in the design, recruitment or conduct of the study. The results of measurements would be disseminated to participants after the study which was completed by the study team. The burden of the intervention will not be assessed by patients themselves.

Results

In this survey, we interviewed 14618 residents aged 35 to 101 years (mean age: 50.8±12.6 years), comprised of 6,819 (46.6%) men and 7,799 (53.4%) women. Among these participants,

5,757 (39.4%) were Han ethnicities with a mean age of 52.5±12.7 years, 4,767 (32.6%) were Uygur ethnicities with a mean age of 50.7±13.0 years, and 4,094 (28.0%) were Kazakh ethnicities with a mean age of 48.6±11.7 years. According to the BMI classification for Chinese people, the overall prevalence of overweight was 36.5% (male 40.1%; female 33.4%), and the prevalence of obesity was 26.5% (male 27.2%; female 25.8%) in Xinjiang Province **(Table 1)**. There were differences in age, area, race, occupation, education, marriage, drinking, hypertension history and plasma levels of TG, TC among the overweight and obesity groups, while there was no significant difference in sex, smoking, diabetes history and the level of LDL-c and HDL-C among the 2 groups.

From the age-stratified and gender-stratified results in **Table 2**, for men, the prevalence of both overweight and obesity all peaked at 45-54 years, while no significant trend was illustrated in the prevalence of overweight increased with age. For women, the prevalence of overweight and obesity increased with age, peaking at 55-64 years, though there has a slight decrease at ≥65 years. In addition, a higher proportion of enrolled males were overweight than females. Interestingly, the proportions of females who were obese were higher than those of males.

From the age-stratified and race-stratified results in **Table 3**, as a whole, obesity prevalence in the different ethnicities was found to be the highest in Kazakh and the lowest in Han participants, and there was a statistical significance among the three ethnic groups (P<0.001). Further, overweight prevalence also showed an interesting significant difference among the three ethnicities, the highest in Han and the lowest in Kazakh participants.

We divided the participants into two groups: normal weight; overweight and obese. **Table 1** has shown that the following factors all had a significant effect: age, area, race, education, marriage status, occupation, drinking, hypertension and dyslipidemia (P<0.05). We applied multivariable unconditional logistic regression analysis model on all identified risk factors and attempted to identify any existing difference in these risk factors which may explain the difference in overweight and obesity prevalence. **Table 4** shows the results of logistic regression models comparing the prevalence of the potential risk factors: sex, age, area, marriage status, occupation, smoking, drinking, hypertension, diabetes and the level of dyslipidemia, including hypercholesterolemia, hypertriglyceridemia and low HDL-C. The multivariable logistic regression results reveal that female adults prefer to become overweight and obese than male adults (OR 0.8, 95% CI 0.7 to 0.8).

We categorized age into four groups, which clearly showed that increasing age is a risk factor for overweight/obesity, especially age 45-54 years (OR 1.5, 95% CI 1.3 to 1.6). Among the three races, Kazak population (OR 1.7, 95% CI 1.5 to 1.8) and Uygur population (OR 1.4, 95% CI 1.3 to 1.6) carried higher risk to become overweight and obese. Participants who have married (OR 1.8, 95% CI 1.4 to 2.5) or widowed (OR 1.8, 95% CI 1.3 to 2.5) are more likely to be overweight/obese than those who have unmarried. In addition, smokers (OR 0.9, 95% CI 0.8 to 0.9) are less likely to become overweight and obese than nonsmokers. Participants who drink are easier to become overweight or obese than those who never or rarely drink (OR 1.5, 95% CI 1.3 to 1.6). Overweight and obesity are more common among those who had hypertension (OR 2.1, 95% CI 2.0 to 2.3) and diabetes (OR 1.3, 95% CI 1.1 to 1.6) compared with those who had no hypertension and diabetes history. In the overweight and obese population, hypertriglyceridemia (OR 2.4, 95% CI 2.2 to 2.7), hypercholesterolemia (OR 1.2, 95% CI 1.1 to 1.3) and low HDL-C (OR 1.1, 95% CI 1.0 to 1.2) remained as risk factors.

Discussion

The epidemic of obesity is one of the most important health problems worldwide and is estimated to be the second leading cause of preventable death in developed countries, behind cigarette smoking [17 18]. The prevalence of overweight and obesity continues to increase around the world, as have associated comorbidities and healthcare costs [19]. In the US, the prevalence of obesity accounts for one-third of the general population, and another one-third is overweight [20]. Data from the China Chronic Disease Survey conducted by the Chinese Center for Disease Control and Prevention demonstrated that the prevalence of overweight among Chinese adults (age 18–64 years) for 2007 and 2010 was 26.6% and 30.6%, respectively (male 27.4% and 32.1%; female 25.7% and 29.1%), and the prevalence of obesity was 7.7% and 12.1%, respectively (male 6.7% and 12.5%; female 8.7% and 11.1%) [21]. No doubt, we found that the prevalence of both overweight and obesity was high. Our cross-sectional study indicates that the prevalence of overweight and obesity among adults in northwest China was 36.5% (male 40.1%; female 33.4%), and 26.5% (male 27.2%; female 25.8%). In the Russian population [22], the overweight was 64.6% (male 42.3%; female 28.7%), and approximately a third of the participants (30.3%) had obesity (male 27.5%; female 31.4%). Contrary to what was observed in our research, the prevalence of overweight was higher than obesity. This

implies that overweight and obesity have a higher prevalence in both sexes and are more common in northwest China and Russian than in other areas, although effective actions might have been taken to control the upward trend [23].

In this study, we found that the prevalence of both overweight and obesity is high in middle age (45-64 years). Similarly, age gradients in the prevalence of obesity are found in Russia [22]. It is worth noting that more than half of all women aged 55–64 years have obesity, and nearly 80% men in the groups aged 45–54 years had overweight and obesity, which consists with our age gradients. Chinese people are more likely to have positive perceptions of obesity because it is considered good fortune to become fat during middle age in traditional Chinese culture [24]. Moreover, a large segment of the middle-aged and older adult population will be living with overweight and obesity, which is associated with additional health impairments [25].

Through the present study, we found a very high prevalence of overweight and obesity in three ethnicities in Xinjiang, and there is no doubt that the result is similar to the previous study in Xinjiang [10]. In addition, the prevalence rate of obesity was significantly different among Han, Uygur and Kazak groups and the prevalence in Kazak group was significantly higher compared with Han and Uygur. Overall, our findings indicate that 16.3% of Han, 11.2% of Uygur, and 9.1% of Kazak people more than 35 years of age in Xinjiang have overweight, as with 7.4% of Han, 9.3% of Uygur, and 9.8% of Kazak people have obesity. Xinjiang is a multi-ethnic co-populated area in China. The national census showed that there are 47 ethnicities in Xinjiang, and 13 of them are confirmed to be native ethnicities, such as the Uygur and Kazak. The explanations for this increase of prevalence as follows: firstly, Kazak live in the grassland and forests, whose dietary habits were characterized by eating more animal and consuming fewer fresh vegetables; Secondly, Kazak is a nomadic ethnic who usually lives in hypoxia area and high altitude where the climate is cold and dry; Thirdly, different genetic backgrounds may also be an important factor underlying the different prevalence of obesity [26].

Multivariable logistic regression analysis suggested that several factors are associated with the prevalence of overweight and obesity. A previous review revealed that various marital transitions are related with changes in body weight: transition into marriage appears to be associated with weight gain, whereas transition out of marriage is associated with weight loss [27]. Our study found a

similar result that, transition into marriage including married, divorce and widowed are risk factors for becoming overweight and obese. Plausible explanations are behaviors and lifestyle which differ among married individuals, however, the exact mechanism is not clear to illustrate this apparent association with marriage status. In our study, it is also found that different educational levels, occupations and area of residence are closely related to body weight. We have observed that low education level is a risk factor because of insufficient level of cognition. Urban population, especially unemployed, retiree, student and full-time housewife, are easier to become overweight and obese, which contribute to urban working conditions, for example sitting in the office, fast-paced life and supermarket or fast food restaurant availability [28].

The 2015 Global Burden of Disease Study, representing 195 countries and territories, estimated that 25.0% of men and 5.4% of women worldwide smoked daily, which is the leading preventable cause of death worldwide [29]. In this study, we found a lower prevalence of overweight and obesity in smokers than non-smokers, which is consistent with studies conducted in Switzerland, India and Jilin, China [21 30 31]. In addition, reasonable explanations to illustrated the issue according to two different criteria. In terms of tobacco use, using tobacco is connected with multiple system functions, especially cardiovascular and digestive systems [32]. In terms of the organism itself, smoking has been considered as methods of pressure and energy relief. Affected by the traditional culture of drinking alcohol, especially in northwest China, it is generally believed that, the more you drink, the more weight you get. Wang et al [21] showed the consisted results.

To the best of our knowledge, obesity is an independent risk factor both of CVD and death [33-35]. We explore that the prevalence of overweight and obesity are higher if subjects are with hypertension or diabetes or dyslipidemia. The results provide a compelling reason why the occurrence of obesity is combined with cardiovascular risk factors such as hypertension, diabetes or dyslipidemia. Previous studies reported that the benefits of weight loss are well established, with a 5–10% reduction in weight associated with improvement in health and quality of life, and a 3% reduction being positive for health improvement where it is maintained [36].

These departments should heed the high prevalence of overweight and obesity in Xinjiang Province and provide effective guidelines to help to reverse the trend. The main strengths of our study are its large sample size and precise physical measurements, which increase the validity of

our results. However, the present study has several limitations. First, the main limitation is the cross-sectional design which prohibits inferring a causal link between overweight and obesity and risk factors. As in cross-sectional studies data on exposure and outcome are gathered simultaneously in a specific time point, prospective studies are necessary to confirm our findings. In addition, self-reported data and the nature of cross-sectional data may lead to recall and reporting biases, which may be the reason for the insignificant difference in the effect of obesity on reasons. Finally, other indicators of adiposity, such as body fat percentage and waist circumference which plenty of studies reported to reflect the prevalence of overweight and obesity and body fat distribution, were not obtained in our study [37 38].

Conclusions

In conclusion, the present study indicates that the prevalence of overweight and obesity among adult residents in Xinjiang, the northwest China, is very high during the past years. Furthermore, the main influencing factors for overweight and obesity are sex, age, race, marriage status, education level, occupation, smoking, drinking, hypertension, diabetes and dyslipidemia. These data suggest that efforts toward prevention and control of overweight and obesity should be a public health priority in the northwest of China, which will be submitted to relevant departments as a reference to reverse the trends.

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Contributors: Conceived and designed the experiments: Yi-Ning Yang, Xiao-Mei Li. Performed the experiments: Ning Song, Fen Liu. Analyzed the data: Min Han, Qiang Zhao, Qian Zhao. Contributed reagents/materials/analysis tools: Xiang-Mei Li, Guo-Li Du, Hui Zhai. Quality control the study and revision: Yi-Ning Yang, Xiao-Mei Li. Wrote the paper: Ning Song. All authors read and approved the final manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

Ethics approval: This study was carried out in accordance with the Declaration of Helsinki and the study protocol was approved by the Ethics Committee of the First Affiliated Hospital of Xinjiang Medical University (Xinjiang, China) (approval ID:20100116-01).

Data sharing statement: All data relevant to the study are included in the article. No additional data are available.

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Table 1 Prevalence of overweight and obesity according to demographic characteristics

Characteristic	N	Overweight			Obesity		
		n (%)	χ2	*P*	n (%)	χ2	*P*
Sex							
Male	6819	2735(40.1)	71.1	<0.001*	1856 (27.2)	3.7	0.05
Female	7799	2603(33.4)			2013(25.8)		
Age(years)							
35-44	5425	1866(34.4)	20.3	<0.001*	1146(21.1)	149.8	<0.001*
45-54	3759	1441(38.3)			1153(30.7)		
55-64	2932	1067(36.4)			919(31.3)		
≥65	2502	964(38.5)			651(26.0)		
Area							
Urban	7974	3163(39.7)	75.1	<0.001*	1956(24.5)	33.9	<0.001*
Rural	6644	2175(32.7)			1913(28.8)		
Ethnicity							
Han	5757	2380(16.3)	99.1	<0.001*	1082(7.4)	331.9	<0.001*
Uyghur	4767	1635(11.2)			1361(9.3)		
Kazak	4094	1323(9.1)			1426(9.8)		
Occupation							
Manual	4583	1760(12.0)	12.1	0.002*	1095(7.5)	32.1	<0.001*
White collar	7751	2736(18.7)			2086(14.3)		
Other	2284	842(5.8)			688(4.7)		
Education							

Primary school and below	5805	1993(13.6)	26.9	<0.001*	1589(10.87)	21.2	<0.001*
Junior middle school	3094	1196(8.2)			844(5.8)		
Senior middle school	4556	1676(11.5)			1191(8.2)		
Undergraduate and above	1163	473(3.2)			245(1.7)		
Marriage							
Unmarried	192	59(0.4)	14.1	<0.001*	27(0.2)	23.1	<0.001*
Married	12988	4795(32.8)			3427(23.4)		
divorced	201	53(0.4)			47(0.2)		
widowed	1237	431(3.0)			368(2.5)		
Drinking							
Yes	4169	923(6.3)	44.5	<0.001*	663(4.5)	24.6	<0.001*
No	10449	4415(30.2)			3206(21.9)		
Smoking							
Yes	2151	1688(11.6)	39.7	<0.001*	1101(7.5)	0.01	0.92
No	12467	3650(25.0)			2768(18.9)		
Hypertension							
Yes	5701	2138(14.6)	3.9	0.05	2155(14.7)	616.8	<0.001*
No	8917	3200(21.9)			1714(11.7)		
Diabetes							
Yes	859	335(2.3)	2.4	0.1	317(2.2)	51.0	<0.001*
No	13759	5003(34.2)			3552(24.3)		
Dyslipidemia							
hypertriglyceridemia							
Yes	4113	1724(11.8)	72.0	<0.001*	1497(10.2)	289.9	<0.001*
No	10505	3614(24.7)			2372(16.2)		
hypercholesterolemia							
Yes	3787	1469(10.1)	11.4	0.001*	1267(8.7)	128.3	<0.001*

No	10831	3869(26.5)			2602(17.8)		
High LDL-C							
Yes	5251	1921(13.1)	0.02	0.9	1334(9.1)	4.8	0.03*
No	9367	3417(23.4)			2535(17.3)		
Low HDL-C							
Yes	4437	1704(11.7)	9.8	0.002*	1215(8.3)	2.8	0.09
No	10831	3634(24.9)			2654(18.2)		

Categorical variables are presented as counts and percentages. HDL-c, high density lipoprotein-cholesterol; LDL-c, low density lipoprotein-cholesterol.

Date were compared by χ^2 tests. *P<0.05, Statistically significant.

Table 2 Prevalence of overweight and obesity in men and women according to age group

Age	Overweight		*P*	Obesity		*P*
(years)	Male(%)	female(%)		male(%)	female(%)	
35-44	994(40.2)	872(29.5)	<0.001	631(25.5)	515(17.4)	<0.001
45-54	735(43.1)	706(34.4)		517(30.3)	636(31.0)	
55-64	476(35.8)	591(36.8)		389(29.3)	531(33.0)	
≥65	530(40.3)	434(36.5)		319(24.3)	332(27.9)	

Date were compared by χ^2 tests. *P<0.05, Statistically significant.

Table 3 Prevalence of overweight and obesity in Han, Uyghur and Kazak according to age group

Age	Overweight			*P*	Obesity			*P*
(years)	Han(%)	Uyghur(%)	Kazak(%)		Han(%)	Uyghur(%)	Kazak(%)	
35-44	712(35.0)	573(34.6)	581(33.6)	<0.001	273(13.4)	422(25.5)	451(26.1)	<0.001
45-54	599(43.9)	481(38.1)	361(31.9)		246(18.0)	436(34.5)	471(41.6)	
55-64	497(45.9)	354(32.6)	216(28.3)		268(24.7)	318(29.3)	333(43.6)	
≥65	572(45.0)	227(29.9)	165(35.1)		295(23.2)	185(24.3)	171(36.4)	

Date were compared by χ^2 tests. *P<0.05, Statistically significant.

Table 4 Multivariable regression analysis of correlates of overweight and obesity in residents

1 of Xinjiang Province

Characteristic	B	S.E.	Wald	df	*P*	OR	95%CI
Area	-0.1	0.04	10.4	1	0.001*	0.9	0.8-0.9
Sex	-0.3	0.05	32.5	1	<0.001*	0.8	0.7-0.8
Ethnic			94.4	2	<0.001*		
Han	-	-	-	-	-	1	-
Uygur	0.4	0.05	50.0	1	<0.001*	1.4	1.3-1.6
Kazakh	0.50	0.05	86.2	1	<0.001*	1.7	1.5-1.8
Age(years)			71.2	3	<0.001*		
35-44	-	-	-	-	-	1	-
45-54	0.4	0.05	62.8	1	<0.001*	1.5	1.3-1.6
55-64	0.3	0.05	24.6	1	<0.001*	1.3	1.2-1.5
≥65	0.1	0.06	3.1	1	0.08	1.11	1.0-1.3
Education			17.9	3	<0.001*		
Primary school and below	-	-	-	-	-	1	-
Junior middle school	0.2	0.05	15.6	1	<0.001*	1.2	1.1-1.4
Senior middle school	0.2	0.06	7.0	1	0.008*	1.2	1.0-1.3
Undergraduate and above	0.2	0.08	6.8	1	0.009*	1.3	1.1-1.5
Occupation			10.4	2	0.006*		
Manual	-	-	-	-	-	1	-
White collar	0.01	0.05	0.04	1	0.8	1.0	0.9-1.1
Other	0.2	0.06	7.9	1	0.005*	1.2	1.1-1.4
Marriage			26.5	3	<0.001		
Unmarried	-	-	-	-	-	1	-
Married	0.6	0.2	15.5	1	<0.001*	1.8	1.4-2.5
Divorced	0.1	0.2	0.2	1	0.7	1.1	0.7-1.7
widowed	0.6	0.2	12.4	1	<0.001*	1.8	1.3-2.5
Smoking	-0.2	0.05	9.0	1	0.003*	0.9	0.8-0.9
Drinking	0.4	0.06	34.8	1	<0.001*	1.5	1.3-1.6

Hypertension	0.8	0.04	340.4	1	<0.001*	2.1	2.0-2.3
Diabetes	0.3	0.09	10.4	1	0.001*	1.3	1.1-1.6
Dyslipidemia							
hypertriglyceridemia	0.9	0.05	371.4	1	<0.001*	2.4	2.2-2.7
hypercholesterolemia	0.2	0.05	20.9	1	<0.001*	1.2	1.1-1.3
Low HDL-C	0.1	0.04	6.4	1	0.01*	1.1	1.0-1.2
High LDL-C	0.02	0.04	0.16	1	0.69	1.0	0.9-1.1
Constant	-1.0	0.2	35.3	1	<0.001	-	-

*P<0.05, Statistically significant.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (On page 1, line 1)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found (On page 2)
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported (On page 2, line 2-5)
Objectives	3	State specific objectives, including any prespecified hypotheses (On page 2, line 2-5)
Methods		
Study design	4	Present key elements of study design early in the paper (On page 4, line 9)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection (On page 2, line 7)
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants (On page 4, line 9-20)
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable (On page 5,6)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group (On page 4,5)
Bias	9	Describe any efforts to address potential sources of bias (On page 11, line 1-3)
Study size	10	Explain how the study size was arrived at (On page 4, line 15-16)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why (On page 4,5)
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding (On page 6)
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy (On page 6)
		(*e*) Describe any sensitivity analyses

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (On page 4, line 15-16)
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (On page 14, Table1)
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures (On page 6-7)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (On page 6,7)
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period (On page 6,7)
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses (On page 6,7)
Discussion		
Key results	18	Summarise key results with reference to study objectives (On page 8)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias (On page 10,11)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence (On page 11)
Generalisability	21	Discuss the generalisability (external validity) of the study results (On page 11)
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based (On page 11)

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Prevalence of overweight and obesity and associated risk factors among adult residents of northwest China: A cross-sectional study

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Prevalence of overweight and obesity and associated risk factors among adult residents of northwest China: A cross- sectional study

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Abstract

Objective: Overweight and obesity have been shown to be related to multiple chronic conditions and lead to a heavy economic burden on society throughout the world. This study aims to estimate the prevalence of overweight and obesity and determine potential influencing factors among adults in Xinjiang, northwest China.

Design: A community-based observational study.

Setting: The First Affiliated Hospital of Xinjiang Medical University.

Methods: In total, 14,618 adult participants (7,799 males; 6,819 females), aged over 35 years old, were recruited from the Cardiovascular Risk Survey conducted in 2010. Data were obtained from face-to-face interview and physical examination. The sample was used to estimate the prevalence of overweight (body mass index (BMI) [24-28) kg/m^2) and obesity (BMI≥28 kg/m^2) in Xinjiang Province, and the influencing factors were analyzed based on statistical methods.

Results: The overall prevalence of overweight was 36.5% (male 40.1%; female 33.4%), and the prevalence of obesity was 26.5% (male 27.2%; female 25.8%) in Xinjiang Province. The prevalence of both overweight and obesity were higher in women than men (P<0.001). The main influencing factors for overweight and obesity are sex, age, race, marriage status, education level, occupation, smoking, drinking, hypertension, diabetes and dyslipidemia (P<0.05).

Conclusions: This study estimated that the prevalence of overweight and obesity among adult residents of Xinjiang Province, northwest China, was high. These data suggest that efforts toward prevention and control of overweight and obesity should be a public health priority in the northwest of China.

Keywords: cross-sectional survey, overweight, obesity, risk factors

Strengths and limitations of this study

- The survey sample was demographically representative of Uygur adults with obesity aged 35–80 years in Xinjiang.
- The main strengths of our study are its large sample size and precise physical measurements, which increase the validity of our results.
- Due to the cross-sectional nature and self-designed questionnaire, indicators and experience

could have been affected by bias.

- Moreover, other indicators of adiposity, such as body fat percentage and waist circumference were not obtained in our study.
- The results were from Xinjiang only and therefore cannot be generalised to the whole China.

Introduction

Obesity is a complex chronic global disease affecting people worldwide across all ages, sexes, ethnicities, and nationalities, which is the fifth leading cause of mortality globally [1 2]. According to the World Health Organization (WHO), the prevalence of worldwide obesity has doubled in more than 70 countries since 1980 [3]; this trend has continuously increased in most other countries. In 2013, in order to make physicians pay more attention to the condition, the American Medical Association classified obesity as a disease [4].

Body mass index (BMI), which is calculated as weight/height squared (kg/m^2), is a common and accepted measure that is used to report obesity rates. While BMI is not a true measure of adiposity, it is simple to use in health screenings and epidemiological surveys [5]. According to the WHO, obesity is defined as a BMI≥30 kg/m^2, and overweight as a BMI of [25-30) kg/m^2 [6]. For Chinese people, a BMI≥28 kg/m^2 suggests obesity and a BMI of [24-28) kg/m^2 indicates overweight [7].

China is the largest developing country and has the largest population in the world. With the rapid economic growth and changes in lifestyle such as dietary habits and physical activity [8], the epidemiological data indicated that individuals with overweight and obesity had a higher prevalence of traditional diseases including dyslipidemia, hypertension, cardiovascular disease, insulin resistance or diabetes, fatty liver disease, and psychosocial complications and some cancers [5 9]. Located in the northwest China, Xinjiang not only is an autonomous minority ethnic region of the People's Republic of China, but also is one of the developing regions in China. It is the largest Chinese administrative division and spans over 1.66 million km^2 which takes up about one sixth of the country's territory. A few of studies had reported the prevalence of overweight among adults in Xinjiang [10]. Nevertheless, the samples in above mentioned studies were small, those results cannot represent accurately the status of overweight and obesity in the whole region of Xinjiang.

In the present study, we estimated the prevalence of overweight and obesity in Xinjiang. Meanwhile, the potential influencing factors in adult residents of northwest China were explored. The results of this study will be considered as a reference for policy makers in making informed decisions.

Materials and Methods

Ethics approval

This study was conducted according to the standards of the Declaration of Helsinki. Written informed consent was acquired from each participant prior to enrollment. Ethics approval was from the Ethics Committee of the First Affiliated Hospital of Xinjiang Medical University (the approval ID: 20100116-01).

Study design and population

This population-based cross-sectional survey is part of the Project on Present Situation and the Cardiovascular Risk Survey (CRS) study in Xinjiang Province of China in 2010.The CRS was a prospective, multiple ethnicity and community-based observational study designed to investigate the prevalence and risk factors for cardiovascular disease (CVD) in the Han, Uygur and Kazakh populations in Xinjiang Province [11]. All the subjects included had lived in Xinjiang Province for more than 1 year. Briefly, the CRS consisted of 16,460 adults aged≥35 years old, of whom 14,618 subjects (5,757 Han, 4,767 Uygur and 4,094 Kazakh Chinese) completed the survey, yielding a response rate of 88.8%. We used a multistage stratified sampling method to select the study sample from 6 different administrative regions including Urumqi, Yili, Hetian, Kelamayi, Fukang, and Turpan. Finally, each participant was selected randomly from each household in the sites mentioned above.

Data collection

The formal survey was made up of two parts: face-to-face interview and physical examination. Before the formal survey, we conducted a pre-survey to explore the feasibility of the questionnaire. During the investigation, each completed questionnaire was examined by two investigators to ensure validity and consistency. After the fieldwork, data were manipulated by parallel double entry, and we also performed three verifications to check for incomplete and inconsistent responses. The questionnaire provided demographics, general personal information and medical histories [12]. Height

and weight were measured using a standard protocol. Height was measured to the nearest 0.1 cm, and weight was measured with a standard scale in the upright position to the nearest 0.1 kg. Smoking and drinking conditions were self-reported.

Blood samples collection was conducted in examination centers at local hospital in the participants' residential area. At the time of the in-person interview, a 5mL of venous blood was collected into EDTA tubes and processed to obtain plasma within 4h. All samples were stored at -80℃ immediately after processing. We measured the concentration of fasting glucose using equipment for chemical analysis (Dimension AR/AVL Clinical Chemistry System, Newark, NJ, USA) employed by the Clinical Laboratory Department of the First Affiliated Hospital of Xinjiang Medical University. Biochemical markers in plasma including total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C) were measured.

Definition of variables

Overweight and obesity were defined by Chinese standards mentioned above. Obesity was defined as BMI≥28 kg/m^2, and overweight was defined as a BMI of [24-28) kg/m^2.

Education was classified into four levels: Primary school and below (including never attended school and elementary schooling only); Junior middle school; Senior middle school (including secondary vocational schooling); undergraduate and above (including post-secondary vocational schooling, master's degree and doctoral degree). Manual labor included farmers, production and service workers. White collar occupations included office and other technical employment. Other occupations included unemployed, retiree, student and full-time housewife [13]. Smoking status classifications were current smokers (which had smoked at least one cigarette a day over the past 30 days), and never-smokers. Drinking status classifications were current drinkers (which had consumed more than one alcoholic drink a week), and never-drinkers. Hypertension was defined as mean systolic BP≥140 mmHg, and/or mean diastolic BP≥90 mmHg, and/or current use of antihypertensive medications [14]. Diabetes was defined as fasting plasma glucose≥126 mg/dL (≥7.0mmol/L) and/or self- reported history of diabetes and/or current use of insulin or antidiabetic medications [15]. Hypercholesterolemia was defined as serum total cholesterol level>6.22 mmol/L (240 mg/dL), and hypertriglyceridemia was defined as serum triglyceride level>2.26 mmol/L (200

mg/dL). A serum LDL-C level of>4.14 mmol/L (160 mg/dL) was defined as high LDL-C, and a serum HDL-C level of<1.04 mmol/L (40 mg/dL) was defined as low HDL-C. In total, dyslipidemia was defined as the existence of at least one of the four abnormal lipid concentrations mentioned above, or self-reported use of lipid-lowing drugs [16].

Statistical analysis

Data was verified and corrected using EpiData 3.02 software (EpiData, Association, Odense, Denmark) by 2 staff members. Frequency distribution was used to present characteristics of the subjects, and data presented as percentages were used to report the prevalence ratio. Continuous variables were expressed as mean±standard deviation (SD) and or numerical data were expressed as rates, and a Chi-square test ($\chi 2$) was used to compare the prevalence of overweight and obesity in different groups.

To analyze the factors for obesity and adjust for potential confounding effects, a multivariable logistic regression analyses were carried out to explore independent factors associated with overweight and obesity. OR with 95% CI was used for the risk analysis. All statistical analyses were conducted using the complex sampling function of Social Sciences SPSS for Windows version 22.0 (SPSS, Inc, Chicago, IL, USA), and a $P<0.05$ level of significance was selected.

Patient and public involvement

This population-based cross-sectional survey is part of the Project on Present Situation and the Cardiovascular Risk Survey (CRS) study in Xinjiang Province of China in 2010. The study was designed to investigate the prevalence of overweight and obesity among adult residents in Xinjiang, the northwest China. However, no patients or members of the public were included in the design, recruitment or conduct of the study. The results of measurements would be disseminated to participants after the study which was completed by the study team. The burden of the intervention will not be assessed by patients themselves.

Results

In this survey, we interviewed 14618 residents aged 35 to 101 years (mean age: 50.8±12.6 years), comprised of 6,819 (46.6%) men and 7,799 (53.4%) women. Among these participants, 5,757 (39.4%) were Han ethnicities with a mean age of 52.5±12.7 years, 4,767 (32.6%) were Uygur ethnicities with a mean age of 50.7±13.0 years, and 4,094 (28.0%) were Kazakh ethnicities with a

mean age of 48.6±11.7 years. According to the BMI classification for Chinese people, the overall prevalence of overweight was 36.5% (male 40.1%; female 33.4%), and the prevalence of obesity was 26.5% (male 27.2%; female 25.8%) in Xinjiang Province **(Table 1)**. There were differences in age, area, race, occupation, education, marriage, drinking, hypertension history and plasma levels of TG, TC among the overweight and obesity groups, while there was no significant difference in sex, smoking, diabetes history and the level of LDL-c and HDL-C among the 2 groups.

From the age-stratified and gender-stratified results in **Table 2**, for men, the prevalence of both overweight and obesity all peaked at 45-54 years, while no significant trend was illustrated in the prevalence of overweight increased with age. For women, the prevalence of overweight and obesity increased with age, peaking at 55-64 years, though there has a slight decrease at ≥65 years. In addition, a higher proportion of enrolled males were overweight than females. Interestingly, the proportions of females who were obese were higher than those of males.

From the age-stratified and race-stratified results in **Table 3**, as a whole, obesity prevalence in the different ethnicities was found to be the highest in Kazakh and the lowest in Han participants, and there was a statistical significance among the three ethnic groups (P<0.001). Further, overweight prevalence also showed an interesting significant difference among the three ethnicities, the highest in Han and the lowest in Kazakh participants.

We divided the participants into two groups: normal weight; overweight and obese. **Table 1** has shown that the following factors all had a significant effect: age, area, race, education, marriage status, occupation, drinking, hypertension and dyslipidemia (P<0.05). We applied multivariable unconditional logistic regression analysis model on all identified risk factors and attempted to identify any existing difference in these risk factors which may explain the difference in overweight and obesity prevalence. **Table 4** shows the results of logistic regression models comparing the prevalence of the potential risk factors: sex, age, area, marriage status, occupation, smoking, drinking, hypertension, diabetes and the level of dyslipidemia, including hypercholesterolemia, hypertriglyceridemia and low HDL-C. The multivariable logistic regression results reveal that female adults prefer to become overweight and obese than male adults (OR 0.8, 95% CI 0.7 to 0.8). We categorized age into four groups, which clearly showed that increasing age is a risk factor for overweight/obesity, especially age 45-54 years (OR 1.5, 95% CI 1.3 to 1.6). Among the three races,

Kazak population (OR 1.7, 95% CI 1.5 to 1.8) and Uygur population (OR 1.4, 95% CI 1.3 to 1.6) carried higher risk to become overweight and obese. Participants who have married (OR 1.8, 95% CI 1.4 to 2.5) or widowed (OR 1.8, 95% CI 1.3 to 2.5) are easier to be overweight/obese than those who have unmarried. In addition, smokers (OR 0.9, 95% CI 0.8 to 0.9) are less likely to become overweight and obese than nonsmokers. Participants who drink are more likely to become overweight or obese than those who never or rarely drink (OR 1.5, 95% CI 1.3 to 1.6). Overweight and obesity are more common among those who had hypertension (OR 2.1, 95% CI 2.0 to 2.3) and diabetes (OR 1.3, 95% CI 1.1 to 1.6) compared with those who had no hypertension and diabetes history. In the overweight and obese population, hypertriglyceridemia (OR 2.4, 95% CI 2.2 to 2.7), hypercholesterolemia (OR 1.2, 95% CI 1.1 to 1.3) and low HDL-C (OR 1.1, 95% CI 1.0 to 1.2) remained as risk factors.

Discussion

The epidemic of obesity is one of the most important health problems worldwide and is estimated to be the second leading cause of preventable death in developed countries, behind cigarette smoking [17 18]. The prevalence of overweight and obesity continues to increase around the world, as have associated comorbidities and healthcare costs [19]. In the US, the prevalence of obesity accounts for one-third of the general population, and another one-third is overweight [20]. Data from the China Chronic Disease Survey conducted by the Chinese Center for Disease Control and Prevention demonstrated that the prevalence of overweight among Chinese adults (age 18–64 years) for 2007 and 2010 was 26.6% and 30.6%, respectively (male 27.4% and 32.1%; female 25.7% and 29.1%), and the prevalence of obesity was 7.7% and 12.1%, respectively (male 6.7% and 12.5%; female 8.7% and 11.1%) [21]. No doubt, we found that the prevalence of both overweight and obesity was high. Our cross-sectional study indicates that the prevalence of overweight and obesity among adults in northwest China was 36.5% (male 40.1%; female 33.4%), and 26.5% (male 27.2%; female 25.8%). In the Russian population [22], the overweight was 64.6% (male 42.3%; female 28.7%), and approximately a third of the participants (30.3%) had obesity (male 27.5%; female 31.4%). Contrary to what was observed in our research, the prevalence of overweight was higher than obesity. This implies that overweight and obesity have a higher prevalence in both sexes and are more common in northwest China and Russian than in other areas, although effective actions might have been

taken to control the upward trend [23]. The prevalence of underweight (according to the Chinese standards: underweight<18.5 kg/m^2) was significant difference among each group (P<0.05) **(Supplementary Table 1)**, however, due to the special dietary habits (high sugar and high fat diet) and living habits in Xinjiang, the number of low-weight people is too small.

In this study, we found that the prevalence of both overweight and obesity is high in middle age (45-64 years). Similarly, age gradients in the prevalence of obesity are found in Russia [22]. It is worth noting that more than half of all women aged 55–64 years have obesity, and nearly 80% men in the groups aged 45–54 years had overweight and obesity, which consists with our age gradients. Chinese people are more likely to have positive perceptions of obesity because it is considered good fortune to become fat during middle age in traditional Chinese culture [24]. Moreover, a large segment of the middle-aged and older adult population will be living with overweight and obesity, which is associated with additional health impairments [25].

Through the present study, we found a very high prevalence of overweight and obesity in three ethnicities in Xinjiang, and there is no doubt that the result is similar to the previous study in Xinjiang [10]. In addition, the prevalence rate of obesity was significantly different among Han, Uygur and Kazak groups and the prevalence in Kazak group was significantly higher compared with Han and Uygur. Overall, our findings indicate that 16.3% of Han, 11.2% of Uygur, and 9.1% of Kazak people more than 35 years of age in Xinjiang have overweight, as with 7.4% of Han, 9.3% of Uygur, and 9.8% of Kazak people have obesity. Xinjiang is a multi-ethnic co-populated area in China. The national census showed that there are 47 ethnicities in Xinjiang, and 13 of them are confirmed to be native ethnicities, such as the Uygur and Kazak. The explanations for this increase of prevalence as follows: firstly, Kazak live in the grassland and forests, whose dietary habits were characterized by eating more animal and consuming fewer fresh vegetables; Secondly, Kazak is a nomadic ethnic who usually lives in hypoxia area and high altitude where the climate is cold and dry; Thirdly, different genetic backgrounds may also be an important factor underlying the different prevalence of obesity [26].

Multivariable logistic regression analysis suggested that several factors are associated with the prevalence of overweight and obesity. A previous review revealed that various marital transitions are related with changes in body weight: transition into marriage appears to be associated with

weight gain, whereas transition out of marriage is associated with weight loss [27]. Our study found a similar result that, transition into marriage including married, divorce and widowed are risk factors for becoming overweight and obese. Plausible explanations are behaviors and lifestyle which differ among married individuals, however, the exact mechanism is not clear to illustrate this apparent association with marriage status. In our study, it is also found that different educational levels, occupations and area of residence are closely related to body weight. We have observed that low education level is a risk factor because of insufficient level of cognition. Urban population, especially unemployed, retiree, student and full-time housewife, are easier to become overweight and obese, which contribute to urban working conditions, for example sitting in the office, fast-paced life and supermarket or fast food restaurant availability [28].

The 2015 Global Burden of Disease Study, representing 195 countries and territories, estimated that 25.0% of men and 5.4% of women worldwide smoked daily, which is the leading preventable cause of death worldwide [29]. In this study, we found a lower prevalence of overweight and obesity in smokers than non-smokers, which is consistent with studies conducted in Switzerland, India and Jilin, China [21 30 31]. In addition, reasonable explanations to illustrated the issue according to two different criteria. In terms of tobacco use, using tobacco is connected with multiple system functions, especially cardiovascular and digestive systems [32]. In terms of the organism itself, smoking has been considered as methods of pressure and energy relief. Affected by the traditional culture of drinking alcohol, especially in northwest China, it is generally believed that, the more you drink, the more weight you get. Wang et al [21] showed the consisted results.

To the best of our knowledge, obesity is an independent risk factor both of CVD and death [33-35]. We explore that the prevalence of overweight and obesity are higher if subjects are with hypertension or diabetes or dyslipidemia. The results provide a compelling reason why the occurrence of obesity is combined with cardiovascular risk factors such as hypertension, diabetes or dyslipidemia. Previous studies reported that the benefits of weight loss are well established, with a 5–10% reduction in weight associated with improvement in health and quality of life, and a 3% reduction being positive for health improvement where it is maintained [36].

These departments should heed the high prevalence of overweight and obesity in Xinjiang Province and provide effective guidelines to help to reverse the trend. The main strengths of our

study are its large sample size and precise physical measurements, which increase the validity of our results. However, the present study has several limitations. First, the main limitation is the cross-sectional design which prohibits inferring a causal link between overweight and obesity and risk factors. As in cross-sectional studies data on exposure and outcome are gathered simultaneously in a specific time point, prospective studies are necessary to confirm our findings. In addition, self-reported data and the nature of cross-sectional data may lead to recall and reporting biases, which may be the reason for the insignificant difference in the causes of obesity. Finally, other indicators of adiposity, such as body fat percentage and waist circumference which plenty of studies reported to reflect the prevalence of overweight and obesity and body fat distribution, were not obtained in our study [37 38].

Conclusions

In conclusion, the present study indicates that the prevalence of overweight and obesity among adult residents in Xinjiang, the northwest China, is very high during the past years. Furthermore, the main influencing factors for overweight and obesity are sex, age, race, marriage status, education level, occupation, smoking, drinking, hypertension, diabetes and dyslipidemia. These data suggest that efforts toward prevention and control of overweight and obesity should be a public health priority in the northwest of China, which will be submitted to relevant departments as a reference to reverse the trends.

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approved the final manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

Ethics approval: This study was carried out in accordance with the Declaration of Helsinki and the study protocol was approved by the Ethics Committee of the First Affiliated Hospital of Xinjiang Medical University (Xinjiang, China) (approval ID:20100116-01).

Data availability statement: All data relevant to the study are included in the article or uploaded as supplementary information. No additional data are available.

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Table 1 Prevalence of overweight and obesity according to demographic characteristics

Characteristic	N	Overweight			Obesity		
		n (%)	χ2	*P*	n (%)	χ2	*P*
Sex							
Male	6819	2735(40.1)	71.1	<0.001*	1856 (27.2)	3.7	0.05
Female	7799	2603(33.4)			2013(25.8)		
Age(years)							
35-44	5425	1866(34.4)	20.3	<0.001*	1146(21.1)	149.8	<0.001*
45-54	3759	1441(38.3)			1153(30.7)		
55-64	2932	1067(36.4)			919(31.3)		
≥65	2502	964(38.5)			651(26.0)		
Area							
Urban	7974	3163(39.7)	75.1	<0.001*	1956(24.5)	33.9	<0.001*
Rural	6644	2175(32.7)			1913(28.8)		
Ethnicity							
Han	5757	2380(16.3)	99.1	<0.001*	1082(7.4)	331.9	<0.001*
Uyghur	4767	1635(11.2)			1361(9.3)		
Kazak	4094	1323(9.1)			1426(9.8)		
Occupation							
Manual	4583	1760(12.0)	12.1	0.002*	1095(7.5)	32.1	<0.001*
White collar	7751	2736(18.7)			2086(14.3)		

Other	2284	842(5.8)			688(4.7)		
Education							
Primary school and below	5805	1993(13.6)	26.9	<0.001*	1589(10.87)	21.2	<0.001*
Junior middle school	3094	1196(8.2)			844(5.8)		
Senior middle school	4556	1676(11.5)			1191(8.2)		
Undergraduate and above	1163	473(3.2)			245(1.7)		
Marriage							
Unmarried	192	59(0.4)	14.1	<0.001*	27(0.2)	23.1	<0.001*
Married	12988	4795(32.8)			3427(23.4)		
divorced	201	53(0.4)			47(0.2)		
widowed	1237	431(3.0)			368(2.5)		
Drinking							
Yes	4169	923(6.3)	44.5	<0.001*	663(4.5)	24.6	<0.001*
No	10449	4415(30.2)			3206(21.9)		
Smoking							
Yes	2151	1688(11.6)	39.7	<0.001*	1101(7.5)	0.01	0.92
No	12467	3650(25.0)			2768(18.9)		
Hypertension							
Yes	5701	2138(14.6)	3.9	0.05	2155(14.7)	616.8	<0.001*
No	8917	3200(21.9)			1714(11.7)		
Diabetes							
Yes	859	335(2.3)	2.4	0.1	317(2.2)	51.0	<0.001*
No	13759	5003(34.2)			3552(24.3)		
Dyslipidemia							
hypertriglyceridemia							
Yes	4113	1724(11.8)	72.0	<0.001*	1497(10.2)	289.9	<0.001*
No	10505	3614(24.7)			2372(16.2)		

hypercholesterolemia							
Yes	3787	1469(10.1)	11.4	0.001*	1267(8.7)	128.3	<0.001*
No	10831	3869(26.5)			2602(17.8)		
High LDL-C							
Yes	5251	1921(13.1)	0.02	0.9	1334(9.1)	4.8	0.03*
No	9367	3417(23.4)			2535(17.3)		
Low HDL-C							
Yes	4437	1704(11.7)	9.8	0.002*	1215(8.3)	2.8	0.09
No	10831	3634(24.9)			2654(18.2)		

Categorical variables are presented as counts and percentages. HDL-c, high density lipoprotein-cholesterol; LDL-c, low density lipoprotein-cholesterol.

Date were compared by χ^2 tests. *P<0.05, Statistically significant.

Table 2 Prevalence of overweight and obesity in men and women according to age group

Age	Overweight		P	Obesity		P
(years)	Male(%)	female(%)		male(%)	female(%)	
35-44	994(40.2)	872(29.5)	<0.001	631(25.5)	515(17.4)	<0.001
45-54	735(43.1)	706(34.4)		517(30.3)	636(31.0)	
55-64	476(35.8)	591(36.8)		389(29.3)	531(33.0)	
≥65	530(40.3)	434(36.5)		319(24.3)	332(27.9)	

Date were compared by χ^2 tests. *P<0.05, Statistically significant.

Table 3 Prevalence of overweight and obesity in Han, Uyghur and Kazak according to age group

Age	Overweight			P	Obesity			P
(years)	Han(%)	Uyghur(%)	Kazak(%)		Han(%)	Uyghur(%)	Kazak(%)	
35-44	712(35.0)	573(34.6)	581(33.6)	<0.001	273(13.4)	422(25.5)	451(26.1)	<0.001
45-54	599(43.9)	481(38.1)	361(31.9)		246(18.0)	436(34.5)	471(41.6)	
55-64	497(45.9)	354(32.6)	216(28.3)		268(24.7)	318(29.3)	333(43.6)	
≥65	572(45.0)	227(29.9)	165(35.1)		295(23.2)	185(24.3)	171(36.4)	

Date were compared by χ^2 tests. *P<0.05, Statistically significant.

Table 4 Multivariable regression analysis of correlates of overweight and obesity in residents of Xinjiang Province

Characteristic	B	S.E.	Wald	df	*P*	OR	95%CI
Area	-0.1	0.04	10.4	1	0.001*	0.9	0.8-0.9
Sex	-0.3	0.05	32.5	1	<0.001*	0.8	0.7-0.8
Ethnic			94.4	2	<0.001*		
Han	-	-	-	-	-	1	-
Uygur	0.4	0.05	50.0	1	<0.001*	1.4	1.3-1.6
Kazakh	0.50	0.05	86.2	1	<0.001*	1.7	1.5-1.8
Age(years)			71.2	3	<0.001*		
35-44	-	-	-	-	-	1	-
45-54	0.4	0.05	62.8	1	<0.001*	1.5	1.3-1.6
55-64	0.3	0.05	24.6	1	<0.001*	1.3	1.2-1.5
≥65	0.1	0.06	3.1	1	0.08	1.11	1.0-1.3
Education			17.9	3	<0.001*		
Primary school and below	-	-	-	-	-	1	-
Junior middle school	0.2	0.05	15.6	1	<0.001*	1.2	1.1-1.4
Senior middle school	0.2	0.06	7.0	1	0.008*	1.2	1.0-1.3
Undergraduate and above	0.2	0.08	6.8	1	0.009*	1.3	1.1-1.5
Occupation			10.4	2	0.006*		
Manual	-	-	-	-	-	1	-
White collar	0.01	0.05	0.04	1	0.8	1.0	0.9-1.1
Other	0.2	0.06	7.9	1	0.005*	1.2	1.1-1.4
Marriage			26.5	3	<0.001		
Unmarried	-	-	-	-	-	1	-
Married	0.6	0.2	15.5	1	<0.001*	1.8	1.4-2.5
Divorced	0.1	0.2	0.2	1	0.7	1.1	0.7-1.7
widowed	0.6	0.2	12.4	1	<0.001*	1.8	1.3-2.5

Smoking	-0.2	0.05	9.0	1	0.003*	0.9	0.8-0.9
Drinking	0.4	0.06	34.8	1	<0.001*	1.5	1.3-1.6
Hypertension	0.8	0.04	340.4	1	<0.001*	2.1	2.0-2.3
Diabetes	0.3	0.09	10.4	1	0.001*	1.3	1.1-1.6
Dyslipidemia							
hypertriglyceridemia	0.9	0.05	371.4	1	<0.001*	2.4	2.2-2.7
hypercholesterolemia	0.2	0.05	20.9	1	<0.001*	1.2	1.1-1.3
Low HDL-C	0.1	0.04	6.4	1	0.01*	1.1	1.0-1.2
High LDL-C	0.02	0.04	0.16	1	0.69	1.0	0.9-1.1
Constant	-1.0	0.2	35.3	1	<0.001	-	-

*P<0.05, Statistically significant.

Supplementary Table 1 Prevalence of underweight

Characteristic	N	Underweight	
		n（%）	*P*
Sex			
Male	6819	71(1.04)	<0.001
Female	7799	219(2.81)	

*$P<0.05$, Statistically significant.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (On page 1, line 1)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found (On page 2)
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported (On page 2, line 2-5)
Objectives	3	State specific objectives, including any prespecified hypotheses (On page 2, line 2-5)
Methods		
Study design	4	Present key elements of study design early in the paper (On page 4, line 9)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection (On page 2, line 7)
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants (On page 4, line 9-20)
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable (On page 5,6)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group (On page 4,5)
Bias	9	Describe any efforts to address potential sources of bias (On page 11, line 1-3)
Study size	10	Explain how the study size was arrived at (On page 4, line 15-16)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why (On page 4,5)
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding (On page 6)
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy (On page 6)
		(*e*) Describe any sensitivity analyses

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (On page 4, line 15-16)
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (On page 14, Table1)
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures (On page 6-7)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (On page 6,7)
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period (On page 6,7)
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses (On page 6,7)
Discussion		
Key results	18	Summarise key results with reference to study objectives (On page 8)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias (On page 10,11)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence (On page 11)
Generalisability	21	Discuss the generalisability (external validity) of the study results (On page 11)
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based (On page 11)

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Secondary Subject Heading:	Cardiovascular medicine, Epidemiology, Ethics, Global health
Keywords:	cross-sectional survey, overweight, obesity, risk factors

Prevalence of overweight and obesity and associated risk factors among adult residents of northwest China: A cross- sectional study

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Abstract

Objective: Overweight and obesity have been shown to be related to multiple chronic conditions, leading to a heavy economic burden on society throughout the world. This study aims to estimate the prevalence of overweight and obesity and determine potential influencing factors among adults in Xinjiang, northwest China.

Design: A community-based observational study.

Setting: The First Affiliated Hospital of Xinjiang Medical University.

Methods: In total, 14,618 adult participants (7,799 males; 6,819 females) over 35 years old were recruited from the Cardiovascular Risk Survey conducted in 2010. Data were obtained from face-to-face interviews and physical examinations. The sample was used to estimate the prevalence of overweight (body mass index (BMI) [24-28) kg/m^2) and obesity (BMI≥28 kg/m^2) in Xinjiang Province. Influencing factors were analysed based on statistical methods.

Results: In Xinjiang Province, the overall prevalence of overweight was 36.5% (male 40.1%; female 33.4%), and the prevalence of obesity was 26.5% (male 27.2%; female 25.8%). The prevalence of both overweight and obesity were higher in women than in men (P<0.001). The main influencing factors for overweight and obesity were sex, age, race, marital status, education level, occupation, smoking, drinking, hypertension, diabetes and dyslipidaemia (P<0.05).

Conclusions: This study estimated that the prevalence of overweight and obesity among adult residents of Xinjiang Province, northwest China, was high. These data suggest that efforts related to the prevention and control of overweight and obesity should be a public health priority in northwest China.

Keywords: cross-sectional survey, overweight, obesity, risk factors

Strengths and limitations of this study

- The survey sample was demographically representative of Uygur adults with obesity who are 35–80 years old and reside in Xinjiang.
- The main strengths of our study are its large sample size and precise physical measurements, which increase the validity of our results.
- Due to the cross-sectional nature of the study and the self-designed questionnaire, indicators

and experience could have been affected by bias.

- Moreover, other indicators of adiposity, such as body-fat percentage and waist circumference, were not obtained in our study.
- The results were from Xinjiang only and therefore cannot be generalised to all of China.

Introduction

Obesity is a complex chronic global disease affecting people worldwide across all ages, sexes, ethnicities, and nationalities, and it is the fifth leading cause of mortality globally [1 2]. According to the World Health Organization (WHO), the prevalence of worldwide obesity has doubled in more than 70 countries since 1980 [3]. Moreover, this trend has continuously increased in most other countries. In 2013, in order to draw physicians' attention to the condition, the American Medical Association classified obesity as a disease [4].

Body mass index (BMI), which is calculated as weight/height squared (kg/m^2), is a common and accepted measure that is used to report obesity rates. While BMI is not a true measure of adiposity, it is simple to use in health screenings and epidemiological surveys [5]. According to the WHO, obesity is defined as a BMI≥30 kg/m^2, and overweight as a BMI of [25-30) kg/m^2 [6]. For Chinese people, a BMI≥28 kg/m^2 suggests obesity and a BMI of [24-28) kg/m^2 indicates overweight [7].

China is the largest developing country and has the largest population in the world. With rapid economic growth and changes in lifestyle, such as dietary habits and physical activity [8], the epidemiological data indicate that individuals with overweight and obesity have a higher prevalence of traditional diseases, including dyslipidaemia, hypertension, cardiovascular disease, insulin resistance or diabetes, fatty liver disease, and psychosocial complications and some cancers [5 9]. Located in northwest China, Xinjiang is not only an autonomous minority ethnic region within the People's Republic of China, but also one of the fastest developing regions in China. It is the largest Chinese administrative division and spans over 1.66 million km^2, which represents approximately one-sixth of the country's territory. A few studies had reported the prevalence of overweight among adults in Xinjiang [10]. Nevertheless, the samples in the abovementioned studies were small, and those results cannot accurately represent the status of overweight and obesity in the whole region of

Xinjiang.

In the present study, we estimated the prevalence of overweight and obesity in Xinjiang, northwestern part of China. Furthermore, we investigated the associated factors of overweight and obesity, which will be regarded as a reference for policy makers to make informed decisions.

Materials and Methods

Ethics approval

This study was conducted according to the standards of the Declaration of Helsinki. Written informed consent was acquired from each participant prior to enrolment. Ethics approval was granted by the Ethics Committee of the First Affiliated Hospital of Xinjiang Medical University (the approval ID: 20100116-01).

Study design and population

This survey is a population-based cross-sectional program and the Cardiovascular Risk Survey (CRS) study was conducted in Xinjiang Province of China in 2010. Previously, several studies had described in details [11-14]. The CRS was a prospective, multiple-ethnicity and community-based observational study designed to investigate the prevalence and risk factors for cardiovascular disease (CVD) in the Han, Uygur and Kazakh populations in Xinjiang Province [11]. All participants we recruited had lived in Xinjiang for more than one year. In short, a total of 16,460 adults aged ≥35 years have been joined the CRS, 14,618 subjects (5,757 Han, 4,767 Uygur and 4,094 Kazakh Chinese) of them completed the investigation. We adopt the method of multistage stratified sampling to randomly select the representative sample from 6 different administrative regions, including Urumqi, Yili, Hetian, Kelamayi, Fukang and Turpan.

Data collection

The standard survey mainly consisted of two aspects [15], one is the face-to-face interview, the other is the physical examination. Before launching the regular survey, it is necessary to carry out a pre-survey to ensure the accuracy and feasibility of the questionnaire. At the investigation stage, two independent investigators ensured the validity of every survey questionnaire. In the questionnaire processing stage, we used parallel double method to handle data, and carried out three validations to verify the self-contradictory responses. The questionnaire provided demographics, general personal information and medical histories [16]. Height and weight were measured adopting

the standards. Height was measured to the nearest 0.1 cm, and weight was measured with a standard scale in the upright position to the nearest 0.1 kg [15]. Smoking and drinking habits were self-reported.

Blood samples were collected in examination centres at local hospitals in the participants' residential area. The collected and detected methods have also been described in detail previously [13 14]. At the time of the in-person interview, a 5 mL fasting venous blood was collected into EDTA tubes and separated to acquire plasma within 4 h. Finally, all samples after processing were stored at -80℃ immediately. We measured the biochemical markers in plasma using the equipment for chemical analysis (Dimension AR/AVL Clinical Chemistry System, Newark, NJ, USA), operated by the Clinical Laboratory Department of the First Affiliated Hospital of Xinjiang Medical University. Relevant markers in plasma, which contained total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C), were measured.

Definition of variables

Overweight and obesity were defined by the Chinese standards mentioned above. Obesity was defined as BMI≥28 kg/m^2, and overweight was defined as a BMI of [24-28) kg/m^2.

Education was classified into four levels: primary school and below (including never having attended school and elementary schooling only); junior middle school; senior middle school (including secondary vocational schooling); undergraduate and above (including post-secondary vocational schooling, master's degree and doctoral degree). The occupations consist of three parts: manual labour (including farmers, production and service workers), white-collar occupations (including office and other technical employment) and other occupations (including unemployed, retiree, student and full-time homemaker) [17]. Smoking-status classifications included current smokers (who had smoked at least one cigarette a day over the past 30 days) and never-smokers. Drinking-status classifications included current drinkers (who had consumed more than one alcoholic drink a week) and never-drinkers. Hypertension was defined as mean systolic BP≥140 mmHg, mean diastolic BP≥90 mmHg, and/or current use of antihypertensive medications [14 18]. Diabetes was defined as fasting plasma glucose≥126 mg/dL (≥7.0 mmol/L), self-reported history of diabetes and/or current use of insulin or antidiabetic medications [14 19]. Hypercholesterolemia was defined as serum total cholesterol level>6.22 mmol/L (240 mg/dL), and hypertriglyceridemia was

defined as serum triglyceride level>2.26 mmol/L (200 mg/dL). A serum LDL-C level of>4.14 mmol/L (160 mg/dL) was defined as high LDL-C, and a serum HDL-C level of<1.04 mmol/L (40 mg/dL) was defined as low HDL-C. In total, dyslipidaemia was defined as the existence of at least one of the four abnormal lipid concentrations mentioned above or self-reported use of lipid-lowing drugs [13 20].

Statistical analysis

Data were entered and corrected by 2 staff members using EpiData 3.02 software (EpiData, Association, Odense, Denmark). The subjects' continuous variables were expressed by frequency distributions, meanwhile, the prevalence rates were shown through the percentage. Chi-square testing ($\chi 2$) was used to compare the prevalence of overweight and obesity in different groups. To analyse the factors associated with obesity and adjust for potential confounding effects, multivariable logistic regression analyses were carried out to explain independent factors associated with overweight and obesity. ORs with 95% CIs were used for the risk analysis. All statistical analyses were conducted using the complex sampling function of Social Sciences SPSS for Windows version 22.0 (SPSS, Inc, Chicago, IL, USA), with a $P<0.05$ indicating statistical significance.

Patient and public involvement

This survey is a population-based cross-sectional program and the Cardiovascular Risk Survey (CRS) study was conducted in Xinjiang Province of China in 2010. The study was designed to investigate the prevalence of overweight and obesity among adult residents in Xinjiang in northwest China. However, no patients or members of the public were included in the design, recruitment or conduct of the study. The results were to be disseminated to participants after the study was completed by the study team. The burden of intervention would not be assessed by the patients themselves.

Results

In this survey, we interviewed 14618 residents aged 35 to 101 years (mean age: 50.8±12.6 years), including 6,819 (46.6%) men and 7,799 (53.4%) women. Among these participants, 5,757 (39.4%) were Han, with a mean age of 52.5±12.7 years; 4,767 (32.6%) were Uygur, with a mean age of 50.7±13.0 years; and 4,094 (28.0%) were Kazakh, with a mean age of 48.6±11.7 years.

According to the BMI classification for Chinese people, the overall prevalence of overweight was 36.5% (male 40.1%; female 33.4%), and the prevalence of obesity was 26.5% (male 27.2%; female 25.8%) in Xinjiang Province **(Table 1)**. There were differences in age, area, race, occupation, education, marriage, drinking habits, hypertension history and plasma levels of TG and TC between the overweight and obesity groups, while there were no significant differences in sex, smoking, diabetes history and the level of LDL-c and HDL-C between the 2 groups.

From the age-stratified and gender-stratified results in **Table 2**, for men, the prevalence of both overweight and obesity peaked at 45-54 years, while a significant trend indicating an increase in the prevalence of overweight with age was not demonstrated. For women, the prevalence of overweight and obesity increased with age, peaking at 55-64 years, though there was a slight decrease at ≥65 years. In addition, a higher proportion of enrolled males were overweight than females. Interestingly, the proportion of females who were obese was higher than that of males.

From the age-stratified and race-stratified results in **Table 3**, as a whole, obesity prevalence was found to be the highest among the Kazakh participants and the lowest among Han participants. The differences among the three ethnic groups were statistically significant (P<0.001). Further, overweight prevalence was also significantly different among the three ethnicities, with the highest rate among Han participants and the lowest among Kazakh participants.

We divided the participants into two groups: normal weight and overweight/obese. **Table 1** shows that the following factors all had a significant effect on overweight/obese: age, area, race, education, marital status, occupation, drinking, hypertension and dyslipidaemia (P<0.05). We applied multivariable unconditional logistic regression analysis to all of the identified risk factors and attempted to identify any existing differences in these risk factors that could explain the difference in overweight and obesity prevalence. **Table 4** shows the results of logistic regression models comparing the prevalence of the potential risk factors: sex, age, area, marriage status, occupation, smoking, drinking, hypertension, diabetes and level of dyslipidaemia, including hypercholesterolemia, hypertriglyceridemia and low HDL-C. The multivariable logistic regression results reveal that female adults were more likely to become overweight and obese than male adults (OR 0.8, 95% CI 0.7 to 0.8). We categorised age into four groups, which clearly showed that increasing age was a risk factor for overweight/obesity, especially age 45-54 years (OR 1.5, 95%

CI 1.3 to 1.6). Among the three ethnic groups, the Kazak participants (OR 1.7, 95% CI 1.5 to 1.8) and Uygur participants (OR 1.4, 95% CI 1.3 to 1.6) were at higher risk of becoming overweight and obese. Participants who were married (OR 1.8, 95% CI 1.4 to 2.5) or widowed (OR 1.8, 95% CI 1.3 to 2.5) were more likely to be overweight/obese than those who were unmarried. In addition, smokers (OR 0.9, 95% CI 0.8 to 0.9) were less likely to become overweight and obese than non-smokers. Participants who drank were more likely to become overweight or obese than those who never or rarely drank (OR 1.5, 95% CI 1.3 to 1.6). Overweight and obesity were more common among those who had hypertension (OR 2.1, 95% CI 2.0 to 2.3) and diabetes (OR 1.3, 95% CI 1.1 to 1.6) compared with those who had no hypertension and diabetes history. In the overweight and obese group, hypertriglyceridemia (OR 2.4, 95% CI 2.2 to 2.7), hypercholesterolemia (OR 1.2, 95% CI 1.1 to 1.3) and low HDL-C (OR 1.1, 95% CI 1.0 to 1.2) remained risk factors.

Discussion

The epidemic of obesity is one of the most important health problems worldwide and is estimated to be the second leading cause of preventable death in developed countries, behind cigarette smoking [21 22]. The prevalence of overweight and obesity continues to increase around the world, as have associated comorbidities and healthcare costs [23]. In the US, the prevalence of obesity accounts for one-third of the general population, and another one-third is overweight [24]. The China Chronic Disease Survey conducted by the Chinese Centre for Disease Control and Prevention demonstrated that the prevalence of overweight among Chinese adults (age 18–64 years) in 2007 and 2010 was 26.6% and 30.6%, respectively (males, 27.4% and 32.1%; females, 25.7% and 29.1%), and the prevalence of obesity was 7.7% and 12.1%, respectively (males, 6.7% and 12.5%; females, 8.7% and 11.1%) [15]. We found that the prevalence of both overweight and obesity was high. Our cross-sectional study indicates that the prevalence of overweight and obesity among adults in northwest China was 36.5% (males, 40.1%; females, 33.4%) and 26.5% (males, 27.2%; females, 25.8%), respectively. In the Russian population [25], the prevalence of overweight was 64.6% (males, 42.3%; females, 28.7%), and approximately one-third of the participants (30.3%) were obese (males, 27.5%; females, 31.4%). Contrary to what was observed in our research, the prevalence of overweight was higher than obesity in that study. This implies that overweight and obesity have a higher prevalence in both sexes and are more common in northwest China and Russia than in other

areas, although effective actions might have been taken to control the upward trend [26]. The prevalence of underweight (according to Chinese standards, underweight reflects <18.5 kg/m^2) was significantly different among the ethnic groups (P<0.05) **(Supplementary Table 1).** However, due to the special dietary habits (high-sugar and high-fat diet) and living habits in Xinjiang, the number of low-weight people was too small to reliably detect differences.

In this study, we found that the prevalence of both overweight and obesity was high in middle age (45-64 years). Similarly, age gradients in the prevalence of obesity have been found in Russia [26]. It is worth noting that more than half of all women aged 55–64 years were obese, and nearly 80% of men in the group aged 45–54 years were overweight or obese, which is consistent with our age gradients. Chinese people are more likely to have positive perceptions of obesity because it is considered good fortune to become fat during middle age in traditional Chinese culture [27]. Moreover, a large segment of the middle-aged and older adult population will be living with overweight and obesity, which is associated with additional health impairments [28].

Through the present study, we found a very high prevalence of overweight and obesity in three ethnicities in Xinjiang, and there is no doubt that this result is similar to those observed in the previous study conducted in Xinjiang [10]. In addition, the prevalence rate of obesity was significantly different among Han, Uygur and Kazak groups, as the prevalence in the Kazak group was significantly higher compared with the Han and Uygur groups. Overall, our findings indicate that 16.3% of Han, 11.2% of Uygur, and 9.1% of Kazak people more than 35 years of age in Xinjiang were overweight and that 7.4% of Han, 9.3% of Uygur, and 9.8% of Kazak people were obese. Xinjiang is a multi-ethnic co-populated area in China. The national census showed that there are 47 ethnicities in Xinjiang, and 13 of them are confirmed to be native ethnicities, such as the Uygur and Kazak. Explanations for this increase in prevalence are as follows: First, Kazak people live in the grasslands and forests, and their dietary habits are characterised by eating more animals and consuming fewer fresh vegetables. Second, the Kazak group is a nomadic ethnicity, the members of which usually live in hypoxic areas and at high altitude where the climate is cold and dry. Third, differences in genetic background may be an important factor underlying the differences in the prevalence of obesity [29].

Multivariable logistic regression analysis showed that the prevalence of overweight and obesity

was related to several factors. A previous review revealed that various marital transitions are related with changes in body weight: transition into marriage appears to be associated with weight gain, whereas transition out of marriage is associated with weight loss [30]. Our study found a similar result, namely, that marriage-related transitions, including marrying, divorcing and being widowed, are risk factors for becoming overweight and obese. A plausible explanation is that behaviours and lifestyles differ among married and unmarried individuals, but the exact mechanism underlying this association with marriage status is not clear. In our study, we also found that different educational levels, occupations and areas of residence are closely related to body weight. We observed that a low education level is a risk factor because of insufficient levels of cognition. Urban populations, especially the unemployed, retirees, students and full-time housewives, are more likely to become overweight and obese, which may be attributable to urban working conditions, for example, sitting in an office and living a fast-paced life as well as supermarket or fast-food restaurant availability [31].

The 2015 Global Burden of Disease Study, representing 195 countries and territories, estimated that 25.0% of men and 5.4% of women worldwide smoked daily, which is the leading preventable cause of death worldwide [32]. In this study, we found a lower prevalence of overweight and obesity in smokers than in non-smokers, which is consistent with studies conducted in Switzerland, India and Jilin, China [15 33 34]. In addition, reasonable explanations illustrate the issue based on two different criteria. Using tobacco is associated with the function of multiple systems, especially that of cardiovascular and digestive systems [35]. In terms of the organism itself, smoking has been considered to be a method of relieving stress and anxiety. In northwest China in particular, it is generally believed that the more you drink, the more weight you gain. Wang et al [15] found results consistent with this belief.

To the best of our knowledge, obesity is an independent risk factor for both CVD and death [36-38]. We explored whether the prevalence of overweight and obesity is higher among subjects with hypertension or diabetes or dyslipidaemia. The results provide a compelling reason why the occurrence of obesity is combined with cardiovascular risk factors such as hypertension, diabetes and dyslipidaemia. Previous studies reported that the benefits of weight loss are well established, with a 5–10% reduction in weight associated with improvements in health and quality of life and a 3% reduction being positive for health improvement when maintained [39].

Relevant departments should heed the high prevalence of overweight and obesity in Xinjiang Province and provide effective guidelines to help to reverse the trend. The main strengths of our study are its large sample size and precise physical measurements, which increase the validity of our results. However, the present study has several limitations. First, the main limitation is the cross-sectional design, which prohibits inferring a causal link between overweight and obesity and risk factors. As in cross-sectional studies, data on exposure and outcome are gathered simultaneously at a specific time point. Prospective studies are necessary to confirm our findings. In addition, self-reported data and the nature of cross-sectional data may lead to recall and reporting biases, which may be the reason for the non-significant difference in the causes of obesity. Finally, other indicators of adiposity, such as body-fat percentage and waist circumference, which many studies have noted reflect the prevalence of overweight, obesity and body-fat distribution, were not obtained in our study [40 41].

Conclusions

In conclusion, the present study indicates that the prevalence of overweight and obesity among adult residents in Xinjiang in northwest China has been very high during the past years. Furthermore, the main influencing factors for overweight and obesity are sex, age, race, marital status, education level, occupation, smoking, drinking, hypertension, diabetes and dyslipidaemia. These data suggest that efforts related to the prevention and control of overweight and obesity should be a public health priority in the northwest of China. These findings will be submitted to relevant departments as a reference for efforts to reverse these trends.

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Conflicts of Interest: The authors declare no conflict of interest.

Ethics approval: This study was carried out in accordance with the Declaration of Helsinki and the study protocol was approved by the Ethics Committee of the First Affiliated Hospital of Xinjiang Medical University (Xinjiang, China) (approval ID:20100116-01).

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Table 1 Prevalence of overweight and obesity according to demographic characteristics

Characteristic	N	Overweight			Obesity		
		n (%)	χ2	*P*	n (%)	χ2	*P*
Sex							
Male	6819	2735(40.1)	71.1	<0.001*	1856 (27.2)	3.7	0.05
Female	7799	2603(33.4)			2013(25.8)		
Age (years)							
35-44	5425	1866(34.4)	20.3	<0.001*	1146(21.1)	149.8	<0.001*
45-54	3759	1441(38.3)			1153(30.7)		
55-64	2932	1067(36.4)			919(31.3)		
≥65	2502	964(38.5)			651(26.0)		

Area							
Urban	7974	3163(39.7)	75.1	<0.001*	1956(24.5)	33.9	<0.001*
Rural	6644	2175(32.7)			1913(28.8)		
Ethnicity							
Han	5757	2380(16.3)	99.1	<0.001*	1082(7.4)	331.9	<0.001*
Uyghur	4767	1635(11.2)			1361(9.3)		
Kazak	4094	1323(9.1)			1426(9.8)		
Occupation							
Manual labour	4583	1760(12.0)	12.1	0.002*	1095(7.5)	32.1	<0.001*
White collar	7751	2736(18.7)			2086(14.3)		
Other	2284	842(5.8)			688(4.7)		
Education							
Primary school and below	5805	1993(13.6)	26.9	<0.001*	1589(10.87)	21.2	<0.001*
Junior middle school	3094	1196(8.2)			844(5.8)		
Senior middle school	4556	1676(11.5)			1191(8.2)		
Undergraduate and above	1163	473(3.2)			245(1.7)		
Marriage							
Unmarried	192	59(0.4)	14.1	<0.001*	27(0.2)	23.1	<0.001*
Married	12988	4795(32.8)			3427(23.4)		
Divorced	201	53(0.4)			47(0.2)		
Widowed	1237	431(3.0)			368(2.5)		
Drinking							
Yes	4169	923(6.3)	44.5	<0.001*	663(4.5)	24.6	<0.001*
No	10449	4415(30.2)			3206(21.9)		
Smoking							
Yes	2151	1688(11.6)	39.7	<0.001*	1101(7.5)	0.01	0.92
No	12467	3650(25.0)			2768(18.9)		

Hypertension							
Yes	5701	2138(14.6)	3.9	0.05	2155(14.7)	616.8	<0.001*
No	8917	3200(21.9)			1714(11.7)		
Diabetes							
Yes	859	335(2.3)	2.4	0.1	317(2.2)	51.0	<0.001*
No	13759	5003(34.2)			3552(24.3)		
Dyslipidaemia							
Hypertriglyceridemia							
Yes	4113	1724(11.8)	72.0	<0.001*	1497(10.2)	289.9	<0.001*
No	10505	3614(24.7)			2372(16.2)		
Hypercholesterolemia							
Yes	3787	1469(10.1)	11.4	0.001*	1267(8.7)	128.3	<0.001*
No	10831	3869(26.5)			2602(17.8)		
High LDL-C							
Yes	5251	1921(13.1)	0.02	0.9	1334(9.1)	4.8	0.03*
No	9367	3417(23.4)			2535(17.3)		
Low HDL-C							
Yes	4437	1704(11.7)	9.8	0.002*	1215(8.3)	2.8	0.09
No	10831	3634(24.9)			2654(18.2)		

Categorical variables are presented as counts and percentages. HDL-c, high density lipoprotein-cholesterol; LDL-c, low density lipoprotein-cholesterol.

Data were compared by χ^2 tests. *P<0.05, Statistically significant.

Table 2 Prevalence of overweight and obesity in men and women according to age group

Age	Overweight		P	Obesity		P
(years)	Male(%)	female(%)		male(%)	female(%)	
35-44	994(40.2)	872(29.5)	<0.001	631(25.5)	515(17.4)	<0.001
45-54	735(43.1)	706(34.4)		517(30.3)	636(31.0)	
55-64	476(35.8)	591(36.8)		389(29.3)	531(33.0)	
≥65	530(40.3)	434(36.5)		319(24.3)	332(27.9)	

Date were compared by χ^2 tests. *P<0.05, Statistically significant.

Table 3 Prevalence of overweight and obesity in Han, Uyghur and Kazak according to age group

Age (years)	Overweight			*P*	Obesity			*P*
	Han(%)	Uyghur(%)	Kazak(%)		Han(%)	Uyghur(%)	Kazak(%)	
35-44	712(35.0)	573(34.6)	581(33.6)	<0.001	273(13.4)	422(25.5)	451(26.1)	<0.001
45-54	599(43.9)	481(38.1)	361(31.9)		246(18.0)	436(34.5)	471(41.6)	
55-64	497(45.9)	354(32.6)	216(28.3)		268(24.7)	318(29.3)	333(43.6)	
≥65	572(45.0)	227(29.9)	165(35.1)		295(23.2)	185(24.3)	171(36.4)	

Date were compared by χ^2 tests. *P<0.05, Statistically significant.

Table 4 Multivariable regression analysis of correlates of overweight and obesity in residents of Xinjiang Province

Characteristic	**B**	**S.E.**	**Wald**	**df**	***P***	**OR**	**95%CI**
Area	-0.1	0.04	10.4	1	0.001*	0.9	0.8-0.9
Sex	-0.3	0.05	32.5	1	<0.001*	0.8	0.7-0.8
Ethnicity			94.4	2	<0.001*		
Han	-	-	-	-	-	1	-
Uygur	0.4	0.05	50.0	1	<0.001*	1.4	1.3-1.6
Kazakh	0.50	0.05	86.2	1	<0.001*	1.7	1.5-1.8
Age (years)			71.2	3	<0.001*		
35-44	-	-	-	-	-	1	-
45-54	0.4	0.05	62.8	1	<0.001*	1.5	1.3-1.6
55-64	0.3	0.05	24.6	1	<0.001*	1.3	1.2-1.5
≥65	0.1	0.06	3.1	1	0.08	1.11	1.0-1.3
Education			17.9	3	<0.001*		
Primary school and below	-	-	-	-	-	1	-
Junior middle school	0.2	0.05	15.6	1	<0.001*	1.2	1.1-1.4
Senior middle school	0.2	0.06	7.0	1	0.008*	1.2	1.0-1.3

Undergraduate and above	0.2	0.08	6.8	1	0.009*	1.3	1.1-1.5
Occupation			10.4	2	0.006*		
Manual labour	-	-	-	-	-	1	-
White collar	0.01	0.05	0.04	1	0.8	1.0	0.9-1.1
Other	0.2	0.06	7.9	1	0.005*	1.2	1.1-1.4
Marriage			26.5	3	<0.001		
Unmarried	-	-	-	-	-	1	-
Married	0.6	0.2	15.5	1	<0.001*	1.8	1.4-2.5
Divorced	0.1	0.2	0.2	1	0.7	1.1	0.7-1.7
Widowed	0.6	0.2	12.4	1	<0.001*	1.8	1.3-2.5
Smoking	-0.2	0.05	9.0	1	0.003*	0.9	0.8-0.9
Drinking	0.4	0.06	34.8	1	<0.001*	1.5	1.3-1.6
Hypertension	0.8	0.04	340.4	1	<0.001*	2.1	2.0-2.3
Diabetes	0.3	0.09	10.4	1	0.001*	1.3	1.1-1.6
Dyslipidaemia							
Hypertriglyceridemia	0.9	0.05	371.4	1	<0.001*	2.4	2.2-2.7
Hypercholesterolemia	0.2	0.05	20.9	1	<0.001*	1.2	1.1-1.3
Low HDL-C	0.1	0.04	6.4	1	0.01*	1.1	1.0-1.2
High LDL-C	0.02	0.04	0.16	1	0.69	1.0	0.9-1.1
Constant	-1.0	0.2	35.3	1	<0.001	-	-

*P<0.05, Statistically significant.

Supplementary Table 1 Prevalence of underweight

Characteristic	N	Underweight	
		n（%）	*P*
Sex			
Male	6819	71(1.04)	<0.001
Female	7799	219(2.81)	

*$P<0.05$, Statistically significant.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (On page 1, line 1)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found (On page 2)
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported (On page 2, line 2-5)
Objectives	3	State specific objectives, including any prespecified hypotheses (On page 2, line 2-5)
Methods		
Study design	4	Present key elements of study design early in the paper (On page 4, line 9)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection (On page 2, line 7)
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants (On page 4, line 9-20)
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable (On page 5,6)
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group (On page 4,5)
Bias	9	Describe any efforts to address potential sources of bias (On page 11, line 1-3)
Study size	10	Explain how the study size was arrived at (On page 4, line 15-16)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why (On page 4,5)
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding (On page 6)
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy (On page 6)
		(*e*) Describe any sensitivity analyses

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (On page 4, line 15-16)
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (On page 14, Table1)
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures (On page 6-7)
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (On page 6,7)
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period (On page 6,7)
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses (On page 6,7)
Discussion		
Key results	18	Summarise key results with reference to study objectives (On page 8)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias (On page 10,11)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence (On page 11)
Generalisability	21	Discuss the generalisability (external validity) of the study results (On page 11)
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based (On page 11)

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.