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Prevalence and distribution of hypertension and related risk factors in Jilin Province, China 2015

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Abstract

Objective: To investigate the prevalence and distribution of hypertension and its associated factors in Jilin province in China.

Design: a cross-sectional study in four cities and four rural counties in the province as part of a national China study.

Participants and setting: A total of 15206 participants aged 15 years old or older selected using a stratified multistage random sampling method.

Main outcome measures: prevalence of hypertension.

Results: The prevalence of hypertension in Jilin province was found to be 24.7%. Moreover, the prevalence of hypertension increased with age in both sexes, and was higher in males than in females. Body mass index, smoking and alcohol drinking were associated with the prevalence of hypertension. All these risk factors above are similar compared with southern China, except smoking, which has no association with hypertension prevalence in the South.

Conclusions: Age, sex, body mass index, smoking, and alcohol drinking are risk factors of hypertension. Control of these related risk factors, especially smoking, may be helpful in the treatment and management of hypertension in Jilin province.

Strength and limitations of this study

This is a cross-sectional population-based study performed in four cities and four rural counties in Jilin province.

A large sample of participants allowed for the subgroups of related factors for

statistical analysis.

The causality cannot be assumed between the risk factors and hypertension.

Data relevant to physical activity, salt intake and blood lipids were not collected.

Key words

Prevalence, hypertension, epidemiology, China, Jilin province

Introduction

As highlighted in the recent World Health Organization report, cardiovascular disease (CVD) is at the top of the list of the four prioritized non-communicable diseases worldwide that require immediate global action plans for prevention and control[1]. Hypertension is among the leading cause of cardiovascular disease and deaths worldwide [2, 3]. It is estimated that the global economic burden related to hypertension could be as high as US$ 370 billion [4].

In the People's Republic of China, the prevalence of hypertension has been increasing dramatically from 5.1% in 1959, 7.7% in 1979, 13.6% in 1991 to 18.8% in 2002 [5, 6]. Further, there is a disproportionately higher hypertension rate reported among people living in the northern region of China[7, 8]. The province of Jilin is located in the northeast of China, with a population of approximately 27.5 million according to the National Bureau of Statistics. As for other northern provinces, Jilin has a longer winter season in comparison with the southern China, and, limited by this environment, the lifestyle of the people is different from the other parts of the country.

An in-depth analysis of the survey results from Jilin province related to risk factors for hypertension will provide an opportunity to understand the differential reasons for hypertension in the North, and will assist in the development of effective intervention and control strategies for this preventable disease. The objectives of this study were: to estimate the prevalence of hypertension in Jilin province and to explore potential risk factors associated with hypertension in the province. This will provide information for making recommendations on the prevention and control of hypertension in the northern region of China.

Methods

Study population

This cross-sectional study was conducted between July 2014 and December 2015. A 4-stage, stratified sampling method was used to select a representative sample of the general population age 15 years and older in Jilin province, China. First, four cities from the urban areas and four counties from rural areas were selected using probability proportional to size (PPS). Then two districts or two townships were selected in each city or county using simple random sampling (SRS). Next, in each district and township, three communities or villages were chosen respectively using SRS. Finally, participants stratified by sex (50% men and 50% women) and age (aged 15-24, 25-34, 35-44, 45-54, 55-64, 65-74, , 65-74, ≥75 years) were chosen using SRS according to the national population composition. Participants were chosen from the list provided by the local government registers of households [9].

Considering a design effect of 2.5 and assuming a prevalence of hypertension of 17.7% among the population aged 15 years and older, an estimated sample size of 15,200 participants was needed to ensure that the bound on the error of estimation (i.e. width of the 95% confidence interval (CI)) for the prevalence in the entire population and subpopulation defined by age and sex were less than 0.4% and 1.8%, respectively [9]. As a result, a total of 15,206 participants living in Jilin province over 6 months and aged 15 years and older were randomly selected to participate in the survey.

Measurement

A questionnaire interview and physical examination were conducted in the survey. The standardized questionnaire was developed by the national coordinating center of the Fuwai Hospital (Beijing, China) and included questions on demographic, health behaviors and physical activities. The questionnaire was completed by the participants in a face-to-face interview with trained staff.

The physical examination included blood pressure (BP), body weight and height. BP was measured on the right arm supported at the heart level after participants rested for five minutes, using the Omron HBP-1300 Professional Portable Blood Pressure Monitor (OMRON, Japan). BP was measured three times, with 30 seconds between each measurement. The average of three readings was used for further analysis [10]. Body weight without heavy clothing, basal metabolism (BM), body fat percentage (BFP) and visceral fat index (VFI) were measured using an OMRON body fat and weight measurement device (Vbody HBF-371, OMRON, Japan). Height was

measured without shoes using a standard right-angle device and a fixed measurement tape (to the nearest 0.5 cm).

Definitions

Hypertension was defined as systolic BP (SBP)≥140mmHg or diastolic BP (DBP)≥90mmHg, or self-reported use of antihypertensive medication [11]. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Overweight was defined as BMI 25-30kg/m^2, and obesity was defined as BMI＞30kg/m^2.

Statistical analysis

Data was entered and validated using Epidata® 3.0 software[12]. All estimates and analyses were weighted to represent the population in Jilin Province aged 15 years or older. The weights were calculated based on the 2010 Jilin province population census data, and the sampling age, sex and geographic subgroups were taken into account. Continuous data were presented as mean ± standard deviation (SD) or mean with 95% confidence intervals (CI), and differences between groups were compared using the t-est. Categorical data were presented as frequency, rate and 95% CI, and the prevalence between different groups was compared using the corrected Rao-Scott chi-square test. Logistic regression analysis was conducted assessing the relationship of age, sex, obesity, smoking, and alcohol drinking for hypertension adjusted for demographic factors, that have been included in similar studies, including

sex, region, age, education level, employment status, marital status, BMI, and family history of hypertension. All analyses were conducted using SPSS® 18.0 software[13].

Results

Distribution of participants

A total of 14,956 participants from 15,206 eligible participants (6,946 males and 8,010 females; aged 15–97 years) completed the survey and were included in the statistical analysis. The non-responders (1.6%) were mainly young people with nonresponse likely related to their busy work schedule. The average age of the participants was 45.5 years, with the average age for males being 45.6±19.6 years and for females 45.5±18.9 years. There was no statistically significant difference in age between the sexes (p=0.92). The distribution of participants by age and sex are shown in Table 1 and Figure 1.

Characteristics of participants

The BMI of the participants was 24.01±3.67 kg/m^2, BM was (1397.47±244.15), BFP was 26.20±8.4 and VFI was 8.54±4.99. The SBP of the participants was 128.92±17.97) mmHg, and the DBP was 76.81±10.36 mmHg. These physical characteristics by age and sex are shown in Supplementary Table 1. All these characters were statistically significantly different between males and females (p<0.01). In particular, BM and VFI for males was higher than for females in all age groups (Figure 2A and 2B), while BFP for females was higher than males in all age

groups (Figure 2C). BMI reached its highest value for males in the 35-44 year age group and for females in the 55-66 year age group (Figure 2D). The SBP was similar between males and females in all age groups (Figure 2E), yet the DBP of males was higher than for female in all age groups (Figure 2F).

Lifestyle risk factors - obesity, smoking and alcohol drinking

The prevalence of overweight and obesity of participants was 29.8% and 6.2%, respectively. The prevalence of overweight for the male participants was 30.9%, higher than for the female participants at 28.7% (p=0.013). On the other hand, there was no statistical difference between the prevalence of obesity of male participants (6.3%) and female participants (6.2%) (p=0.78). The percentage of current smoking and ever smoking was 22.7% and 1.4%, respectively. When stratified by sex, the percentage of current smoking in males (36.9%) was higher than in females (8.2%) (p<0.001). Similarly, the percentage of ever smoking in males (2.3%) was higher than that in females (0.5%) (p<0.001). The percentage of alcohol drinking was 17.6%. The percentage in males (32.0%) was significantly higher than in females (2.9%) (p<0.001). The risk factors BMI, smoking and alcohol drinking, summarized by age and sex, are shown in Table 2.

Prevalence of hypertension stratified by age and sex

Of the 14,956 participants, 4,332 were diagnosed with hypertension, and the prevalence of hypertension was 24.7% (95% CI: 23.9%, 25.5%). The prevalence of

hypertension was larger for the older age groups, and was higher in males (25.6%) than in females (23.8%) (p=0.03). For each age group less than 45 years, the prevalence of hypertension in males was higher than in females (p<0.001); while for the 65-74 year age group, the prevalence of hypertension in females was higher than in males (p=0.04); and in the other age groups, the prevalence of hypertension in males and females showed no statistical difference (p>0.05). The prevalence of hypertension stratified by age and sex is shown in Table 3.

Prevalence of hypertension stratified by obesity, smoking and alcohol drinking

The prevalence of hypertension was statistically different across BMI categories (p<0.001); the highest prevalence being reported was 48.1% in the obese group, followed by the overweight group at 35.7%. When stratified by smoking, the prevalence of hypertension also showed statistical differences between the current smoking, ever smoking, and never smoking groups (p<0.001); with the highest prevalence of 53.1% in the ever smoking group, followed by 32.2% in the current smoking group and 22.0% in the never smoking group. The prevalence of hypertension in the alcohol drinking group was 34.6%, higher than 22.6% in the no-alcohol drinking group (p<0.001). The prevalence of hypertension stratified by BMI, smoking and alcohol drinking are shown in Table 4.

Factors associated with hypertension

Several factors, including age, sex, obesity, smoking, and alcohol drinking, are

associated with the prevalence of hypertension, both in the crude model and adjusted logistic model. In particular, in the absence of adjusting for other factors, the univariate logistic model indicated that the risk of hypertension was greater in males with an OR=1.1 (95% CI: 1.01, 1.2) than in females, overweight partipants with an OR=2.52 (95% CI: 2.3, 2.77) than in normal participants, obese participants with an OR=4.21 (95% CI: 3.56, 4.96) than in normal participants, smokers with OR=1.64 (95% CI: 1.48, 1.81) than in non-smokers, and alcohol drinkers with OR=1.81 (95% CI: 1.62, 2.02) than in non-alcohol drinkers. All the difference were statistically significant ($p<0.05$). A multivariable logistic regression model was used to adjust for potential influencing factors. After adjustment for age, sex, region, education level, employment status, BMI, family history of hypertension, and marital status that may affect hypertension, the risk of hypertension was greater in males with an adjusted OR=1.26 (95% CI:1.13, 1.39) than in females, in overweigh participants with an adjusted OR=2.3 (95% CI: 2.06, 2.58) than in normal participants, in obese participants with an adjusted OR=5.11 (95% CI: 4.16, 6.27) than in normal participants, in smokers with an adjusted OR=1.28 (95% CI: 1.13, 1.46) than in non-smokers, and in alcohol drinkers with an adjusted OR=1.49 (95% CI: 1.28, 1.73). These results are shown in Table 5.

Discussion

With the estimated prevalence of hypertension in Jilin province of 24.7%, a population of approximately 6.8 million in the province are hypertensive. At the

national level, the prevalence of hypertension in Jilin is comparable to that in Zhejiang province [12]; while the prevalence is lower than in other regions in China, including Jiangxi [13], Inner Mongolia [14], and Macau [15], as well as, lower than the overall prevalence in China [16]. Worldwide, this prevalence is lower than that in the US, the UK, but is higher than that in Canada [4]. However, there are some limitations in terms of the direct comparisons among these studies, given the varying methods and environments and variations of population genetics.

Although the prevalence of 24.7% is lower than 30.8% that was found in 2012 [17], it is still not acceptable in terms of optimal hypertension health in the province. Our study found that the prevalence of overweight and obesity was 29.8% and 6.2%, respectively, which is higher than that reported at the national level of 17.7% and 5.6%, respectively[18]. Several studies have shown that obesity is a risk factor for the development of hypertension[19-21]. Obesity can increase hypertension through multiple mechanisms, including insulin resistance, activation of sympathetic nervous system, sodium retention leading to increase in renal reabsorption, and activation of the renin-angiotensin system[22]. The growing number of people with obesity and being overweight in the province of Jilin presents a strong indicator of the potential risk of future increasing incidence of hypertension. Unfortunately, this modifiable risk factor has exhibited no change in between the report in 2012 and now[17], not to mention that the population of overweight and obesity may have been underestimated, since the standard definition of overweight and obesity used in our research may be set too high for asian people[23, 24]. Moreover, some people may be abdominal obese

with a normal BMI value (18.5-24.9kg/m^2). Studies have reported that despite the normal BMI value, abdominal obesity is also a risk factor for hypertension worldwide[25, 26]. This modifiable risk factor deserves attention and requires an effective proactive intervention program to slow and ultimately reduce the number of individuals with obesity becoming hypertensive.

Our study found that the overall prevalence of hypertension increases with age in both males and females, especially in the range of 35-74 years of age. This result supports the hypothesis that age is one of the risk factors of hypertension [27-30]. An increasing lifespan among the population in Jilin requires that a practical and effective hypertension management strategy of intervention and control targeting the aging population be devloped. The overall prevalence of hypertension is higher in males than in females. However, the prevalence in females increased more rapidly than in males aged 65-74 years. This may be partially explained by hormonal changes in post-menopausal women and the difference in lifespan between males and females [4, 31]. However, the exact mechanisms need to be explored.

Consistent with previous studies [32, 33], our study also showed that smoking, both current and ever smoking, is associated with an increased risk of hypertension. Smoking can increase blood viscosity, stimulate the adrenergic nervous system, and contribute to the development of both micro- and macro-vascular diseases[34]. Although some studies reported weak associations between smoking and hypertension [13, 20], smoking is considered a major risk factor worldwide [13, 20, 35-37], Additionally, drinking of alcohol is also a factor associated with increasing the risk of

hypertension in our study, which is consistent with previous studies [4, 38-40]. These results indicate that changes in living habits, including quitting smoking and alcohol drinking, should help to reduce the prevalence of hypertension.

National studies reported that the prevalence of hypertension is higher in northern China than that in southern China[7, 16]. When comparing the associations between risk factors and hypertension with Zhejiang province located in the South[12], we found that the risk of hypertension with demographic factors, such as age, sex, and region, and clinical factors, such as family history of hypertension and abdominal waist circumference, were similar in Jilin province and in southern China. When it comes to the lifestyle factors, the risk of hypertension with obesity and alcohol drinking were similar, however, there was a marked difference in the modifiable risk factor smoking; in particular, in Jilin province there was a strong association with an adjusted OR=1.28 (95% CI: 1.13, 1.46), whereas no association between smoking and hypertension in southern China was found, with an adjusted OR=1.0 (95% CI: 0.9, 1.1). These findings indicate that programs aimed at reducing smoking would be an important step to mitigate the prevalence of hypertension in Jilin province. Some social factors including retirement status, marital status, and educationan level were also different between the North and the South. Of interest, there was a difference on BFP categories. In particular, for category 10-19 for males and 20-29 for females, there was no association between BFP and hypertension in Jilin province with an adjusted OR=0.95 (95%CI: 0.71, 1.27), whereas in this category BFP is protective againt hypertension in south China with an adjusted OR=0.6 (95% CI: 0.5, 0.8). In the

range of over 25 for males and over 35 for females, BFP is strongly associated with hypertension in Jilin province with an adjusted OR=1.45 (95% CI: 1.07, 1.96), whereas no association was found in the South with an adjusted OR=1.3 (95%CI: 1.0, 1.5). These results indicate that BFP tends to be more of a risk for hypertension in the North compared to the South. Studies have reported that high BFP increase blood pressure[41, 42]. There are also studies reporting that the relationship between BFP and BMI may be different in different ethnic groups[43], and the latter is already known to be a risk factor for hypertension. These studies provide inside of the different role BFP has on hypertension in the northern and southern China. Further studies on the relationship between BFP and hypertension need to be done.

A survey in 2012 found a prevalence of hypertension of 30.8% [17]. The prevalence of hypertension in our study was lower. This reduction may be related to the following two factors. First, the government of Jilin province is aware of the damage and burdern of hypertension and is dedicated to increase the funding of medical insurance, especially for rural residents, from RMB ¥3.9 billion in 2012 to RMB ¥6.4 billion, according to the statistical bureau of Jilin province. Second, new hypertension guidelines on grass-roots management of hypertension[44] and patient education[45] have been published in China since 2012. However, some key modifiable risk factors have exhibited slight negative changes, in particular, the trend towards obesity, drinking and smoking. This can be due in part to the evolving economy of Jilin province with the gross domestic product increasing from RMB ¥361.5 billion in 2015, to RMB ¥857.8 billion in 2010, to RMB ¥1.4 trillion in 2015,

according to the statistical bureau of Jilin province. To reverse these trends will require an effective and workable intervention program to control hypertension by incorporating best practices identified in theory and practice. For example, rates of hypertension awareness have greatly improved from 24.4% to 42.6%, treatment from 20.0% to 24.2% based on national surveys[16]. However, the control rate is only 9.3% in comparison with 53% in the USA[4]. One of the challenges is to improve adherence to anti-hypertension drugs.

There are some limitations in this study. First, this is a cross-sectional study design, thus the causality cannot be assumed between the risk factors and hypertension. Second, due to limited financial resource, data relevant to physical activity, salt intake and blood lipids were not collected. Third, the decrease of prevalence of hypertension in our study compared with that in 2012 may be related with sampling factor.

In summary, the prevalence of hypertension in Jilin province decreased compared with that in 2012, and is lower than the overall prevalence in China. In addition, the study showed that hypertension is associated with age, sex, obesity, smoking and alcohol drinking. In particular, smoking seemed to be responsible for the different prevalence of hypertension in northern and southern China. These factors above, especially smoking, might be important points to control and manage hypertension in Jilin province.

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Footnotes

Contributors

BL is involved in the design, JW, XS, LL, YY, YL, and CQ collected the data, YZ and YL performed the statistical analysis, TL, WS, and BL wrote the paper. All authors reviewed and approved the final version of the paper.

Ethics approval

This study was approved by the Fuwai Hospital Ethics Review Board.

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Competing interests

None declared.

Data sharing statement

No additional data are available.

Figure Captions

Figure 1: Population pyramid by age and sex of participants in Jilin province

Figure 2: Trends of physical characteristics by age and sex. (A) basal metabolism BM (B) body fat percentage - BFP (C) visceral fat index - VFI (D) body mass index - BMI (E) systolic blood pressure - SBP (F) diastolic blood pressure - DBP

Table 1: Distribution of participants by age and sex in Jilin province (N, %)

Age	Male		Female		Total	
	N	%	N	%	N	%
15-24	1120	9.07	1146	8.51	2266	17.59
25-34	1316	8.91	1520	8.52	2836	17.43
35-44	1084	11.95	1359	11.40	2443	23.35
45-54	1043	10.02	1333	9.68	2376	19.70
55-64	950	6.36	1121	6.47	2071	12.83
65-74	755	3.01	823	3.23	1578	6.24
75+	678	1.31	708	1.55	1386	2.86
Total	6946	50.63	8010	49.37	14956	100.0

492 **Table 2:** Distribution of participants by age and sex stratified by body mass index, smoking and alcoholic drinking in Jilin province (%, 95%CI)

	BMI				Smoking			Alcohol Drinking
	<18.5	18.5-25.0	25.0-30.0	>30.0	Current	Ever	Never	
Male								
15-24	13.33	67.57	14.85	4.25	6.95	0.36	92.69	5.80
	(11.11,15.91)	(64.24,70.73)	(12.58,17.46)	(3.03,5.93)	(5.47,8.80)	(0.10,1.22)	(90.79,94.22)	(4.62, 7.26)
25-34	2.80	57.76	31.36	8.08	39.19	0.64	60.17	29.70
	(1.98,3.93)	(54.70,60.77)	(28.57,34.30)	(6.52,9.96)	(36.20,42.26)	(0.30,1.37)	(57.09,63.17)	(26.96, 32.60)
35-44	1.89	54.86	35.26	7.99	46.92	1.32	51.76	39.90
	(0.18,3.01)	(51.49,58.18)	(32.10,38.55)	(6.35,10.02)	(43.57,50.30)	(0.79,2.18)	(48.39,55.12)	(36.62, 43.26)
45-54	1.56	55.63	36.25	6.56	48.42	3.19	48.38	44.70
	(0.93,2.60)	(52.33,58.88)	(33.14,39.47)	(5.11,8.39)	(45.13,51.73)	(2.25,4.52)	(45.10,51.68)	(41.44, 48.00)
55-64	0.79	59.10	35.17	4.94	44.79	5.19	50.02	39.30
	(0.39,1.60)	(55.67,62.44)	(31.96,38.52)	(3.65,6.66)	(41.38,48.25)	(3.88,6.91)	(46.57,53.47)	(35.99, 42.71)
65-74	2.16	60.45	33.51	3.88	32.13	6.99	60.88	34.30
	(1.26,3.69)	(56.54,64.22)	(29.91,37.33)	(2.66,5.62)	(28.57,35.91)	(5.22,9.30)	(56.97,64.65)	(30.65, 38.14)
75+	3.71	62.83	30.22	3.23	22.06	5.58	72.35	18.74
	(2.53,5.42)	(58.82,66.68)	(26.61,34.10)	(2.01,5.15)	(18.85,25.64)	(3.96,7.82)	(68.54,75.87)	(15.72, 22.19)
Female								
15-24	13.46	70.77	12.55	3.22	0.36	0.00	99.64	0.76
	(11.24,16.03)	(67.48,73.85)	(10.34,15.16)	(2.34,4.43)	(0.11,1.16)		(98.84,99.89)	(0.43,1.35)
25-34	6.46	66.10	22.33	5.11	2.90	0.06	97.04	3.50
	(5.25,7.94)	(63.37,68.72)	(20.06,24.79)	(3.97,6.55)	(2.05,4.08)	(0.01,0.44)	(95.85,97.89)	(2.65,4.62)
35-44	1.81	61.59	29.86	6.74	8.00	0.07	91.93	4.40
	(1.16,2.81)	(58.64,64.45)	(27.18,32.67)	(5.38,8.41)	(6.45,9.88)	(0.01,0.50)	(90.05,93.49)	(3.37,5.73)

45-54	1.99	54.20	36.38	7.44	10.36	0.52	89.12	3.08
	(1.29,3.04)	(51.27,57.09)	(33.62,39.24)	(6.05,9.11)	(8.69,12.31)	(0.23,1.17)	(87.14,90.83)	(2.23,4.25)
55-64	2.53	48.89	40.24	8.34	16.81	1.46	81.73	2.53
	(1.72,3.71)	(45.72,52.08)	(37.17,43.39)	(6.72,10.30)	(14.58,19.30)	(0.85,2.49)	(79.16,84.05)	(1.68,3.81)
65-74	4.89	50.05	38.50	6.57	17.61	1.68	80.71	1.81
	(3.53,6.72)	(46.31,53.78)	(34.91,42.22)	(4.94,8.67)	(14.97,20.60)	(0.93,2.99)	(77.62,83.47)	(1.03,3.16)
75+	10.17	57.46	26.17	6.20	12.82	1.27	85.91	2.48
	(7.87,13.04)	(53.37,61.45)	(22.77,29.89)	(4.50,8.50)	(10.29,15.87)	(0.64,2.50)	(82.77,88.55)	(1.45,4.23)

Table 3: Prevalence of hypertension by age and sex in Jilin province

Age group	Male n	Male CR(95%CI)	Female n	Female CR(95%CI)	Total n	Total CR(95%CI)
15-24	80	6.86(5.27,8.87)	23	1.88(1.19,2.96)	103	4.45(3.53,5.59)
25-34	106	8.47(6.89,10.36)	50	4.28(3.20,5.69)	156	6.42(5.43,7.58)
35-44	221	21.00(18.36,23.91)	195	15.21(13.14,17.55)	416	18.17(16.45,20.03)
45-54	379	35.13(32.06,38.33)	430	32.57(29.89,35.36)	809	33.87(31.82,35.99)
55-64	449	46.42(43.00,49.87)	576	50.72(47.54,53.90)	1025	48.59(46.25,50.94)
65-74	451	59.91(55.98,63.71)	518	65.32(61.72,68.76)	969	62.71(60.06,65.29)
75+	405	61.24(57.24,65.10)	449	62.37(58.30,66.28)	854	61.86(59.00,64.63)

CI: confidence interval

496 **Table.4** Prevalence of hypertension by age and sex stratified by body mass index, smoking and alcoholic drinking (%, 95%CI)

	BMI				Smoking			Alcohol Drinking	
	<18.5	18.5-25.0	25.0-30.0	>30.0	Current	Ever	Never	Yes	No
Male									
15-24	1.48 (0.37,5.76)	4.39 (2.94,6.51)	16.22 (10.62,24.00)	30.17 (16.58,48.44)	8.17 (3.45,18.15)	13.13 (1.35,62.57)	6.73 (5.10,8.84)	11.60 (5.85,21.69)	6.56 (4.95, 8.66)
25-34	1.45 (0.20,9.72)	5.33 (3.78,7.46)	9.15 (6.43,12.85)	30.70 (21.42,41.86)	11.49 (8.66,15.08)	6.89 (0.88,38.13)	6.51 (4.80,8.78)	10.64 (7.63, 14.64)	7.55 (5.80, 9.77)
35-44	5.49 (0.97,25.57)	14.76 (11.77,18.34)	25.87 (21.16,31.22)	45.98 (34.53,57.87)	23.76 (19.72,28.33)	36.23 (16.51,62.01)	18.11 (14.77,22.00)	28.02 (23.40, 33.16)	16.34 (13.35,19.84)
45-54	27.39 (10.96,53.63)	25.02 (21.38,29.05)	44.90 (39.57,50.35)	68.73 (55.83,79.27)	37.10 (32.60,41.83)	41.53 (25.83,59.16)	32.74 (28.51,37.27)	43.01 (38.20, 47.96)	28.76 (24.95, 32.91)
55-64	11.46 (2.44,40.14)	39.64 (35.33,44.11)	55.87 (50.07,79.30)	65.91 (50.62,78.48)	47.15 (42.04,52.33)	61.46 (46.39,74.61)	44.21 (39.43,49.09)	52.10 (46.61, 57.54)	42.74 (38.42, 47.18)
65-74	19.58 (6.35,46.63)	52.27 (47.16,57.34)	73.86 (67.56,15.96)	80.86 (61.30,91.85)	60.60 (53.60,67.20)	74.69 (59.79,85.42)	57.84 (52.78,62.74)	66.86 (60.21, 72.89)	56.58 (51.40, 61.04)
75+	37.87 (21.57,57.45)	58.85 (53.77,63.76)	66.71 (59.34,73.34)	83.47 (57.75,94.91)	68.66 (60.13,76.08)	59.10 (41.42,74.69)	59.15 (54.42,63.71)	65.17 (55.63, 73.63)	60.34 (55.90, 64.62)
Female									
15-24	1.50 (0.37,5.81)	0.91 (0.42,1.98)	5.62 (2.53,12.01)	10.02 (3.85,23.67)	0.00	0.00	1.88 (1.19,2.97)	0.00	1.89 (1.19,2.98)
25-34	0.00	2.16 (1.29,3.59)	6.56 (4.03,10.51)	27.09 (16.97,40.31)	12.35 (4.36,30.33)	0.00	4.04 (2.98,5.44)	0.66 (0.09,4.63)	4.41 (3.29,5.87)
35-44	17.78 (5.86,42.90)	9.70 (7.67,12.20)	22.05 (17.69,27.14)	34.59 (24.35,46.49)	19.76 (12.41,29.97)	100.00 (100.00,100.00)	14.75 (12.62,17.17)	25.47 (14.99,39.84)	14.74 (12.65,17.11)

45-54	0.00	24.68	40.48	60.03	34.92	61.78	32.13	27.45	32.73
		(21.42,28.27)	(35.84,45.30)	(49.33,69.86)	(26.73,44.12)	(22.45,90.03)	(29.31,35.08)	(15.31,44.19)	(30.01,35.57)
55-64	40.61	39.07	61.42	70.47	51.28	62.47	50.40	51.62	50.70
	(23.68,60.12)	(34.71,43.61)	(56.48,66.14)	(59.27,79.64)	(43.64,58.86)	(35.28,83.56)	(46.87,53.92)	(31.60,71.13)	(47.48,53.91)
65-74	38.58	59.74	74.83	72.04	65.26	57.48	65.50	50.45	65.60
	(24.16,55.33)	(54.53,64.73)	(69.27,79.68)	(57.14,83.28)	(56.45,73.13)	(29.24,81.56)	(61.48,69.31)	(24.78,75.88)	(61.97,69.05)
75+	45.30	60.64	73.24	60.53	64.01	100.00	61.57	51.72	62.64
	(32.73,58.49)	(55.25,65.79)	(65.79,79.57)	(43.53,75.31)	(52.10,74.41)	(100.00,100.00)	(57.18,65.79)	(26.49,76.10)	(58.53,66.58)

Table.5 Risk factors associated with the prevalence of hypertension

	Hypertension prevalence	
	Unadjusted	Adjusted
Age(Ref: 15-24)		
25-34	1.47(1.09,1.99)	1.05(0.71,1.55)
35-44	4.77(3.65,6.24)	2.83(1.90,4.22)
45-54	11.01(8.51,14.24)	6.93(4.69,10.24)
55-64	20.31(15.69,26.29)	13.43(9.06,19.90)
65-74	36.14(27.73,47.11)	26.18(17.56,39.03)
75+	34.85(26.65,45.57)	29.89(19.83,45.03)
Sex(Ref: female)	1.1(1.01,1.2)	1.25(1.13,1.39)
Region(Ref: Urban)	1.19(1.09,1.3)	1.25(1.12,1.39)
Race(Ref: Han)	1.15(0.93,1.42)	0.93(0.74,1.18)
Employment(Ref: be employed)		
Retired	2.67(2.22,3.2)	0.67(0.53,0.85)
Student	0.15(0.11,0.21)	1.09(0.71,1.70)
Unemployed	1.18(1.07,1.3)	0.84(0.74,0.95)
Marital(Ref: married)	0.72(0.63,0.83)	1.29(1.00,1.65)
Education level(Ref: college or higher)		
Illiterate	6.69(5.19,8.63)	2.18(1.62,2.93)
Primary	3.26(2.7,3.93)	1.98(1.60,2.44)
Middle	1.55(1.24,1.94)	1.24(0.97,1.57)
BMI(Ref: Normal)		
Overweight	2.22(2.01,2.46)	2.30(2.06,2.57)
Obese	3.96(3.31,4.75)	5.17(4.20,6.37)
AWC(Ref:<90M,<85F)		
≥90M，≥85F	1.41(1.23,1.62)	1.35(1.16,1.57)
≥95M，≥90F	1.5(1.32,1.72)	1.68(1.43,1.96)
Family history of hypertension	1.74(1.55,1.96)	2.35(2.06,2.67)
Family history of stroke	1.33(0.85,2.06)	1.79(1.09,2.92)
Family history of CAD	3.18(2.64,3.83)	1.65(1.33,2.03)
Smoker(Ref: no)	1.37(1.23,1.53)	1.23(1.08,1.40)
Drinker(Ref: no)	1.56(1.38,1.77)	1.47(1.27,1.71)
VAI（Ref:＜10)		
10~14	1.6(1.41,1.8)	1.40(1.22,1.60)
15~30	2.69(2.29,3.16)	2.05(1.69,2.49)
BFP(Ref:＜10M，＜20F)		
10~19M，20~29F	1.31(1,1.71)	0.95(0.71,1.27)
20~24M，30~34F	2.72(2.09,3.55)	1.24(0.92,1.66)
≥25M，≥35F	3.48(2.67,4.54)	1.45(1.07,1.96)

CI: confidence interval; BMI: body mass index; AWC: Abdominal waist circumference; CAD: coronary heart disease; M: male; F: female; VAI: Visceral Fat; BFP: body fat percentage.

Adjusted for sex, region, age, education level, employment status, marital status, BMI, and family history of hypertension

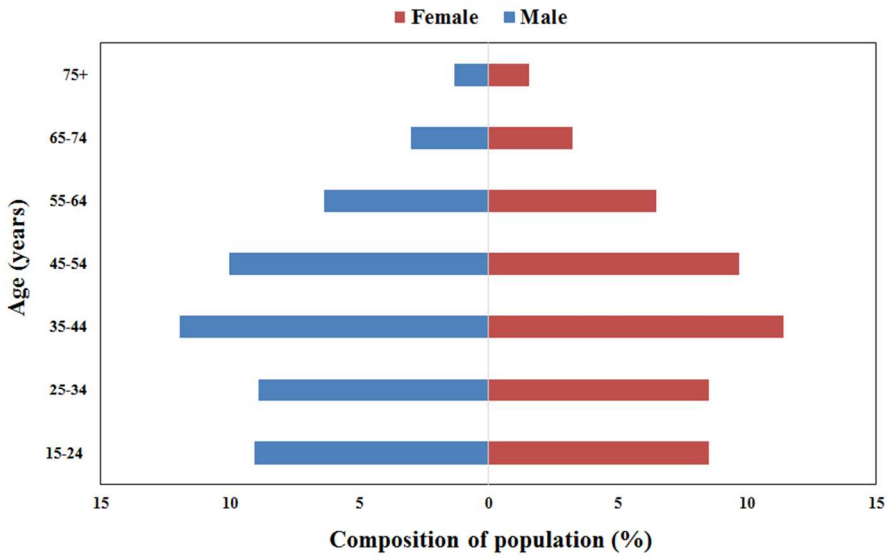

Figure 1: Population pyramid by age and sex of participants in Jilin province

83x58mm (300 x 300 DPI)

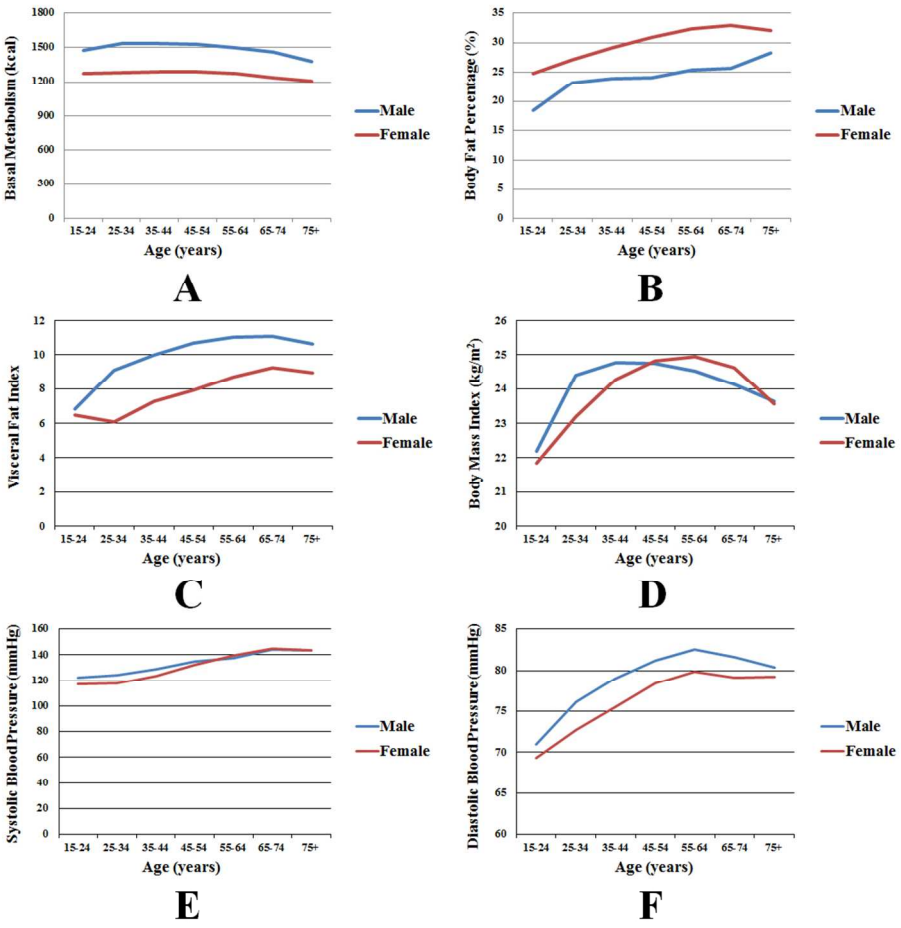

Figure 2: Trends of physical characteristics by age and sex. (A) basal metabolism BM (B) body fat percentage - BFP (C) visceral fat index - VFI (D) body mass index - BMI (E) systolic blood pressure - SBP (F) diastolic blood pressure - DBP

99x98mm (300 x 300 DPI)

Supplementary Table Descriptions of basal metabolism – BM, body fat percentage – BFP, visceral fat index - VFI by age and sex in Jilin province

	Age	Male		Female	
		Mean	95%CI	Mean	95%CI
BM	Total	1511.50	(1504.56, 1518.43)	1280.52	(1276.09, 1284.96)
	15-24	1478.92	(1456.95, 1500.88)	1279.31	(1264.09, 1294.53)
	25-34	1538.93	(1524.04, 1553.81)	1281.66	(1272.68,1290.64)
	35-44	1534.48	(1519.02, 1549.95)	1293.35	(1284.03, 1302.67)
	45-54	1528.84	(1514.65, 1543.02)	1293.81	(1284.74, 1302.87)
	55-64	1499.65	(1486.40, 1512.90)	1274.36	(1264.67, 1284.06)
	65-74	1460.36	(1443.82, 1476.89)	1241.86	(1230.00, 1253.73)
	75+	1382.81	(1367.17, 1398.45)	1209.84	(1195.08, 1224.59)
Body Fat percentage	Total	23.28	(23.03, 23.53)	29.19	(29.02, 29.35)
	15-24	18.46	(17.52, 19.40)	24.78	(24.38, 25.18)
	25-34	23.26	(22.87, 23.65)	27.20	(26.88,27.52)
	35-44	24.02	(23.64, 24.40)	29.19	(28.86, 29.52)
	45-54	24.09	(23.76, 24.41)	30.95	(30.61, 31.29)
	55-64	25.34	(24.58, 26.10)	32.39	(31.99, 32.80)
	65-74	25.74	(25.30, 26.17)	32.97	(32.46, 33.48)
	75+	28.31	(27.06, 29.56)	32.08	(31.15, 33.00)
VAI	Total	9.63	(9.49, 9.77)	7.42	(7.29, 7.55)
	15-24	6.81	(6.54, 7.08)	6.48	(6.05, 6.91)
	25-34	9.13	(8.81, 9.46)	6.07	(5.83, 6.30)
	35-44	10.01	(9.70, 10.32)	7.25	(6.96, 7.54)
	45-54	10.71	(10.39, 11.03)	7.90	(7.68, 8.11)
	55-64	11.06	(10.74, 11.37)	8.71	(8.47, 8.96)
	65-74	11.11	(10.72, 11.49)	9.27	(8.81, 9.73)
	75+	10.64	(10.21, 11.07)	8.95	(8.56, 9.35)
BMI	Total	24.15	(24.05,24.25)	23.88	(23.78,23.97)
	15-24	22.20	(21.93,22.47)	21.86	(21.63,22.10)
	25-34	24.41	(24.18,24.63)	23.20	(22.99,23.42)
	35-44	24.78	(24.55,25.01)	24.29	(24.08,24.51)
	45-54	24.75	(24.54,25.01)	24.82	(24.63,25.02)
	55-64	24.54	(24.33,24.76)	24.96	(24.74,25.18)

	65-74	24.14	(23.88,24.40)	24.63	(24.35,24.92)
	75+	23.63	(23.37,23.89)	23.56	(23.24,23.88)
SBP	Total	130.44	(129.99,130.88)	127.36	(126.90,127.81)
	15-24	122.45	(121.67,123.24)	116.81	(116.13,117.50)
	25-34	124.43	(123.77,125.08)	117.93	(117.28,118.58)
	35-44	128.76	(127.85,129.67)	123.85	(122.95,124.75)
	45-54	134.69	(133.51,135.87)	132.39	(131.28,133.49)
	55-64	137.56	(136.22,138.91)	139.53	(138.17,140.90)
	65-74	143.98	(142.25,145.71)	145.16	(143.55,146.76)
	75+	143.69	(141.96,145.42)	143.44	(141.60,145.28)
DBP	Total	78.14	(77.84,78.43)	75.45	(75.19,75.71)
	15-24	70.98	(70.43,71.53)	69.35	(68.82,69.88)
	25-34	76.13	(75.63,76.63)	72.69	(72.25,73.13)
	35-44	79.04	(78.42,79.66)	75.47	(74.91,76.03)
	45-54	81.24	(80.51,81.96)	78.41	(77.79,79.03)
	55-64	82.50	(81.67,83.33)	79.87	(79.15,80.60)
	65-74	81.56	(80.72,82.40)	79.13	(78.35,79.91)
	75+	80.38	(79.61,81.15)	79.26	(78.41,80.11)

CI: confidence interval

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 P1-2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found P2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported P3
Objectives	3	State specific objectives, including any prespecified hypotheses P4
Methods		
Study design	4	Present key elements of study design early in the paper P4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection P4-5
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 P4
		(*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 P6
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 P5
Bias	9	Describe any efforts to address potential sources of bias P5
Study size	10	Explain how the study size was arrived at P4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why P5-6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding P6
		(*b*) Describe any methods used to examine subgroups and interactions P6
		(*c*) Explain how missing data were addressed P6
		(*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 N/A
		(*e*) Describe any sensitivity analyses N/A

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 P7
		(b) Give reasons for non-participation at each stage P7
		(c) Consider use of a flow diagram N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders P7
		(b) Indicate number of participants with missing data for each variable of interest N/A
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount) N/A
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 P7
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 P8
		(*b*) Report category boundaries when continuous variables were categorized P6
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses P8-9
Discussion		
Key results	18	Summarise key results with reference to study objectives P10
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 P15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence P10-14
Generalisability	21	Discuss the generalisability (external validity) of the study results P15
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 P19

*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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Prevalence and distribution of hypertension and related risk factors in Jilin Province, China 2015: a cross-sectional study

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Abstract

Objective: To investigate the prevalence and distribution of hypertension and its associated factors in Jilin province, China.

Design: a cross-sectional study in four cities and four rural counties in the province as part of a national Chinese study.

Participants and setting: A total of 15206 participants aged 15 years old or older selected using a stratified multistage random sampling method.

Main outcome measures: prevalence of hypertension.

Results: The prevalence of hypertension in Jilin province was found to be 24.7%. Moreover, the prevalence of hypertension increased with age in both sexes, and was higher in males than in females. The modifiable factors found to be associated with hypertension were, body mass index, smoking and alcohol drinking. The risk factors identified are similar to those in southern China, except smoking, which has no association with hypertension prevalence in the South.

Conclusions: Age, sex, body mass index, smoking, and alcohol drinking are risk factors of hypertension. Control of these related risk factors, especially smoking, may be helpful in the treatment and management of hypertension in Jilin province.

Strength and limitations of this study

This cross-sectional population-based study evaluated a large representative sample ofindividuals from four cities and four rural counties in Jilin province.

A large sample of participants allowed for the subgroups of related factors for

statistical analysis.

The causality cannot be assumed between the risk factors and hypertension.

Data relevant to physical activity, salt intake and blood lipids were not collected.

Key words

Prevalence, hypertension, epidemiology, China

Introduction

As highlighted in the recent World Health Organization report, cardiovascular diseases (CVD) are at the top of the list of the four prioritized non-communicable diseases worldwide that require immediate global action plans for prevention and control[1]. Hypertension is among the leading cause of cardiovascular diseases and deaths worldwide [2, 3]. It is estimated that the global economic burden related to hypertension could be as high as US$ 370 billion [4].

In the People's Republic of China, the prevalence of hypertension has been increasing dramatically from 5.1% in 1959, to 7.7% in 1979, 13.6% in 1991, and 18.8% in 2002 [5, 6]. Furthermore, there is a disproportionately higher hypertension rate reported among people living in the northern region of China[7, 8]. There are about 109.4 million people in the northeastern China. The province of Jilin is located in the northeast of China, with a population of approximately 27.5 million according to the National Bureau of Statistics. As for other northern provinces, Jilin has a longer winter season in comparison with the southern China, and, limited by this

environment, the lifestyle of the people is different from the other parts of the country.

An in-depth analysis of the survey results from Jilin province related to risk factors for hypertension will provide an opportunity to understand the differential reasons for hypertension in the North, and will assist in the development of effective intervention and control strategies for this preventable disease. The objectives of this study were: to estimate the prevalence of hypertension in Jilin province and to explore potential risk factors associated with hypertension in the province. This will provide information for making recommendations on the prevention and control of hypertension in the northern region of China.

Methods

Study population

This cross-sectional study was conducted between July 2014 and December 2015 as a part of national China study. A 4-stage, stratified sampling method was used to select a study sample of the general population age 15 years and older in Jilin province, China. First, four cities from the urban areas and four counties from rural areas were selected using probability proportional to size (PPS). Then two districts or two townships were selected in each city or county using simple random sampling (SRS). Next, in each district and township, three communities or villages were chosen respectively using SRS. Finally, participants stratified by sex (50% men and 50% women) and age (aged 15-24, 25-34, 35-44, 45-54, 55-64, 65-74, , 65-74, ≥75 years) were chosen using SRS according to the national population composition. Participants

were chosen from the list provided by the local government registers of households [9].

Considering a design effect of 2.5 and assuming a prevalence of hypertension of 17.7% among the population aged 15 years and older, an estimated sample size of 15,200 participants was needed to ensure that the bound on the error of estimation (i.e. width of the 95% confidence interval (CI)) for the prevalence in the entire population and subpopulation defined by age and sex were less than 0.4% and 1.8%, respectively [9]. As a result, a total of 15,206 participants living in Jilin province over 6 months and aged 15 years and older were randomly selected to participate in the survey.

Measurement

A questionnaire interview and physical examination were conducted in the survey. The standardized questionnaire was developed by the national coordinating center of the Fuwai Hospital (Beijing, China) and included questions on demographic, health behaviors and physical activities. The questionnaire was completed by the participants in a face-to-face interview with trained staff.

The physical examination included blood pressure (BP), body weight and height. BP was measured on the right arm supported at the heart level after participants rested for five minutes, using the Omron HBP-1300 Professional Portable Blood Pressure Monitor (OMRON, Japan). BP was measured three times, with 30 seconds between each measurement. The average of three readings was used for further analysis [10]. Body weight without heavy clothing, basal metabolism (BM), body fat percentage

(BFP) and visceral fat index (VFI) were measured using an OMRON body fat and weight measurement device (Vbody HBF-371, OMRON, Japan). Height was measured without shoes using a standard right-angle device and a fixed measurement tape (to the nearest 0.5 cm).

Definitions

Hypertension was defined as systolic BP (SBP)≥140mmHg or diastolic BP (DBP)≥90mmHg, or self-reported use of antihypertensive medication [11]. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared. Overweight was defined as BMI 25-30kg/m^2, and obesity was defined as BMI＞30kg/m^2.

Statistical analysis

Data was entered and validated using Epidata® 3.0 software[12]. All estimates and analyses were weighted to represent the population in Jilin Province aged 15 years or older. The weights were calculated based on the 2010 Jilin province population census data, and the sampling age, sex and geographic subgroups were taken into account. Continuous data were presented as mean ± standard deviation (SD) or mean with 95% confidence intervals (CI), and differences between groups were compared using the t-est. Categorical data were presented as frequency, rate and 95% CI, and the prevalence between different groups was compared using the corrected Rao-Scott chi-square test. Logistic regression analysis was conducted assessing the

relationship of hypertension with age, sex, obesity, smoking, and alcohol drinking for hypertension adjusted for demographic factors, that have been included in similar studies, including sex, region, age, education level, employment status, marital status, BMI, and family history of hypertension. All analyses were conducted using SPSS® 18.0 software[13].

Results

Distribution of participants

A total of 14,956 participants from 15,206 eligible participants (6,946 males and 8,010 females; aged 15–97 years) completed the survey and were included in the statistical analysis. The percentage of males and females were 50.63% and 49.37%, respectively. The non-responders (1.6%) were mainly young people with nonresponse likely related to their busy work schedule.

Characteristics of participants

The average age of the participants was 45.5 years, with the average age for males being 45.6±19.6 years and for females 45.5±18.9 years. There was no statistically significant difference in age between the sexes (p=0.92). The distribution of participants by age and sex are shown in Table 1. The BMI of the participants was 24.01±3.67 kg/m^2, BM was (1397.47±244.15), BFP was 26.20±8.4 and VFI was 8.54±4.99. The mean SBP of the participants was 128.92±17.97) mmHg, and the mean DBP was 76.81±10.36 mmHg. These physical characteristics by age and sex are

shown in Supplementary Table 1. All these characters were statistically significantly different between males and females ($p<0.01$). In particular, BM and VFI for males was higher than for females in all age groups (Figure 1A and 1B), while BFP for females was higher than males in all age groups (Figure 1C). BMI reached its highest value for males in the 35-44 year age group and for females in the 55-66 year age group (Figure 1D). The SBP was similar between males and females in all age groups (Figure 1E), yet the DBP of males was higher than for female in all age groups (Figure 1F).

Lifestyle risk factors - obesity, smoking and alcohol drinking

The prevalence of overweight and obesity of participants was 29.8% and 6.2%, respectively. The prevalence of overweight for the male participants was 30.9%, higher than for the female participants at 28.7% ($p=0.013$). On the other hand, there was no statistical difference between the prevalence of obesity of male participants (6.3%) and female participants (6.2%) ($p=0.78$). The percentage of current smoking and ever smoking was 22.7% and 1.4%, respectively. When stratified by sex, the percentage of current smoking in males (36.9%) was higher than in females (8.2%) ($p<0.001$). Similarly, the percentage of ever smoking in males (2.3%) was higher than that in females (0.5%) ($p<0.001$). The percentage of alcohol drinking was 17.6%. The percentage in males (32.0%) was significantly higher than in females (2.9%) ($p<0.001$). The risk factors BMI, smoking and alcohol drinking, summarized by age and sex, are shown in Table 2.

Prevalence of hypertension stratified by non-modifiable factors-age and sex

Of the 14,956 participants, 4,332 were diagnosed with hypertension, and the prevalence of hypertension was 24.7% (95% CI: 23.9%, 25.5%). The prevalence of hypertension was larger for the older age groups, and was higher in males (25.6%) than in females (23.8%) (p=0.03). For each age group less than 45 years, the prevalence of hypertension in males was higher than in females (p<0.001); while for the 65-74 year age group, the prevalence of hypertension in females was higher than in males (p=0.04); and in the other age groups, the prevalence of hypertension in males and females showed no statistical difference (p>0.05). The prevalence of hypertension stratified by age and sex is shown in Table 3.

Prevalence of hypertension stratified by modifiable factors-obesity, smoking and alcohol drinking

The prevalence of hypertension was statistically different across BMI categories (p<0.001); the highest prevalence being reported was 48.1% in the obese group, followed by the overweight group at 35.7%. When stratified by smoking, the prevalence of hypertension also showed statistical differences between the current smoking, ever smoking, and never smoking groups (p<0.001); with the highest prevalence of 53.1% in the ever smoking group, followed by 32.2% in the current smoking group and 22.0% in the never smoking group. The prevalence of hypertension in the alcohol drinking group was 34.6%, higher than 22.6% in the

no-alcohol drinking group (p<0.001). The prevalence of hypertension stratified by BMI, smoking and alcohol drinking are shown in Table 4.

Factors associated with hypertension

Several factors, including age, sex, obesity, smoking, and alcohol drinking, are associated with the prevalence of hypertension, both in the crude model and adjusted logistic model. In particular, in the absence of adjusting for other factors, the univariate logistic model indicated that the risk of hypertension was greater in males with an OR=1.1 (95% CI: 1.01, 1.2) than in females, overweight partipants with an OR=2.52 (95% CI: 2.3, 2.77) than in normal participants, obese participants with an OR=4.21 (95% CI: 3.56, 4.96) than in normal participants, smokers with OR=1.64 (95% CI: 1.48, 1.81) than in non-smokers, and alcohol drinkers with OR=1.81 (95% CI: 1.62, 2.02) than in non-alcohol drinkers. All the difference were statistically significant (p<0.05). A multivariable logistic regression model was used to adjust for potential influencing factors. After adjustment for age, sex, region, education level, employment status, BMI, family history of hypertension, and marital status that may affect hypertension, the risk of hypertension was greater in males with an adjusted OR=1.26 (95% CI:1.13, 1.39) than in females, in overweigh participants with an adjusted OR=2.3 (95% CI: 2.06, 2.58) than in normal participants, in obese participants with an adjusted OR=5.11 (95% CI: 4.16, 6.27) than in normal participants, in smokers with an adjusted OR=1.28 (95% CI: 1.13, 1.46) than in non-smokers, and in alcohol drinkers with an adjusted OR=1.49 (95% CI: 1.28, 1.73).

These results are shown in Table 5.

Discussion

With the estimated prevalence of hypertension in Jilin province of 24.7%, a population of approximately 6.8 million in the province are hypertensive. At the national level, the prevalence of hypertension in Jilin is comparable to that in Zhejiang province [12]; while the prevalence is lower than in other regions in China, including Jiangxi [13], Inner Mongolia [14], and Macau [15], as well as, lower than the overall prevalence in China [16]. Worldwide, this prevalence is lower than that in the US, the UK, but is higher than that in Canada [4]. However, there are some limitations in terms of the direct comparisons among these studies, given the varying methods and environments and variations of population genetics, and the different population age structures.

Although the prevalence of 24.7% is lower than 30.8% that was found in 2012 [17], it is still not acceptable in terms of optimal hypertension health in the province. Our study found that the prevalence of overweight and obesity was 29.8% and 6.2%, respectively, which is higher than that reported at the national level of 17.7% and 5.6%, respectively[18]. Several studies have shown that obesity is a risk factor for the development of hypertension[19-21]. Obesity can increase hypertension through multiple mechanisms, including insulin resistance, activation of sympathetic nervous system, sodium retention leading to increase in renal reabsorption, and activation of the renin-angiotensin system[22]. The growing number of people with obesity and

being overweight in the province of Jilin presents a strong indicator of the potential risk of future increasing incidence of hypertension. Unfortunately, this modifiable risk factor has exhibited no change in between the report in 2012 and now[17], not to mention that the population of overweight and obesity may have been underestimated, since the standard definition of overweight and obesity used in our research may be set too high for asian people[23, 24]. Moreover, some people may be abdominal obese with a normal BMI value (18.5-24.9kg/m^2). Studies have reported that despite the normal BMI value, abdominal obesity is also a risk factor for hypertension worldwide[25, 26]. This modifiable risk factor deserves attention and requires an effective proactive intervention program to slow and ultimately reduce the number of individuals with obesity becoming hypertensive.

Our study found that the overall prevalence of hypertension increases with age in both males and females, especially in the range of 35-74 years of age. This result supports the hypothesis that age is one of the risk factors of hypertension [27-30]. An increasing lifespan among the population in Jilin requires that a practical and effective hypertension management strategy of intervention and control targeting the aging population be devloped. The overall prevalence of hypertension is higher in males than in females. However, the prevalence in females increased more rapidly than in males aged 65-74 years. This may be partially explained by hormonal changes in post-menopausal women and the difference in lifespan between males and females [4, 31]. However, the exact mechanisms need to be explored.

Consistent with previous studies [32, 33], our study also showed that smoking,

both current and ever smoking, is associated with an increased risk of hypertension. Smoking can increase blood viscosity, stimulate the adrenergic nervous system, and contribute to the development of both micro- and macro-vascular diseases[34]. Although some studies reported weak associations between smoking and hypertension [13, 20], smoking is considered a major risk factor worldwide [13, 20, 35-37], Additionally, drinking of alcohol is also a factor associated with increasing the risk of hypertension in our study, which is consistent with previous studies [4, 38-40]. These results indicate that changes in living habits, including quitting smoking and alcohol drinking, should help to reduce the prevalence of hypertension.

National studies reported that the prevalence of hypertension is higher in northern China than that in southern China[7, 16]. When comparing the associations between risk factors and hypertension with Zhejiang province located in the South[12], we found that the risk of hypertension with demographic factors, such as age, sex, and region, and clinical factors, such as family history of hypertension and abdominal waist circumference, were similar in Jilin province and in southern China. When it comes to the lifestyle factors, the risk of hypertension with obesity and alcohol drinking were similar, however, there was a marked difference in the modifiable risk factor smoking; in particular, in Jilin province there was a strong association with an adjusted OR=1.28 (95% CI: 1.13, 1.46), whereas no association between smoking and hypertension in southern China was found, with an adjusted OR=1.0 (95% CI: 0.9, 1.1). These findings indicate that programs aimed at reducing smoking would be an important step to mitigate the prevalence of hypertension in Jilin province. Some

social factors including retirement status, marital status, and educationan level were also different between the North and the South. Of interest, there was a difference on BFP categories. In particular, for category 10-19 for males and 20-29 for females, there was no association between BFP and hypertension in Jilin province with an adjusted OR=0.95 (95%CI: 0.71, 1.27), whereas in this category BFP is protective againt hypertension in south China with an adjusted OR=0.6 (95% CI: 0.5, 0.8). In the range of over 25 for males and over 35 for females, BFP is strongly associated with hypertension in Jilin province with an adjusted OR=1.45 (95% CI: 1.07, 1.96), whereas no association was found in the South with an adjusted OR=1.3 (95%CI: 1.0, 1.5). These results indicate that BFP tends to be more of a risk for hypertension in the North compared to the South. Studies have reported that high BFP increase blood pressure[41, 42]. There are also studies reporting that the relationship between BFP and BMI may be different in different ethnic groups[43], and the latter is already known to be a risk factor for hypertension. These studies provide inside of the different role BFP has on hypertension in the northern and southern China. Further studies on the relationship between BFP and hypertension need to be done.

A survey in 2012 found a prevalence of hypertension of 30.8% [17]. The prevalence of hypertension in our study was lower. This reduction may be related to the following two factors. First, the government of Jilin province is aware of the damage and burdern of hypertension and is dedicated to increase the funding of medical insurance, especially for rural residents, from RMB ¥3.9 billion in 2012 to RMB ¥6.4 billion, according to the statistical bureau of Jilin province. Second, new

hypertension guidelines on grass-roots management of hypertension[44] and patient education[45] have been published in China since 2012. However, some key modifiable risk factors have exhibited slight negative changes, in particular, the trend towards obesity, drinking and smoking. This can be due in part to the evolving economy of Jilin province with the gross domestic product increasing from RMB ¥361.5 billion in 2015, to RMB ¥857.8 billion in 2010, to RMB ¥1.4 trillion in 2015, according to the statistical bureau of Jilin province. To reverse these trends will require an effective and workable intervention program to control hypertension by incorporating best practices identified in theory and practice. For example, rates of hypertension awareness have greatly improved from 24.4% to 42.6%, treatment from 20.0% to 24.2% based on national surveys[16]. However, the control rate is only 9.3% in comparison with 53% in the USA[4]. One of the challenges is to improve adherence to anti-hypertension drugs.

There are some limitations in this study. First, this is a cross-sectional study design, thus the causality cannot be assumed between the risk factors and hypertension. Second, due to limited financial resource, data relevant to physical activity, salt intake and blood lipids were not collected. Third, the decrease of prevalence of hypertension in our study compared with that in 2012 may be related with sampling factor.

In summary, the prevalence of hypertension in Jilin province decreased compared with that in 2012, and is lower than the overall prevalence in China. In addition, the study showed that hypertension is associated with age, sex, obesity, smoking and

alcohol drinking. In particular, smoking seemed to be responsible for the different prevalence of hypertension in northern and southern China. These factors above, especially smoking, might be important points to control and manage hypertension in Jilin province.

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Footnotes

Contributors

BL is involved in the design, JW, XS, LL, YY, YL, and CQ collected the data, YZ and YL performed the statistical analysis, TL, WS, and BL wrote the paper. All authors reviewed and approved the final version of the paper.

Ethics approval

This study was approved by the Fuwai Hospital Ethics Review Board.

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Competing interests

None declared.

Data sharing statement

No additional data are available.

Figure Captions

Figure 1: Trends of physical characteristics by age and sex. (A) basal metabolism BM (B) body fat percentage - BFP (C) visceral fat index - VFI (D) body mass index - BMI (E) systolic blood pressure - SBP (F) diastolic blood pressure - DBP

Table 1: Distribution of participants by age and sex in Jilin province (N, %)

Age	Male		Female		Total	
	N	%	N	%	N	%
15-24	1120	9.07	1146	8.51	2266	17.59
25-34	1316	8.91	1520	8.52	2836	17.43
35-44	1084	11.95	1359	11.40	2443	23.35
45-54	1043	10.02	1333	9.68	2376	19.70
55-64	950	6.36	1121	6.47	2071	12.83
65-74	755	3.01	823	3.23	1578	6.24
75+	678	1.31	708	1.55	1386	2.86
Total	6946	50.63	8010	49.37	14956	100.0

496 **Table 2:** Distribution of participants by age and sex stratified by body mass index, smoking and alcoholic drinking in Jilin province (%, 95%CI)

	BMI				Smoking			Alcohol Drinking
	<18.5	18.5-25.0	25.0-30.0	>30.0	Current	Ever	Never	
Male								
15-24	13.33	67.57	14.85	4.25	6.95	0.36	92.69	5.80
	(11.11,15.91)	(64.24,70.73)	(12.58,17.46)	(3.03,5.93)	(5.47,8.80)	(0.10,1.22)	(90.79,94.22)	(4.62, 7.26)
25-34	2.80	57.76	31.36	8.08	39.19	0.64	60.17	29.70
	(1.98,3.93)	(54.70,60.77)	(28.57,34.30)	(6.52,9.96)	(36.20,42.26)	(0.30,1.37)	(57.09,63.17)	(26.96, 32.60)
35-44	1.89	54.86	35.26	7.99	46.92	1.32	51.76	39.90
	(0.18,3.01)	(51.49,58.18)	(32.10,38.55)	(6.35,10.02)	(43.57,50.30)	(0.79,2.18)	(48.39,55.12)	(36.62, 43.26)
45-54	1.56	55.63	36.25	6.56	48.42	3.19	48.38	44.70
	(0.93,2.60)	(52.33,58.88)	(33.14,39.47)	(5.11,8.39)	(45.13,51.73)	(2.25,4.52)	(45.10,51.68)	(41.44, 48.00)
55-64	0.79	59.10	35.17	4.94	44.79	5.19	50.02	39.30
	(0.39,1.60)	(55.67,62.44)	(31.96,38.52)	(3.65,6.66)	(41.38,48.25)	(3.88,6.91)	(46.57,53.47)	(35.99, 42.71)
65-74	2.16	60.45	33.51	3.88	32.13	6.99	60.88	34.30
	(1.26,3.69)	(56.54,64.22)	(29.91,37.33)	(2.66,5.62)	(28.57,35.91)	(5.22,9.30)	(56.97,64.65)	(30.65, 38.14)
75+	3.71	62.83	30.22	3.23	22.06	5.58	72.35	18.74
	(2.53,5.42)	(58.82,66.68)	(26.61,34.10)	(2.01,5.15)	(18.85,25.64)	(3.96,7.82)	(68.54,75.87)	(15.72, 22.19)
Female								
15-24	13.46	70.77	12.55	3.22	0.36	0.00	99.64	0.76
	(11.24,16.03)	(67.48,73.85)	(10.34,15.16)	(2.34,4.43)	(0.11,1.16)		(98.84,99.89)	(0.43,1.35)
25-34	6.46	66.10	22.33	5.11	2.90	0.06	97.04	3.50
	(5.25,7.94)	(63.37,68.72)	(20.06,24.79)	(3.97,6.55)	(2.05,4.08)	(0.01,0.44)	(95.85,97.89)	(2.65,4.62)
35-44	1.81	61.59	29.86	6.74	8.00	0.07	91.93	4.40
	(1.16,2.81)	(58.64,64.45)	(27.18,32.67)	(5.38,8.41)	(6.45,9.88)	(0.01,0.50)	(90.05,93.49)	(3.37,5.73)

45-54	1.99	54.20	36.38	7.44	10.36	0.52	89.12	3.08
	(1.29,3.04)	(51.27,57.09)	(33.62,39.24)	(6.05,9.11)	(8.69,12.31)	(0.23,1.17)	(87.14,90.83)	(2.23,4.25)
55-64	2.53	48.89	40.24	8.34	16.81	1.46	81.73	2.53
	(1.72,3.71)	(45.72,52.08)	(37.17,43.39)	(6.72,10.30)	(14.58,19.30)	(0.85,2.49)	(79.16,84.05)	(1.68,3.81)
65-74	4.89	50.05	38.50	6.57	17.61	1.68	80.71	1.81
	(3.53,6.72)	(46.31,53.78)	(34.91,42.22)	(4.94,8.67)	(14.97,20.60)	(0.93,2.99)	(77.62,83.47)	(1.03,3.16)
75+	10.17	57.46	26.17	6.20	12.82	1.27	85.91	2.48
	(7.87,13.04)	(53.37,61.45)	(22.77,29.89)	(4.50,8.50)	(10.29,15.87)	(0.64,2.50)	(82.77,88.55)	(1.45,4.23)

Table 3: Prevalence of hypertension by age and sex in Jilin province

Age group	Male n	Male CR(95%CI)	Female n	Female CR(95%CI)	Total n	Total CR(95%CI)
15-24	80	6.86(5.27,8.87)	23	1.88(1.19,2.96)	103	4.45(3.53,5.59)
25-34	106	8.47(6.89,10.36)	50	4.28(3.20,5.69)	156	6.42(5.43,7.58)
35-44	221	21.00(18.36,23.91)	195	15.21(13.14,17.55)	416	18.17(16.45,20.03)
45-54	379	35.13(32.06,38.33)	430	32.57(29.89,35.36)	809	33.87(31.82,35.99)
55-64	449	46.42(43.00,49.87)	576	50.72(47.54,53.90)	1025	48.59(46.25,50.94)
65-74	451	59.91(55.98,63.71)	518	65.32(61.72,68.76)	969	62.71(60.06,65.29)
75+	405	61.24(57.24,65.10)	449	62.37(58.30,66.28)	854	61.86(59.00,64.63)
Total	2091	25.60(24.41,26.79)	2241	23.84(22.80,24.89)	4332	24.73(23.94,25.53)

CI: confidence interval

Table.4 Prevalence of hypertension by age and sex stratified by body mass index, smoking and alcoholic drinking (%, 95%CI)

	BMI				Smoking			Alcohol Drinking	
	<18.5	18.5-25.0	25.0-30.0	>30.0	Current	Ever	Never	Yes	No
Male									
15-24	1.48 (0.37,5.76)	4.39 (2.94,6.51)	16.22 (10.62,24.00)	30.17 (16.58,48.44)	8.17 (3.45,18.15)	13.13 (1.35,62.57)	6.73 (5.10,8.84)	11.60 (5.85,21.69)	6.56 (4.95, 8.66)
25-34	1.45 (0.20,9.72)	5.33 (3.78,7.46)	9.15 (6.43,12.85)	30.70 (21.42,41.86)	11.49 (8.66,15.08)	6.89 (0.88,38.13)	6.51 (4.80,8.78)	10.64 (7.63, 14.64)	7.55 (5.80, 9.77)
35-44	5.49 (0.97,25.57)	14.76 (11.77,18.34)	25.87 (21.16,31.22)	45.98 (34.53,57.87)	23.76 (19.72,28.33)	36.23 (16.51,62.01)	18.11 (14.77,22.00)	28.02 (23.40, 33.16)	16.34 (13.35,19.84)
45-54	27.39 (10.96,53.63)	25.02 (21.38,29.05)	44.90 (39.57,50.35)	68.73 (55.83,79.27)	37.10 (32.60,41.83)	41.53 (25.83,59.16)	32.74 (28.51,37.27)	43.01 (38.20, 47.96)	28.76 (24.95, 32.91)
55-64	11.46 (2.44,40.14)	39.64 (35.33,44.11)	55.87 (50.07,79.30)	65.91 (50.62,78.48)	47.15 (42.04,52.33)	61.46 (46.39,74.61)	44.21 (39.43,49.09)	52.10 (46.61, 57.54)	42.74 (38.42, 47.18)
65-74	19.58 (6.35,46.63)	52.27 (47.16,57.34)	73.86 (67.56,15.96)	80.86 (61.30,91.85)	60.60 (53.60,67.20)	74.69 (59.79,85.42)	57.84 (52.78,62.74)	66.86 (60.21, 72.89)	56.58 (51.40, 61.04)
75+	37.87 (21.57,57.45)	58.85 (53.77,63.76)	66.71 (59.34,73.34)	83.47 (57.75,94.91)	68.66 (60.13,76.08)	59.10 (41.42,74.69)	59.15 (54.42,63.71)	65.17 (55.63, 73.63)	60.34 (55.90, 64.62)
Female									
15-24	1.50 (0.37,5.81)	0.91 (0.42,1.98)	5.62 (2.53,12.01)	10.02 (3.85,23.67)	0.00	0.00	1.88 (1.19,2.97)	0.00	1.89 (1.19,2.98)
25-34	0.00	2.16 (1.29,3.59)	6.56 (4.03,10.51)	27.09 (16.97,40.31)	12.35 (4.36,30.33)	0.00	4.04 (2.98,5.44)	0.66 (0.09,4.63)	4.41 (3.29,5.87)
35-44	17.78 (5.86,42.90)	9.70 (7.67,12.20)	22.05 (17.69,27.14)	34.59 (24.35,46.49)	19.76 (12.41,29.97)	100.00 (100.00,100.00)	14.75 (12.62,17.17)	25.47 (14.99,39.84)	14.74 (12.65,17.11)

45-54	0.00	24.68	40.48	60.03	34.92	61.78	32.13	27.45	32.73
		(21.42,28.27)	(35.84,45.30)	(49.33,69.86)	(26.73,44.12)	(22.45,90.03)	(29.31,35.08)	(15.31,44.19)	(30.01,35.57)
55-64	40.61	39.07	61.42	70.47	51.28	62.47	50.40	51.62	50.70
	(23.68,60.12)	(34.71,43.61)	(56.48,66.14)	(59.27,79.64)	(43.64,58.86)	(35.28,83.56)	(46.87,53.92)	(31.60,71.13)	(47.48,53.91)
65-74	38.58	59.74	74.83	72.04	65.26	57.48	65.50	50.45	65.60
	(24.16,55.33)	(54.53,64.73)	(69.27,79.68)	(57.14,83.28)	(56.45,73.13)	(29.24,81.56)	(61.48,69.31)	(24.78,75.88)	(61.97,69.05)
75+	45.30	60.64	73.24	60.53	64.01	100.00	61.57	51.72	62.64
	(32.73,58.49)	(55.25,65.79)	(65.79,79.57)	(43.53,75.31)	(52.10,74.41)	(100.00,100.00)	(57.18,65.79)	(26.49,76.10)	(58.53,66.58)

Table.5 Risk factors associated with the prevalence of hypertension

	Hypertension prevalence	
	Unadjusted	Adjusted
Age(Ref: 15-24)		
25-34	1.47(1.09,1.99)	1.05(0.71,1.55)
35-44	4.77(3.65,6.24)	2.83(1.90,4.22)
45-54	11.01(8.51,14.24)	6.93(4.69,10.24)
55-64	20.31(15.69,26.29)	13.43(9.06,19.90)
65-74	36.14(27.73,47.11)	26.18(17.56,39.03)
75+	34.85(26.65,45.57)	29.89(19.83,45.03)
Sex(Ref: female)	1.1(1.01,1.2)	1.25(1.13,1.39)
Region(Ref: Urban)	1.19(1.09,1.3)	1.25(1.12,1.39)
Race(Ref: Han)	1.15(0.93,1.42)	0.93(0.74,1.18)
Employment(Ref: be employed)		
Retired	2.67(2.22,3.2)	0.67(0.53,0.85)
Student	0.15(0.11,0.21)	1.09(0.71,1.70)
Unemployed	1.18(1.07,1.3)	0.84(0.74,0.95)
Marital(Ref: married)	0.72(0.63,0.83)	1.29(1.00,1.65)
Education level(Ref: college or higher)		
Illiterate	6.69(5.19,8.63)	2.18(1.62,2.93)
Primary	3.26(2.7,3.93)	1.98(1.60,2.44)
Middle	1.55(1.24,1.94)	1.24(0.97,1.57)
BMI(Ref: Normal)		
Overweight	2.22(2.01,2.46)	2.30(2.06,2.57)
Obese	3.96(3.31,4.75)	5.17(4.20,6.37)
AWC(Ref:<90M,<85F)		
≥90M，≥85F	1.41(1.23,1.62)	1.35(1.16,1.57)
≥95M，≥90F	1.5(1.32,1.72)	1.68(1.43,1.96)
Family history of hypertension	1.74(1.55,1.96)	2.35(2.06,2.67)
Family history of stroke	1.33(0.85,2.06)	1.79(1.09,2.92)
Family history of CAD	3.18(2.64,3.83)	1.65(1.33,2.03)
Smoker(Ref: no)	1.37(1.23,1.53)	1.23(1.08,1.40)
Drinker(Ref: no)	1.56(1.38,1.77)	1.47(1.27,1.71)
VAI（Ref:＜10)		
10~14	1.6(1.41,1.8)	1.40(1.22,1.60)
15~30	2.69(2.29,3.16)	2.05(1.69,2.49)
BFP(Ref:＜10M，＜20F)		
10~19M，20~29F	1.31(1,1.71)	0.95(0.71,1.27)
20~24M，30~34F	2.72(2.09,3.55)	1.24(0.92,1.66)
≥25M，≥35F	3.48(2.67,4.54)	1.45(1.07,1.96)

CI: confidence interval; BMI: body mass index; AWC: Abdominal waist circumference; CAD: coronary heart disease; M: male; F: female; VAI: Visceral Fat; BFP: body fat percentage.

Adjusted for sex, region, age, education level, employment status, marital status, BMI, and family history of hypertension

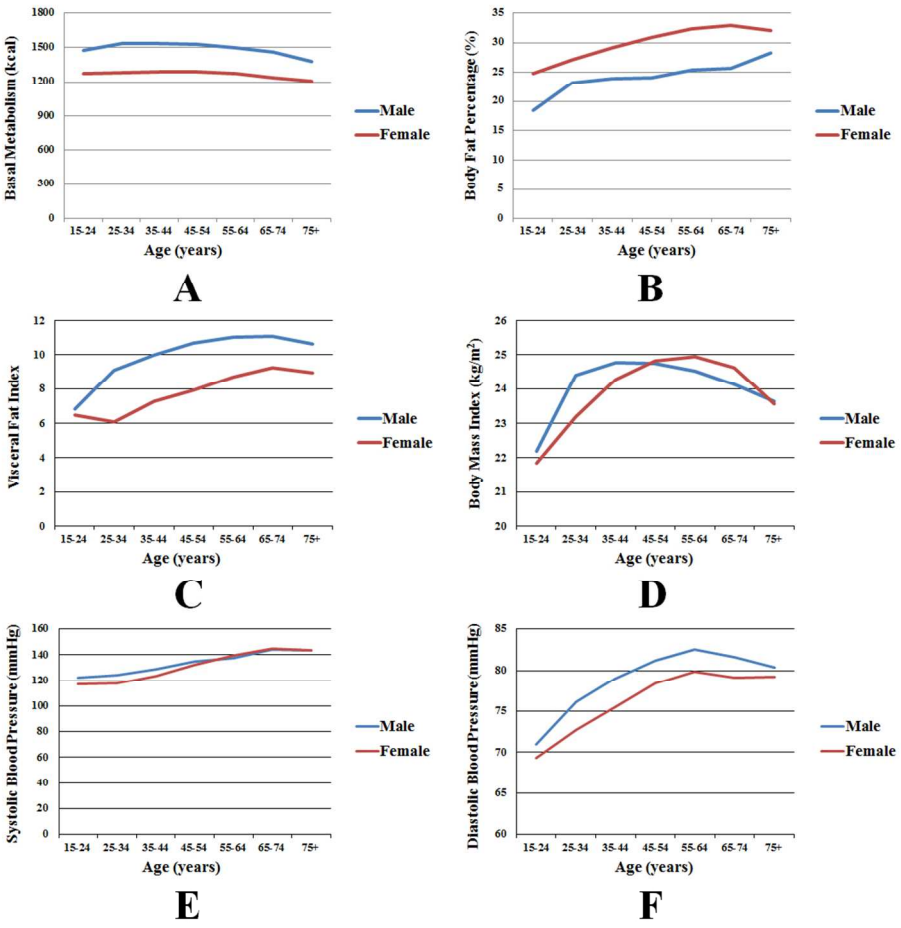

Figure 1: Trends of physical characteristics by age and sex. (A) basal metabolism BM (B) body fat percentage - BFP (C) visceral fat index - VFI (D) body mass index - BMI (E) systolic blood pressure - SBP (F) diastolic blood pressure - DBP

99x98mm (300 x 300 DPI)

Supplementary Table Descriptions of basal metabolism – BM, body fat percentage – BFP, visceral fat index - VFI by age and sex in Jilin province

	Age	Male		Female	
		Mean	95%CI	Mean	95%CI
BM	Total	1511.50	(1504.56, 1518.43)	1280.52	(1276.09, 1284.96)
	15-24	1478.92	(1456.95, 1500.88)	1279.31	(1264.09, 1294.53)
	25-34	1538.93	(1524.04, 1553.81)	1281.66	(1272.68,1290.64)
	35-44	1534.48	(1519.02, 1549.95)	1293.35	(1284.03, 1302.67)
	45-54	1528.84	(1514.65, 1543.02)	1293.81	(1284.74, 1302.87)
	55-64	1499.65	(1486.40, 1512.90)	1274.36	(1264.67, 1284.06)
	65-74	1460.36	(1443.82, 1476.89)	1241.86	(1230.00, 1253.73)
	75+	1382.81	(1367.17, 1398.45)	1209.84	(1195.08, 1224.59)
Body Fat percentage	Total	23.28	(23.03, 23.53)	29.19	(29.02, 29.35)
	15-24	18.46	(17.52, 19.40)	24.78	(24.38, 25.18)
	25-34	23.26	(22.87, 23.65)	27.20	(26.88,27.52)
	35-44	24.02	(23.64, 24.40)	29.19	(28.86, 29.52)
	45-54	24.09	(23.76, 24.41)	30.95	(30.61, 31.29)
	55-64	25.34	(24.58, 26.10)	32.39	(31.99, 32.80)
	65-74	25.74	(25.30, 26.17)	32.97	(32.46, 33.48)
	75+	28.31	(27.06, 29.56)	32.08	(31.15, 33.00)
VAI	Total	9.63	(9.49, 9.77)	7.42	(7.29, 7.55)
	15-24	6.81	(6.54, 7.08)	6.48	(6.05, 6.91)
	25-34	9.13	(8.81, 9.46)	6.07	(5.83, 6.30)
	35-44	10.01	(9.70, 10.32)	7.25	(6.96, 7.54)
	45-54	10.71	(10.39, 11.03)	7.90	(7.68, 8.11)
	55-64	11.06	(10.74, 11.37)	8.71	(8.47, 8.96)
	65-74	11.11	(10.72, 11.49)	9.27	(8.81, 9.73)
	75+	10.64	(10.21, 11.07)	8.95	(8.56, 9.35)
BMI	Total	24.15	(24.05,24.25)	23.88	(23.78,23.97)
	15-24	22.20	(21.93,22.47)	21.86	(21.63,22.10)
	25-34	24.41	(24.18,24.63)	23.20	(22.99,23.42)
	35-44	24.78	(24.55,25.01)	24.29	(24.08,24.51)
	45-54	24.75	(24.54,25.01)	24.82	(24.63,25.02)
	55-64	24.54	(24.33,24.76)	24.96	(24.74,25.18)

	65-74	24.14	(23.88,24.40)	24.63	(24.35,24.92)
	75+	23.63	(23.37,23.89)	23.56	(23.24,23.88)
SBP	Total	130.44	(129.99,130.88)	127.36	(126.90,127.81)
	15-24	122.45	(121.67,123.24)	116.81	(116.13,117.50)
	25-34	124.43	(123.77,125.08)	117.93	(117.28,118.58)
	35-44	128.76	(127.85,129.67)	123.85	(122.95,124.75)
	45-54	134.69	(133.51,135.87)	132.39	(131.28,133.49)
	55-64	137.56	(136.22,138.91)	139.53	(138.17,140.90)
	65-74	143.98	(142.25,145.71)	145.16	(143.55,146.76)
	75+	143.69	(141.96,145.42)	143.44	(141.60,145.28)
DBP	Total	78.14	(77.84,78.43)	75.45	(75.19,75.71)
	15-24	70.98	(70.43,71.53)	69.35	(68.82,69.88)
	25-34	76.13	(75.63,76.63)	72.69	(72.25,73.13)
	35-44	79.04	(78.42,79.66)	75.47	(74.91,76.03)
	45-54	81.24	(80.51,81.96)	78.41	(77.79,79.03)
	55-64	82.50	(81.67,83.33)	79.87	(79.15,80.60)
	65-74	81.56	(80.72,82.40)	79.13	(78.35,79.91)
	75+	80.38	(79.61,81.15)	79.26	(78.41,80.11)

CI: confidence interval

基本资料

A1_____省_____市_____区/县_____居/村委会　　ID 号：□□□□□□□□

A2 姓名：_____　　A3 性别：1=男 2=女 □

A4 出生日期：　　□□□□年□□月□□日

A5 身份证号：□□□□□□□□□□□□□□□□□□

A6 工作单位（或村）及部门：_____

A7 家庭详细住址：_____

A8 电话：_____(家)_____（办公室）_____(手机)

A9 联系人姓名：_____　A10 与本人关系：_____

A11 联系人工作单位：_____

A12 联系人住址：_____

A13 联系人电话：_____(家)_____（办公室）_____(手机)

A14 民族：□□

1 汉族　2 蒙古族　3 回族　4 藏族　5 维吾尔族　6 苗族　7 彝族　8 壮族

9 布依族　10 朝鲜族　11 满族　12 侗族　13 瑶族　14 白族　15 土家族　16 哈尼族

17 哈萨克族　18 傣族　19 黎族　20 其它民族　（注明_____）

A15 文化程度：　1=未上学 2=小学 3=初中 4=高中/中专 5=大学 6=研究生 □

A16 婚姻状况：　0=未婚 1=已婚/再婚/同居 2=分居 3=离异 4=丧偶 □

A17 所享受的医疗保障制度：（多选，有在方框中填 1，无在方框中填 0）

1=城镇职工医疗保险□　2=新农合 □　3=城镇居民医疗保险□

4=商业医疗保险 □　5=公费医疗□　6=其他 □

A18 就业状况：1=在业　2=离退休　3=在校学生　4=无业或失业 □

A19 职业（当前，包括返聘者当前职业） □

1=机关、企业、事业单位管理者　2=专业技术人员　3=一般办事人员和有关人员

4=商业、服务业人员　5=个体工商户　6=非农户产业人员

7=从事非农业劳动的农民　8=农业劳动者（从事农林牧渔工作）　9=其他

A19.1 如已离退休，离退休前职业（分类同上，未退休、农民等无退休概念者填 0） □

A20 是否为本地户籍人口？　0=否　1=是 □

A21 在本地居住时间 1=0-6 个月 2=7-12 个月　3=12-36　4=36 个月及以上 □

健康情况

第一部分：生活方式和行为

Ⅰ．吸烟（包括烟叶、香烟）

B1.1 您最近 30 天的吸烟情况：0=不吸**(转 B1.3)** 1=每天都吸 2=吸烟，但不每天 ☐

B1.1.1 您每天吸烟的习惯有多长时间了？ ☐

1=<3 个月 2=3-6 个月 3=6-12 个月 4=1 年以上(☐☐年)

B1.2 您的吸烟量通常为多少？ **（调查员注意：记不清填"999 或 999.9"）**

		吸烟频度*	吸烟量
B1.2.1	机制卷烟（支）	☐	☐☐☐
B1.2.2	手卷烟（两）	☐	☐☐☐.☐
B1.2.3	旱烟/烟斗（两）	☐	☐☐☐.☐
B1.2.4	雪茄（支）	☐	☐☐☐
B1.2.5	其他：_____ （单位：_____）	☐	☐☐☐.☐

注：*吸烟频度：0=不吸，1=天，2=周，3=月 **（转问 B1.4）**

B1.3 您过去是否吸烟？ 0=不吸(转 B1.8) 1=每天都吸 2=吸烟，但不每天 ☐

B1.4 您多大年龄开始吸烟？ 岁☐☐

B1.5 您吸烟累计有多少年？ 年☐☐.☐

B1.6 从您最初接触烟草到目前为止累计的吸烟量在下述哪个范围 ☐

1=<20 支（1 包香烟） 2=20-400 支（20 包香烟） 3=400 支以上

B1.7 您曾经戒过烟吗（指认真考虑过要戒烟并有所行动） 0=否 1=是 ☐

B1.7.1 您累计戒烟多少年？ 年☐☐.☐

B1.7.2 为什么戒烟？1=疾病 2=其它:_____ ☐

B1.8 通常情况下，您每周在密闭环境里接触二手烟的天数是？**（目前吸烟者不用询问此项）**

0=几乎没有（转到Ⅱ．饮酒 ） 1=有，为_____天 ☐

B1.8.1 累计超过 15 分钟有几天？ ☐

0=没有（转到Ⅱ．饮酒 ） 1=有，为_____天

Ⅱ．饮酒

B2.1 您饮过酒吗？ 0=否（转问Ⅲ. 饮食） 1=是 □

B2.2 您多大年龄开始规律饮酒的？ 岁□□

B2.3 您的饮酒习惯属于下列哪一类？ □

1=每天至少一次 2=每周至少一次 3=每月至少一次

4=季节性饮酒，每年饮酒□□个月，每个月饮酒最少□□次

5=偶尔饮酒，每年饮酒□□□次

B2.4 您最近 1 个月是否每周至少饮 1 次酒？ 0=否 1=是 □

B2.5 您通常饮酒是否一定要喝醉？ □

1=几乎每次 2=绝大部分 3=一半 4=较少 5=很少 6=从没有

B2.6 您曾经戒过酒吗？0=否 1=是 → □

B2.6.1 您多大年龄开始戒酒的？	岁 □□
B2.6.2 您累计戒酒多少年？	年□□.□
B2.6.3 为什么戒酒？1=疾病 2=其它：_____	□

B2.7 您饮酒的种类和饮酒量（当前饮酒者填当前情况，当前不饮酒者填既往情况）：

	饮用频度*	次数**	平均每次饮用量	月数/年	酒精度
B2.7.1 啤酒	□	□□	□□.□斤	□□	□□
B2.7.2 白酒	□	□□	□□.□两	□□	□□
B2.7.3 葡萄酒	□	□□	□□.□两	□□	□□
B2.7.4 黄酒	□	□□	□□.□两	□□	□□
B2.7.5 米酒	□	□□	□□.□两	□□	□□
B2.7.6 其它酒 注明：_____	□	□□	□□.□两	□□	□□

注：*饮用频度：0=不饮，1=天，2=周，3=月，4=年 ** 与频度对应的次数

Ⅲ. 饮食（了解您过去一年食用下列食物的频率和食用量）

B3.1 食物	食用频度（选择其中的一种）	食用量
B3.1.1 大米、面粉、杂粮（小米、高粱、玉米等）	0=不吃 1=天 2=周 3=月 4=年□	□□斤□两
B3.1.2 薯类（红薯、山药、芋头、土豆等）	0=不吃 1=天 2=周 3=月 4=年□	□□斤□两
B3.1.3 新鲜蔬菜（不包括干菜和咸菜）	0=不吃 1=天 2=周 3=月 4=年□	□□斤□两
B3.1.4 畜肉（猪、牛、羊等）	0=不吃 1=天 2=周 3=月 4=年□	□□斤□两
B3.1.5 禽肉（鸡、鸭、鹅等）	0=不吃 1=天 2=周 3=月 4=年□	□□斤□两
B3.1.6 鱼类	0=不吃 1=天 2=周 3=月 4=年□	□□斤□两
B3.1.7 虾、蟹、贝等其它水产品	0=不吃 1=天 2=周 3=月 4=年□	□□斤□两
B3.1.8 蛋类（鸡蛋、鸭蛋等）	0=不吃 1=天 2=周 3=月 4=年□	□□斤□两
B3.1.9 奶类（折合成鲜奶）	0=不吃 1=天 2=周 3=月 4=年□	□□斤□两
B3.1.10 豆制品（以豆腐计）	0=不吃 1=天 2=周 3=月 4=年□	□□斤□两
B3.1.11 新鲜水果	0=不吃 1=天 2=周 3=月 4=年□	□□斤□两
B3.1.12 干果（花生、瓜子、核桃）	0=不吃 1=天 2=周 3=月 4=年□	□□斤□两
B3.1.13 咸菜/泡菜/腌菜	0=不吃 1=天 2=周 3=月 4=年□	□□斤□两

B3.2 请填写您最近**一个月**在下述地点的就餐次数

	餐次	家	单位食堂	餐馆或街头
B3.2.1	早餐	□□	□□	□□
B3.2.2	午餐	□□	□□	□□
B3.2.3	晚餐	□□	□□	□□

B3.3 您家通常有多少人在一起就餐？ □□

B3.4 其中 6 岁及以下的人数？ □□

B3.5 您家通常每个月吃多少斤植物油？ 斤/月 □□.□

B3.6 您家通常每个月吃多少斤动物油？ 斤/月 □□.□

B3.7 您家通常每个月吃多少斤盐？ 斤/月 □□.□

Ⅳ.体力活动

下列问题是通常一周您进行各类身体活动（包括干农活、工作、家务、交通相关的身体活动、休闲性锻炼或运动等）的情况。		
B4.1 **工作、农业及家务性身体活动**		
B4.1.1	在您的工作、农活及家务活动中，有没有高强度活动，并且活动时间持续10 分钟以上？ **（高强度活动是指如搬运重物、挖掘等需要付出较大体力，或引起呼吸、心跳显著增加的活动）** **调查员注意：可出示身体活动分类表**	1=有 2=没有（转 B4.1.4） □
B4.1.2	在您的工作、农活及家务活动中，通常一周内有多少天会进行上述高强度活动？	□天
B4.1.3	在您的工作、农活及家务活动中，通常一天内累计有多长时间进行上述高强度活动？ **(每次活动时间若少于 10 分钟，则不计算在内)**	□□小时□□分钟
B4.1.4	在您的工作、农活及家务活动中，有没有中等强度活动，并且活动时间持续10 分钟以上？ **（中等强度活动是指如锯木头、洗衣服、打扫卫生等需要付出中等体力，或引起呼吸、心跳轻度增加的活动）** **调查员注意：可出示身体活动分类表**	1=有 2=没有（转 B4.2） □
B4.1.5	在您的工作、农活及家务活动中，通常一周内有多少天会进行上述中等强度活动？	□天
B4.1.6	在您的工作、农活及家务活动中，通常一天内累计有多长时间进行上述中等强度活动？ **(每次活动时间若少于 10 分钟，则不计算在内)**	□□小时□□分钟
B4.2 **交通相关的身体活动**（以下问题不包括上述已提及的农业性身体活动和工作及家务性身体活动）		
B4.2.1	您在外出时，有没有步行或骑自行车持续至少 10 分钟的情况？	1=有 2=没有（转 B4.3） □
B4.2.2	通常一周内，您有多少天外出时步行或骑自行车持续至少 10 分钟？	□天
B4.2.3	通常一天内，您步行或骑自行车多长时间？	□□小时□□分钟
B4.3 休闲相关的身体活动 （以下问题不包括上述已提及的农业性、工作、家务和交通相		

关的身体活动）		
B4.3.1	您是否进行持续至少 10 分钟，引起呼吸、心跳显著增加的高强度活动吗？**（如长跑、踢足球等）** **调查员注意：可出示身体活动分类表**	1=有 2=没有（转 B4.3.4）☐
B4.3.2	通常一周内，您有多少天进行上述高强度的运动或休闲活动？	☐天
B4.3.3	通常一天内，您累计有多长时间进行上述高强度的运动或休闲活动？	☐☐小时☐☐分钟
B4.3.4	您是否进行持续至少 10 分钟，引起呼吸、心跳轻度增加的中等强度运动和休闲活动吗？**（如快步走、游泳、打排球等）** **调查员注意：可出示身体活动分类表**	1=有 2=没有（转 B4.4）☐
B4.3.5	通常一周内，您有多少天进行上述中等强度的运动或休闲活动？	☐天
B4.3.6	通常一天内，您累计有多长时间进行上述中等强度的运动或休闲活动？（**调查员注意：每次活动时间若少于 10 分钟，则不计算在内**）	☐☐小时☐☐分钟
B4.4 静态行为		
B4.4.1	通常工作日一天内，您累计有多少时间坐着、靠着或躺着？**（包括坐着工作、学习、阅读、看电视、用电脑、休息等所有静态行为的时间，但不包括睡觉时间）**	☐☐小时☐☐分钟
B4.4.2	通常非工作日一天内，您累计有多少时间坐着、靠着或躺着？**（包括坐着学习、阅读、看电视、用电脑、休息等所有静态行为的时间，但不包括工作和睡觉时间）**	☐☐小时☐☐分钟
B4.5 睡眠行为		
B4.5.1	通常工作日一天内，您睡觉累计有多少时间？	☐☐小时☐☐分钟
B4.5.2	通常非工作日一天内，您睡觉累计有多少时间？	☐☐小时☐☐分钟

第二部分：个人疾病史

C1 您上次测量血压到现在有多长时间了？ 0=从未 99=不知道 年□□.□

C1.1 您是否被诊断为高血压？ □

0=无 （转问 C2） 1=有 →

C1.1.1 您患高血压有多少年了？ 年□□.□

C1.1.2 最高诊断单位级别 1=区/县级以下 2=区/县级 3=区/县级以上 □

C1.1.3 您近一年服用降压药的情况？ 0=不服 1=偶服 2=经常服 □

C1.1.4 您两周内服用降压药的情况？ 0=不服 1=偶服 2=经常服 □

C1.1.5 您目前服用的降压药为：A_____ B_____ C_____ D_____

C1.1.6 是否接受高血压管理服务？ 0=否 1=是 9=不详 □

C2 您是否被诊断为患过心肌梗死？ □

0=无（转问 C3） 1=有(填写表 SV-6) → 9=不详（转问 C3 ）

C2.1 首次发病日期 □□□□年□□月

C2.2 最高诊断单位级别 1=区/县级以下 2=区/县级 3=区/县级以上 □

C3 您是否接受过冠脉血管成形术或支架植入？ □

0=无（转问 C4） 1=有(填写表 SV-7) → 9=不详（转问 C4 ）

C3.1 首次治疗日期 □□□□年□□月

C3.2 最高诊治单位级别 1=区/县级以下 2=区/县级 3=区/县级以上 □

C4 您是否接受过冠状动脉旁路搭桥手术？ □

0=无（转问 C5） 1=有(填写表 SV-8) → 9=不详（转问 C5 ）

C4.1 首次治疗日期 □□□□年□□月

C4.2 最高诊治单位级别 1=区/县级以下 2=区/县级 3=区/县级以上 □

C5 您是否被诊断为患有脑中风（脑卒中）？ □

0=无（转问 D1） 1=有(填写表 SV-9) → 9=不详（转问 D1 ）

C5.1 首次发病日期 □□□□年□□月

C5.2 最高诊断单位级别 1=区/县级以下 2=区/县级 3=区/县级以上 □

C5.3 是否能够独立完成下列事情（不需要他人帮助） 0=不能 1=能

	中风前	目前		中风前	目前
C5.3.1 吃饭、饮水	□	□	C5.3.5 上厕所	□	□
C5.3.2 洗漱梳头	□	□	C5.3.6 洗澡	□	□
C5.3.3 穿脱衣服	□	□	C5.3.7 室内活动	□	□
C5.3.4 上下床	□	□			

第三部分：家族史

D1 您是否有如下疾病家族史？
0=无　1=有　9=不详（兄弟姐妹不包括本人）

	父	母	兄弟姐妹	子女
D1.1 高血压	☐	☐	☐	☐
D1.2 高血脂	☐	☐	☐	☐
D1.3 糖尿病	☐	☐	☐	☐
D1.4 脑卒中	☐	☐	☐	☐
D1.5 冠心病	☐	☐	☐	☐

D2 您是否有早发心血管病家族史（发病年龄：男性<55 岁， 女性<65 岁）？
0=无　1=有　9=不详（兄弟姐妹不包括本人）

	父	母	兄弟姐妹	子女
D2.1 高血压	☐	☐	☐	☐
D2.2 高血脂	☐	☐	☐	☐
D2.3 糖尿病	☐	☐	☐	☐
D2.4 脑卒中	☐	☐	☐	☐
D2.5 冠心病	☐	☐	☐	☐

D3 您目前仍在世的家庭成员中是否有以下年龄组者？请标明，0=否，1=是。

	祖父	祖母	外祖父	外祖母	父	母	兄弟	姐妹
D3.1 80～85 岁	☐	☐	☐	☐	☐	☐	☐	☐
D3.2 85～90 岁	☐	☐	☐	☐	☐	☐	☐	☐
D3.3 ≥90 岁	☐	☐	☐	☐	☐	☐	☐	☐

第四部分：月经史及生育史（只问女性）

E1 您月经来潮年龄 岁□□

E2 您是否已绝经？ □

0=否 1=是 →

E2.1 您多大岁数绝经的？ 岁□□

E2.2 您是否使用雌激素替代？ □

0=否 1=现在服 2=过去服，现在不服

E3 您服用过避孕药吗？ 0=否 1=是 → □

E3.1 您服用避孕药累计有多长时间？ 年□□.□

E4 您怀孕过吗（包括当前怀孕者）？ 0=否 1=是 → □

E4.1 您怀孕过多少次？ 99=不详 次□□

E4.2 您活产婴儿数量？ 个□□

E4.3 您现在是否怀孕？ 0=否 1=是 □

E4.4 您有过哺乳经历吗？ 0=否 1=是 □

E4.5 您现在是否正在哺乳？ 0=否 1=是 □

询问者编码：□□

填表日期：□□□□年□□月□□日

体格检查

室内温度：□□.□℃

H1 身高 □□□.□厘米 H3 腰围 □□□.□厘米	H2 体重 □□□.□公斤
H4 体脂测定	
H4.1 基础代谢 □□□□ H4.3 内脏脂肪指数 □□□.□	H4.2 身体脂肪率 □□□.□
测量者编码：□□	

H5 静息 60 秒脉搏 次/60 秒□□□

H6 外周血压（mmHg）（每 50 人需同时用电子血压计和汞柱血压计测量，如 50，100，….）

电子血压计：	收缩压	舒张压	**汞柱血压计：**	收缩压	舒张压
第一次	□□□	□□□	第一次	□□□	□□□
第二次	□□□	□□□	第二次	□□□	□□□
第三次	□□□	□□□	第三次	□□□	□□□

测量者编码：□□

填表日期：□□□□年□□月□□日

检查项目完成情况记录单

一、调查表	0=未完成	1=已完成	☐
二、血压	0=未完成	1=已完成	☐
三、体格测量	0=未完成	1=已完成	☐

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 P1-2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found P2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported P3
Objectives	3	State specific objectives, including any prespecified hypotheses P4
Methods		
Study design	4	Present key elements of study design early in the paper P4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection P4-5
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 P4
		(*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 P6
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 P5
Bias	9	Describe any efforts to address potential sources of bias P5
Study size	10	Explain how the study size was arrived at P4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why P5-6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding P6
		(*b*) Describe any methods used to examine subgroups and interactions P6
		(*c*) Explain how missing data were addressed P6
		(*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 N/A
		(*e*) Describe any sensitivity analyses N/A

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	P7
		(b) Give reasons for non-participation at each stage	P7
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	P7
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
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	P7
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	P8
		(*b*) Report category boundaries when continuous variables were categorized	P6
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	P8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	P10
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	P15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	P10-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	P15
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	P19

*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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Prevalence and distribution of hypertension and related risk factors in Jilin Province, China 2015: a cross-sectional study

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Prevalence and distribution of hypertension and related risk factors in Jilin Province, China 2015: a cross-sectional study

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Abstract

Objective: This study aimed to investigate the prevalence and distribution of hypertension and its related factors in Jilin province, China.

Design: A cross-sectional study in four cities and four rural counties in Jilin as part of a national Chinese study.

Participants and setting: A total of 15206 participants who were ⩾ 15 years old and were selected using a stratified multistage random sampling method.

Main outcome measures: The prevalence of hypertension.

Results: The prevalence of hypertension in Jilin province was 24.7%. Moreover, the prevalence of hypertension increased with age in both sexes, and was higher in males than in females. The modifiable factors that were associated with hypertension were body mass index, smoking, and alcohol drinking. The risk factors identified are similar to those in southern China, except smoking, which has no association with hypertension prevalence in the South.

Conclusions: Age, sex, body mass index, smoking, and alcohol drinking were risk factors of hypertension. Control of these related risk factors, especially smoking, may be helpful in the treatment and management of hypertension in Jilin province.

Strength and limitations of this study

This cross-sectional population-based study evaluated a large representative sample of individuals from four cities and four rural counties in Jilin province.

A large sample of participants allowed for subgroups analysis of related factors.

The causality of the relationships between hypertension and the related factors cannot be confirmed.

Data were not collected regarding physical activity, salt intake, and blood lipid levels.

Key words

Prevalence, hypertension, epidemiology, China

Introduction

A recent World Health Organization report indicated that cardiovascular diseases (CVD) are at the top of the list of the four prioritized non-communicable diseases worldwide, and that they require immediate global action plans for prevention and control [1]. Hypertension is a leading cause of cardiovascular diseases and related deaths worldwide [2, 3]. It is estimated that the global economic burden related to hypertension could be as high as US$ 370 billion [4].

In the People's Republic of China, the prevalence of hypertension has been increasing dramatically from 5.1% in 1959, to 7.7% in 1979, 13.6% in 1991, and 18.8% in 2002 [5, 6]. Furthermore, there is a disproportionately higher hypertension rate reported among people living in northern China[7, 8]. There are about 109.4 million people in the northeastern China. The province of Jilin is located in the northeast of China, with a population of approximately 27.5 million according to the National Bureau of Statistics. Similar to other northern provinces, Jilin has a longer winter

season than the southern China, and, limited by this environment, the lifestyle of the people is different from the other parts of the country.

An in-depth analysis of data from Jilin province regarding hypertension and its risk factors would improve our understanding of the differential reasons for hypertension in the North. Moreover, the analysis would assist in the development of locally effective intervention and control strategies for this preventable disease. Thus, the objectives of this study were: to estimate the prevalence of hypertension in Jilin province and to explore potential risk factors that are associated with hypertension in the province. This will provide information for making recommendations on the prevention and control of hypertension in the northern region of China.

Methods

Study population

This cross-sectional study was conducted between July 2014 and December 2015 as a part of national China study. A 4-stage, stratified sampling method was used to select participants who were aged 15 years and older from the general population of Jilin province, China. First, four cities from the urban areas and four counties from rural areas were selected using a probability proportional to size. Then two districts or two townships were selected in each city or county using simple random sampling (SRS). Next, in each district and township, three communities or villages were chosen respectively using SRS. Finally, participants stratified by sex (50% men and 50% women) and age (aged 15-24, 25-34, 35-44, 45-54, 55-64, 65-74, , 65-74, ≥75 years)

were chosen using SRS according to the national population composition. Participants were chosen from the list provided by the local government registers of households [9].

Based on a design effect of 2.5 and assuming a prevalence of hypertension of 17.7% among the population aged 15 years and older, an estimated sample size of 15,200 participants was needed to ensure that the bound on the error of estimation (i.e. width of the 95% confidence interval (CI)) for the prevalence in the entire population and subpopulation defined by age and sex were less than 0.4% and 1.8%, respectively [9]. As a result, a total of 15,206 participants living in Jilin province over 6 months and aged 15 years and older were randomly selected to participate in the survey.

Measurement

The survey involved a questionnaire interview and physical examination. The standardized questionnaire was developed by the national coordinating center of Fuwai Hospital (Beijing, China) and included questions on demographic characters, health behaviors and physical activities. The questionnaire was completed by the participants in a face-to-face interview with trained staff.

The physical examination evaluated blood pressure (BP), body weight and height. BP was measured at the right arm supported at the heart level after participants resting for five minutes, using the Omron HBP-1300 Professional Portable Blood Pressure Monitor (OMRON, Japan). BP was measured three times, with 30 seconds between each measurement. The average of three readings was used for further analysis [10].

Body weight, basal metabolism (BM), body fat percentage (BFP) and visceral fat index (VFI) were measured without heavy clothing using an OMRON body fat and weight measurement device (Vbody HBF-371, OMRON, Japan). Height was measured without shoes using a standard right-angle device and a fixed measurement tape (to the nearest 0.5 cm).

Definitions

Hypertension was defined as systolic BP (SBP)≥140mmHg or diastolic BP (DBP)≥90mmHg, or self-reported use of antihypertensive medication [11]. Body mass index (BMI) was calculated as kg/m^2. Overweight was defined as BMI 25-30kg/m^2, and obesity was defined as BMI＞30kg/m^2.

Statistical analysis

Data was entered and validated using Epidata® 3.0 software[12]. All estimates and analyses were weighted to represent the population in Jilin Province aged 15 years or older. The weights were calculated based on the 2010 Jilin province population census data, as well as the sampling age, sex and geographic subgroups. Continuous data were presented as mean ± standard deviation (SD) or mean with 95% confidence intervals (CI), and differences between groups were compared using the t-est. Categorical data were presented as frequency, rate and 95% CI, and the prevalence between different groups was compared using the corrected Rao-Scott chi-square test. Logistic regression analysis was conducted assessing the relationship

of hypertension with age, sex, obesity, smoking, and alcohol drinking adjusted for demographic factors, that have been included in similar studies, including sex, region, age, education level, employment status, marital status, BMI, and family history of hypertension. All analyses were conducted using SPSS® 18.0 software[13].

Results

Distribution of participants

A total of 14,956 participants from 15,206 eligible participants (6,946 males and 8,010 females; aged 15–97 years) completed the survey and were included in the statistical analysis. The percentages of male and female respondents were 50.63% and 49.37%, respectively. The non-responders (1.6%) were mainly young people, and their non-response was likely attributable to their busy work schedule.

Characteristics of participants

The average age of the participants was 45.5 years, with the average age for males being 45.6 ± 19.6 years and for females 45.5 ± 18.9 years. There was no statistically significant difference in age between the sexes (p=0.92). The distribution of participants by age and sex are shown in Table 1. The participants had average values of 24.01 ± 3.67 kg/m^2 for BMI, 1,397.47 ± 244.15 for BM, 26.20 ± 8.4 for BFP, and 8.54 ± 4.99 for VFI. The mean SBP was 128.92 ± 17.97 mmHg, and the mean DBP was 76.81 ± 10.36 mmHg. These physical characteristics by age and sex are shown in Supplementary Table 1. All these characters were statistically significantly

different between males and females ($p<0.01$). In particular, male participants had higher BM and VFI values than female participants in all age groups (Figure 1A, 1B), while female participants had higher BFP values in all age groups (Figure 1C). BMI reached its highest value for males in the 35-44 year age group and for females in the 55-64 year age group (Figure 1D). The SBP was similar between males and females in all age groups (Figure 1E), although male participants had higher DBP values in all age groups (Figure 1F).

The overall prevalence of overweight and obesity of participants was 29.8% and 6.2%, respectively. Male participants had a higher prevalence of overweight than female participants (30.9% vs. 28.7%, $p = 0.013$). No statistical difference was observed in the prevalence of obesity among male and female participants (6.3% vs. 6.2%, $p = 0.78$). The overall percentages of current smoking and ever smoking were 22.7% and 1.4%, respectively. When stratified by sex, the percentage of current smoking in males (36.9%) was significantly higher than that in females (8.2%) ($p<0.001$). Similarly, the percentage of ever smoking in males (2.3%) was significantly higher than that in females (0.5%) ($p<0.001$). The overall percentage of alcohol drinking was 17.6%. The percentage in males (32.0%) was significantly higher than in females (2.9%) ($p<0.001$). The risk factors BMI, smoking and alcohol drinking, summarized by age and sex, are shown in Table 2.

Prevalence of hypertension stratified by non-modifiable factors-age and sex

Of the 14,956 participants, 4,332 were diagnosed with hypertension, and the

prevalence of hypertension was 24.7% (95% CI: 23.9%, 25.5%). The prevalence of hypertension increased as older ages, and was higher in males (25.6%) than in females (23.8%) (p=0.03). among the age groups under 45 years old, the prevalence of hypertension in males was significantly higher than in females (p<0.001); while for the 65-74 year age group, the prevalence of hypertension in females was higher than in males (p=0.04); and in the other age groups, the prevalence of hypertension in males and females showed no statistical difference (p>0.05). The prevalences of hypertension stratified by age and sex are shown in Table 3.

Prevalence of hypertension stratified by modifiable factors-obesity, smoking and alcohol drinking

The prevalences of hypertension varifed statisticallybetween the BMI categories (p < 0.001); the highest prevalence being reported was 48.1% in the obese group, followed by the overweight group at 35.7%. The prevalence of hypertension also verified significantly when stratified by smoking (p < 0.001); with the highest prevalence of 53.1% in the ever smoking group, followed by 32.2% in the current smoking group and 22.0% in the never smoking group. The prevalence of hypertension was significantly higher in the alcohol drinking group than in the no-alcohol drinking group (34.6% vs. 22.6%, p < 0.001). The prevalence of hypertension stratified by BMI, smoking and alcohol drinking are shown in Table 4.

Factors associated with hypertension

Several factors, including age, sex, obesity, smoking, and alcohol drinking, are associated with the prevalence of hypertension, in both the crude model and the adjusted logistic model. In particular, the univariate logistic model indicated that the risk of hypertension was greater in males with an OR=1.1 (95% CI: 1.01, 1.2) than in females, overweight partipants with an OR=2.52 (95% CI: 2.3, 2.77) than in normal participants, obese participants with an OR=4.21 (95% CI: 3.56, 4.96) than in normal participants, smokers with OR=1.64 (95% CI: 1.48, 1.81) than in non-smokers, and alcohol drinkers with OR=1.81 (95% CI: 1.62, 2.02) than in non-alcohol drinkers. All the difference were statistically significant ($p<0.05$). After adjustment for age, sex, region, education level, employment status, BMI, family history of hypertension, and marital status that may affect hypertension, the risk of hypertension was greater in males with an adjusted OR=1.26 (95% CI:1.13, 1.39) than in females, in overweigh participants with an adjusted OR=2.3 (95% CI: 2.06, 2.58) than in normal participants, in obese participants with an adjusted OR=5.11 (95% CI: 4.16, 6.27) than in normal participants, in smokers with an adjusted OR=1.28 (95% CI: 1.13, 1.46) than in non-smokers, and in alcohol drinkers with an adjusted OR=1.49 (95% CI: 1.28, 1.73). These results are shown in Table 5.

Discussion

Based on an estimated prevalence of 24.7% for hypertension in Jilin province, approximately 6.8 million residents would be considered hypertensive. At the national level, the prevalence of hypertension in Jilin is comparable to that in Zhejiang

province [12]; while the prevalence is lower than in other regions in China, including Jiangxi [13], Inner Mongolia [14], and Macau [15], as well as, lower than the overall prevalence in China [16]. At the global level, the prevalence in Jilin is lower than that in the US and the UK, but is higher than that in Canada [4]. However, there are some limitations in terms of the direct comparisons among these studies, given the varying methods, environments, population genetics, and population age structures.

Although the prevalence from the present study is lower than the prevalence form 2012 (24.7% vs. 30.8%) [17], it remains unacceptably high in terms of optimal hypertension health in the province. Our study found that the prevalence of overweight and obesity was 29.8% and 6.2%, respectively, which is higher than that reported at the national level of 17.7% and 5.6%, respectively[18]. Several studies have shown that obesity is a risk factor for the development of hypertension[19-21]. Obesity can increase hypertension through multiple mechanisms, including insulin resistance, activation of sympathetic nervous system, sodium retention leading to increased renal reabsorption, and activation of the renin-angiotensin system[22]. Thus, the increasing populations of overweight and ovese Jilin residents suggest thepotential risk of future increasing incidence of hypertension. Unfortunately, this modifiable risk factor has exhibited no change in between the report in 2012 and now[17], and the population of overweight and obesity may even beunderestimated, because the standard definitions for overweight and obesity used in our research may be too high for Asian population [23, 24]. Moreover, abdominal obesity can be present in individuals with normal BMI values (18.5-24.9kg/m^2), and some studies have

indicated that this condition could be a risk factor for hypertension [25, 26]. Thus, as overweight and ovesity are modifiable risk factors, effective proactive intervention program could help slow and ultimately reduce the number of individuals with obesity becoming hypertensive.

Our study found that the overall prevalence of hypertension increased with age in both males and females, especially at ages of 35-74 years. This result supports the hypothesis that age is a risk factor for hypertension [27-30]. An increasing lifespan among the population in Jilin requires a practical and effective hypertension management strategy that targets its aging population. The overall prevalence of hypertension was higher in males than in females. However, the prevalence in females increased more rapidly than in males aged 65-74 years. This may be partially explained by hormonal changes in post-menopausal women and the difference in lifespan between males and females [4, 31]. However, the exact mechanisms need to be explored.

Consistent with previous studies [32, 33], our study also showed that smoking, both current and ever smoking, was associated with an increased risk of hypertension. Smoking can increase blood viscosity, stimulate the adrenergic nervous system, and contribute to the development of both micro-vascular and macro-vascular diseases[34]. Although some studies reported weak associations between smoking and hypertension [13, 20], smoking is still considered a major risk factor worldwide [13, 20, 35-37], Additionally, drinking of alcohol is also a risk factor for hypertension in our study, which is consistent with previous studies [4, 38-40]. These results indicate

that some lifestyle changes, such as quitting smoking and reducing or stopping alcohol consumption, should help to reduce the prevalence of hypertension.

National studies reported that the prevalence of hypertension is higher in northern China than that in southern China [7, 16]. When comparing the associations between risk factors and hypertension with Zhejiang province located in the South[12], we found that the risk of hypertension with demographic factors, such as age, sex, and region, and clinical factors, such as family history of hypertension and abdominal waist circumference, were similar in Jilin province and in southern China. When it comes to the lifestyle factors, the risk of hypertension with obesity and alcohol drinking were similar, however, there was a marked difference in the modifiable risk factor smoking; in particular, in Jilin province there was a strong association with an adjusted OR=1.28 (95% CI: 1.13, 1.46), whereas no association between smoking and hypertension in southern China was found, with an adjusted OR=1.0 (95% CI: 0.9, 1.1). These findings indicate that smoking cessation programs could help mitigate the prevalence of hypertension in Jilin province. Some social factors including retirement status, marital status, and education level were also different between the North and the South. Of interest, there was a difference on BFP categories. In particular, for category 10-19 for males and 20-29 for females, there was no association between BFP and hypertension in Jilin province with an adjusted OR=0.95 (95%CI: 0.71, 1.27), whereas in this category BFP is protective againt hypertension in south China with an adjusted OR=0.6 (95% CI: 0.5, 0.8). In the range of over 25 for males and over 35 for females, BFP is strongly associated with hypertension in Jilin province

with an adjusted OR=1.45 (95% CI: 1.07, 1.96), whereas no association was found in the South with an adjusted OR=1.3 (95%CI: 1.0, 1.5). These results indicate that BFP tends to be more of a risk for hypertension in the North compared to the South. High BFP values are associated with increased blood pressure[41, 42], and there may be ethnicity-based differences in the relationship between BFP and BMI [43]. Those results may help explain the region-specific relationships between BFP and hypertension in northern and southern China, although further studies are needed to better understand these relationships.

A survey from 2012 found a prevalence of hypertension of 30.8% [17]. The prevalence of hypertension in our study was lower. This reduction may be related to the following two factors. First, the Jilin government is aware of the damage and burdern of hypertension and has increased medical insurance funding (especially for rural residents), from RMB ¥3.9 billion in 2012 to RMB ¥6.4 billion in 2015, according to the statistical bureau of Jilin province. Second, new hypertension guidelines for China were published since 2012, and these guidelines addressed the grass-roots management of hypertension [44] and patient education [45]. However, some key modifiable risk factors have exhibited slight negative changes, in particular, the trend towards obesity, drinking and smoking. This can be due in part to the Jilin's growing economy, which has increased from a gross domestic product of RMB ¥361.5 billion in 1995, to RMB ¥857.8 billion in 2010, to RMB ¥1.4 trillion in 2015, according to the statistical bureau of Jilin province. To reverse these trends will require an effective and workable intervention program to control hypertension by

incorporating best practices identified in theory and practice. For example, rates of hypertension awareness have greatly improved from 24.4% to 42.6%, and the treatment rates have improved from 20.0% to 24.2% based on national surveys [16]. However, the control rate is only 9.3% in comparison with 53% in the USA[4]. One of the challenges is to improve adherence to anti-hypertension drugs.

This study was a cross-sectional study and contained a large representative sample. These factors will allow for the generalisation of our findings to residents aged 15 years and over in northern China. However, there are some limitations in this study. First, this is a cross-sectional study design, thus the causality cannot be assumed between the risk factors and hypertension. Second, financial limitations precluded collection of data regarding physical activity, salt intake and blood lipid levels. Third, the decrease of prevalence of hypertension in our study compared with that in 2012 may be related with sampling factor.

In summary, the prevalence of hypertension in Jilin province decreased compared with that in 2012, and is lower than the overall prevalence in China. In addition, the study showed that hypertension was associated with age, sex, obesity, smoking and alcohol drinking. In particular, smoking may be responsible for the different prevalences of hypertension in northern and southern China. These factors above, especially smoking, will be important points to control and manage hypertension in Jilin province.

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Footnotes

Contributors

BL was involved in the study's design, JW, XS, LL, YY, YL, and CQ collected the data, YZ and YL performed the statistical analysis, TL, WS, and BL wrote the paper. All authors reviewed and approved the final version of the paper.

Ethics approval

This study was approved by the Fuwai Hospital Ethics Review Board.

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Competing interests

None declared.

Data sharing statement

No additional data are available.

Figure Captions

Figure 1: Trends of physical characteristics by age and sex. (A) basal metabolism BM (B) body fat percentage - BFP (C) visceral fat index - VFI (D) body mass index - BMI (E) systolic blood pressure - SBP (F) diastolic blood pressure - DBP

Table 1: Distribution of participants by age and sex in Jilin province (N, %)

Age	Male		Female		Total	
	N	%	N	%	N	%
15-24	1120	9.07	1146	8.51	2266	17.59
25-34	1316	8.91	1520	8.52	2836	17.43
35-44	1084	11.95	1359	11.40	2443	23.35
45-54	1043	10.02	1333	9.68	2376	19.70
55-64	950	6.36	1121	6.47	2071	12.83
65-74	755	3.01	823	3.23	1578	6.24
75+	678	1.31	708	1.55	1386	2.86
Total	6946	50.63	8010	49.37	14956	100.0

490 **Table 2:** Distribution of participants by age and sex stratified by body mass index, smoking and alcoholic drinking in Jilin province (%, 95%CI)

	BMI				Smoking			Alcohol Drinking
	<18.5	18.5-25.0	25.0-30.0	>30.0	Current	Ever	Never	
Male								
15-24	13.33	67.57	14.85	4.25	6.95	0.36	92.69	5.80
	(11.11,15.91)	(64.24,70.73)	(12.58,17.46)	(3.03,5.93)	(5.47,8.80)	(0.10,1.22)	(90.79,94.22)	(4.62, 7.26)
25-34	2.80	57.76	31.36	8.08	39.19	0.64	60.17	29.70
	(1.98,3.93)	(54.70,60.77)	(28.57,34.30)	(6.52,9.96)	(36.20,42.26)	(0.30,1.37)	(57.09,63.17)	(26.96, 32.60)
35-44	1.89	54.86	35.26	7.99	46.92	1.32	51.76	39.90
	(0.18,3.01)	(51.49,58.18)	(32.10,38.55)	(6.35,10.02)	(43.57,50.30)	(0.79,2.18)	(48.39,55.12)	(36.62, 43.26)
45-54	1.56	55.63	36.25	6.56	48.42	3.19	48.38	44.70
	(0.93,2.60)	(52.33,58.88)	(33.14,39.47)	(5.11,8.39)	(45.13,51.73)	(2.25,4.52)	(45.10,51.68)	(41.44, 48.00)
55-64	0.79	59.10	35.17	4.94	44.79	5.19	50.02	39.30
	(0.39,1.60)	(55.67,62.44)	(31.96,38.52)	(3.65,6.66)	(41.38,48.25)	(3.88,6.91)	(46.57,53.47)	(35.99, 42.71)
65-74	2.16	60.45	33.51	3.88	32.13	6.99	60.88	34.30
	(1.26,3.69)	(56.54,64.22)	(29.91,37.33)	(2.66,5.62)	(28.57,35.91)	(5.22,9.30)	(56.97,64.65)	(30.65, 38.14)
75+	3.71	62.83	30.22	3.23	22.06	5.58	72.35	18.74
	(2.53,5.42)	(58.82,66.68)	(26.61,34.10)	(2.01,5.15)	(18.85,25.64)	(3.96,7.82)	(68.54,75.87)	(15.72, 22.19)
Female								
15-24	13.46	70.77	12.55	3.22	0.36	0.00	99.64	0.76
	(11.24,16.03)	(67.48,73.85)	(10.34,15.16)	(2.34,4.43)	(0.11,1.16)		(98.84,99.89)	(0.43,1.35)
25-34	6.46	66.10	22.33	5.11	2.90	0.06	97.04	3.50
	(5.25,7.94)	(63.37,68.72)	(20.06,24.79)	(3.97,6.55)	(2.05,4.08)	(0.01,0.44)	(95.85,97.89)	(2.65,4.62)
35-44	1.81	61.59	29.86	6.74	8.00	0.07	91.93	4.40
	(1.16,2.81)	(58.64,64.45)	(27.18,32.67)	(5.38,8.41)	(6.45,9.88)	(0.01,0.50)	(90.05,93.49)	(3.37,5.73)

45-54	1.99	54.20	36.38	7.44	10.36	0.52	89.12	3.08
	(1.29,3.04)	(51.27,57.09)	(33.62,39.24)	(6.05,9.11)	(8.69,12.31)	(0.23,1.17)	(87.14,90.83)	(2.23,4.25)
55-64	2.53	48.89	40.24	8.34	16.81	1.46	81.73	2.53
	(1.72,3.71)	(45.72,52.08)	(37.17,43.39)	(6.72,10.30)	(14.58,19.30)	(0.85,2.49)	(79.16,84.05)	(1.68,3.81)
65-74	4.89	50.05	38.50	6.57	17.61	1.68	80.71	1.81
	(3.53,6.72)	(46.31,53.78)	(34.91,42.22)	(4.94,8.67)	(14.97,20.60)	(0.93,2.99)	(77.62,83.47)	(1.03,3.16)
75+	10.17	57.46	26.17	6.20	12.82	1.27	85.91	2.48
	(7.87,13.04)	(53.37,61.45)	(22.77,29.89)	(4.50,8.50)	(10.29,15.87)	(0.64,2.50)	(82.77,88.55)	(1.45,4.23)

Table 3: Prevalence of hypertension by age and sex in Jilin province

Age group	Male n	Male CR(95%CI)	Female n	Female CR(95%CI)	Total n	Total CR(95%CI)
15-24	80	6.86(5.27,8.87)	23	1.88(1.19,2.96)	103	4.45(3.53,5.59)
25-34	106	8.47(6.89,10.36)	50	4.28(3.20,5.69)	156	6.42(5.43,7.58)
35-44	221	21.00(18.36,23.91)	195	15.21(13.14,17.55)	416	18.17(16.45,20.03)
45-54	379	35.13(32.06,38.33)	430	32.57(29.89,35.36)	809	33.87(31.82,35.99)
55-64	449	46.42(43.00,49.87)	576	50.72(47.54,53.90)	1025	48.59(46.25,50.94)
65-74	451	59.91(55.98,63.71)	518	65.32(61.72,68.76)	969	62.71(60.06,65.29)
75+	405	61.24(57.24,65.10)	449	62.37(58.30,66.28)	854	61.86(59.00,64.63)
Total	2091	25.60(24.41,26.79)	2241	23.84(22.80,24.89)	4332	24.73(23.94,25.53)

CI: confidence interval

494 **Table.4** Prevalence of hypertension by age and sex stratified by body mass index, smoking and alcoholic drinking (%, 95%CI)

	BMI				Smoking			Alcohol Drinking	
	<18.5	18.5-25.0	25.0-30.0	>30.0	Current	Ever	Never	Yes	No
Male									
15-24	1.48 (0.37,5.76)	4.39 (2.94,6.51)	16.22 (10.62,24.00)	30.17 (16.58,48.44)	8.17 (3.45,18.15)	13.13 (1.35,62.57)	6.73 (5.10,8.84)	11.60 (5.85,21.69)	6.56 (4.95, 8.66)
25-34	1.45 (0.20,9.72)	5.33 (3.78,7.46)	9.15 (6.43,12.85)	30.70 (21.42,41.86)	11.49 (8.66,15.08)	6.89 (0.88,38.13)	6.51 (4.80,8.78)	10.64 (7.63, 14.64)	7.55 (5.80, 9.77)
35-44	5.49 (0.97,25.57)	14.76 (11.77,18.34)	25.87 (21.16,31.22)	45.98 (34.53,57.87)	23.76 (19.72,28.33)	36.23 (16.51,62.01)	18.11 (14.77,22.00)	28.02 (23.40, 33.16)	16.34 (13.35,19.84)
45-54	27.39 (10.96,53.63)	25.02 (21.38,29.05)	44.90 (39.57,50.35)	68.73 (55.83,79.27)	37.10 (32.60,41.83)	41.53 (25.83,59.16)	32.74 (28.51,37.27)	43.01 (38.20, 47.96)	28.76 (24.95, 32.91)
55-64	11.46 (2.44,40.14)	39.64 (35.33,44.11)	55.87 (50.07,79.30)	65.91 (50.62,78.48)	47.15 (42.04,52.33)	61.46 (46.39,74.61)	44.21 (39.43,49.09)	52.10 (46.61, 57.54)	42.74 (38.42, 47.18)
65-74	19.58 (6.35,46.63)	52.27 (47.16,57.34)	73.86 (67.56,15.96)	80.86 (61.30,91.85)	60.60 (53.60,67.20)	74.69 (59.79,85.42)	57.84 (52.78,62.74)	66.86 (60.21, 72.89)	56.58 (51.40, 61.04)
75+	37.87 (21.57,57.45)	58.85 (53.77,63.76)	66.71 (59.34,73.34)	83.47 (57.75,94.91)	68.66 (60.13,76.08)	59.10 (41.42,74.69)	59.15 (54.42,63.71)	65.17 (55.63, 73.63)	60.34 (55.90, 64.62)
Female									
15-24	1.50 (0.37,5.81)	0.91 (0.42,1.98)	5.62 (2.53,12.01)	10.02 (3.85,23.67)	0.00	0.00	1.88 (1.19,2.97)	0.00	1.89 (1.19,2.98)
25-34	0.00	2.16 (1.29,3.59)	6.56 (4.03,10.51)	27.09 (16.97,40.31)	12.35 (4.36,30.33)	0.00	4.04 (2.98,5.44)	0.66 (0.09,4.63)	4.41 (3.29,5.87)
35-44	17.78 (5.86,42.90)	9.70 (7.67,12.20)	22.05 (17.69,27.14)	34.59 (24.35,46.49)	19.76 (12.41,29.97)	100.00 (100.00,100.00)	14.75 (12.62,17.17)	25.47 (14.99,39.84)	14.74 (12.65,17.11)

45-54	0.00	24.68	40.48	60.03	34.92	61.78	32.13	27.45	32.73
		(21.42,28.27)	(35.84,45.30)	(49.33,69.86)	(26.73,44.12)	(22.45,90.03)	(29.31,35.08)	(15.31,44.19)	(30.01,35.57)
55-64	40.61	39.07	61.42	70.47	51.28	62.47	50.40	51.62	50.70
	(23.68,60.12)	(34.71,43.61)	(56.48,66.14)	(59.27,79.64)	(43.64,58.86)	(35.28,83.56)	(46.87,53.92)	(31.60,71.13)	(47.48,53.91)
65-74	38.58	59.74	74.83	72.04	65.26	57.48	65.50	50.45	65.60
	(24.16,55.33)	(54.53,64.73)	(69.27,79.68)	(57.14,83.28)	(56.45,73.13)	(29.24,81.56)	(61.48,69.31)	(24.78,75.88)	(61.97,69.05)
75+	45.30	60.64	73.24	60.53	64.01	100.00	61.57	51.72	62.64
	(32.73,58.49)	(55.25,65.79)	(65.79,79.57)	(43.53,75.31)	(52.10,74.41)	(100.00,100.00)	(57.18,65.79)	(26.49,76.10)	(58.53,66.58)

Table.5 Risk factors associated with the prevalence of hypertension

	Hypertension prevalence	
	Unadjusted	Adjusted
Age(Ref: 15-24)		
25-34	1.47(1.09,1.99)	1.05(0.71,1.55)
35-44	4.77(3.65,6.24)	2.83(1.90,4.22)
45-54	11.01(8.51,14.24)	6.93(4.69,10.24)
55-64	20.31(15.69,26.29)	13.43(9.06,19.90)
65-74	36.14(27.73,47.11)	26.18(17.56,39.03)
75+	34.85(26.65,45.57)	29.89(19.83,45.03)
Sex(Ref: female)	1.1(1.01,1.2)	1.25(1.13,1.39)
Region(Ref: Urban)	1.19(1.09,1.3)	1.25(1.12,1.39)
Race(Ref: Han)	1.15(0.93,1.42)	0.93(0.74,1.18)
Employment(Ref: be employed)		
Retired	2.67(2.22,3.2)	0.67(0.53,0.85)
Student	0.15(0.11,0.21)	1.09(0.71,1.70)
Unemployed	1.18(1.07,1.3)	0.84(0.74,0.95)
Marital(Ref: married)	0.72(0.63,0.83)	1.29(1.00,1.65)
Education level(Ref: college or higher)		
Illiterate	6.69(5.19,8.63)	2.18(1.62,2.93)
Primary	3.26(2.7,3.93)	1.98(1.60,2.44)
Middle	1.55(1.24,1.94)	1.24(0.97,1.57)
BMI(Ref: Normal)		
Overweight	2.22(2.01,2.46)	2.30(2.06,2.57)
Obese	3.96(3.31,4.75)	5.17(4.20,6.37)
AWC(Ref:<90M,<85F)		
≥90M，≥85F	1.41(1.23,1.62)	1.35(1.16,1.57)
≥95M，≥90F	1.5(1.32,1.72)	1.68(1.43,1.96)
Family history of hypertension	1.74(1.55,1.96)	2.35(2.06,2.67)
Family history of stroke	1.33(0.85,2.06)	1.79(1.09,2.92)
Family history of CAD	3.18(2.64,3.83)	1.65(1.33,2.03)
Smoker(Ref: no)	1.37(1.23,1.53)	1.23(1.08,1.40)
Drinker(Ref: no)	1.56(1.38,1.77)	1.47(1.27,1.71)
VAI（Ref:＜10)		
10~14	1.6(1.41,1.8)	1.40(1.22,1.60)
15~30	2.69(2.29,3.16)	2.05(1.69,2.49)
BFP(Ref:＜10M，＜20F)		
10~19M，20~29F	1.31(1,1.71)	0.95(0.71,1.27)
20~24M，30~34F	2.72(2.09,3.55)	1.24(0.92,1.66)
≥25M，≥35F	3.48(2.67,4.54)	1.45(1.07,1.96)

CI: confidence interval; BMI: body mass index; AWC: Abdominal waist circumference; CAD: coronary heart disease; M: male; F: female; VAI: Visceral Fat; BFP: body fat percentage.

Adjusted for sex, region, age, education level, employment status, marital status, BMI, and family history of hypertension

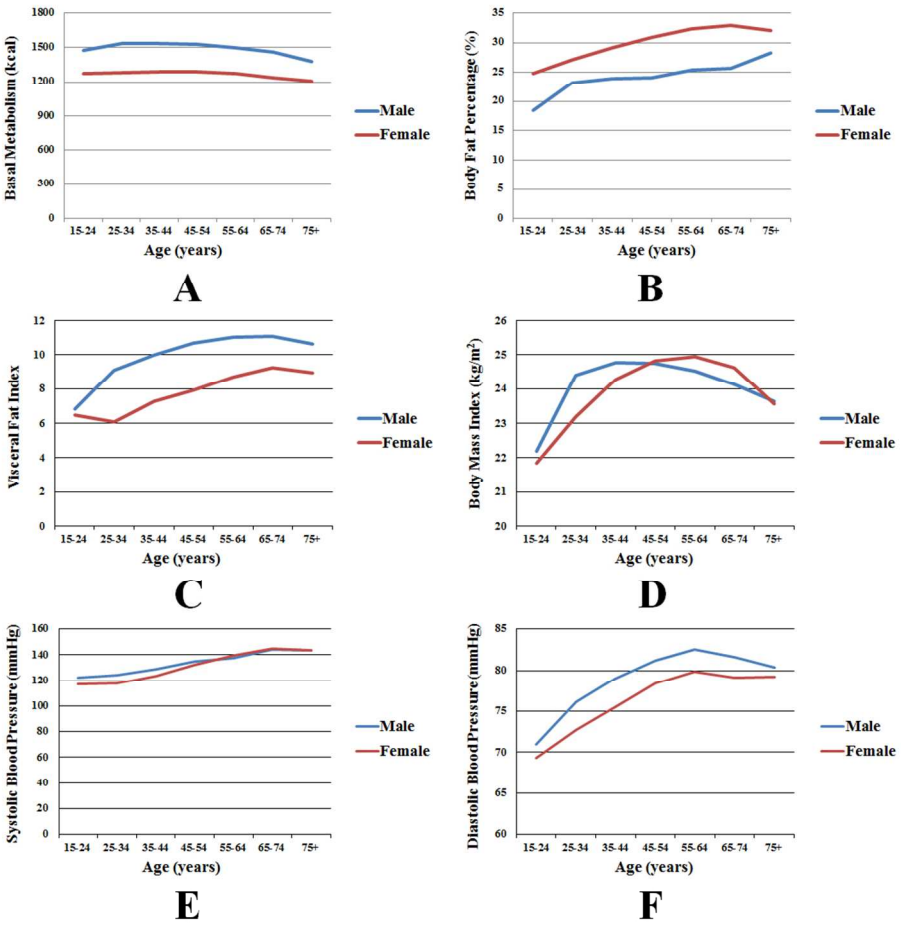

Figure 1: Trends of physical characteristics by age and sex. (A) basal metabolism BM (B) body fat percentage - BFP (C) visceral fat index - VFI (D) body mass index - BMI (E) systolic blood pressure - SBP (F) diastolic blood pressure - DBP

99x98mm (300 x 300 DPI)

Supplementary Table Descriptions of basal metabolism – BM, body fat percentage – BFP, visceral fat index - VFI by age and sex in Jilin province

	Age	Male		Female	
		Mean	95%CI	Mean	95%CI
BM	Total	1511.50	(1504.56, 1518.43)	1280.52	(1276.09, 1284.96)
	15-24	1478.92	(1456.95, 1500.88)	1279.31	(1264.09, 1294.53)
	25-34	1538.93	(1524.04, 1553.81)	1281.66	(1272.68,1290.64)
	35-44	1534.48	(1519.02, 1549.95)	1293.35	(1284.03, 1302.67)
	45-54	1528.84	(1514.65, 1543.02)	1293.81	(1284.74, 1302.87)
	55-64	1499.65	(1486.40, 1512.90)	1274.36	(1264.67, 1284.06)
	65-74	1460.36	(1443.82, 1476.89)	1241.86	(1230.00, 1253.73)
	75+	1382.81	(1367.17, 1398.45)	1209.84	(1195.08, 1224.59)
Body Fat percentage	Total	23.28	(23.03, 23.53)	29.19	(29.02, 29.35)
	15-24	18.46	(17.52, 19.40)	24.78	(24.38, 25.18)
	25-34	23.26	(22.87, 23.65)	27.20	(26.88,27.52)
	35-44	24.02	(23.64, 24.40)	29.19	(28.86, 29.52)
	45-54	24.09	(23.76, 24.41)	30.95	(30.61, 31.29)
	55-64	25.34	(24.58, 26.10)	32.39	(31.99, 32.80)
	65-74	25.74	(25.30, 26.17)	32.97	(32.46, 33.48)
	75+	28.31	(27.06, 29.56)	32.08	(31.15, 33.00)
VAI	Total	9.63	(9.49, 9.77)	7.42	(7.29, 7.55)
	15-24	6.81	(6.54, 7.08)	6.48	(6.05, 6.91)
	25-34	9.13	(8.81, 9.46)	6.07	(5.83, 6.30)
	35-44	10.01	(9.70, 10.32)	7.25	(6.96, 7.54)
	45-54	10.71	(10.39, 11.03)	7.90	(7.68, 8.11)
	55-64	11.06	(10.74, 11.37)	8.71	(8.47, 8.96)
	65-74	11.11	(10.72, 11.49)	9.27	(8.81, 9.73)
	75+	10.64	(10.21, 11.07)	8.95	(8.56, 9.35)
BMI	Total	24.15	(24.05,24.25)	23.88	(23.78,23.97)
	15-24	22.20	(21.93,22.47)	21.86	(21.63,22.10)
	25-34	24.41	(24.18,24.63)	23.20	(22.99,23.42)
	35-44	24.78	(24.55,25.01)	24.29	(24.08,24.51)
	45-54	24.75	(24.54,25.01)	24.82	(24.63,25.02)
	55-64	24.54	(24.33,24.76)	24.96	(24.74,25.18)

	65-74	24.14	(23.88,24.40)	24.63	(24.35,24.92)
	75+	23.63	(23.37,23.89)	23.56	(23.24,23.88)
SBP	Total	130.44	(129.99,130.88)	127.36	(126.90,127.81)
	15-24	122.45	(121.67,123.24)	116.81	(116.13,117.50)
	25-34	124.43	(123.77,125.08)	117.93	(117.28,118.58)
	35-44	128.76	(127.85,129.67)	123.85	(122.95,124.75)
	45-54	134.69	(133.51,135.87)	132.39	(131.28,133.49)
	55-64	137.56	(136.22,138.91)	139.53	(138.17,140.90)
	65-74	143.98	(142.25,145.71)	145.16	(143.55,146.76)
	75+	143.69	(141.96,145.42)	143.44	(141.60,145.28)
DBP	Total	78.14	(77.84,78.43)	75.45	(75.19,75.71)
	15-24	70.98	(70.43,71.53)	69.35	(68.82,69.88)
	25-34	76.13	(75.63,76.63)	72.69	(72.25,73.13)
	35-44	79.04	(78.42,79.66)	75.47	(74.91,76.03)
	45-54	81.24	(80.51,81.96)	78.41	(77.79,79.03)
	55-64	82.50	(81.67,83.33)	79.87	(79.15,80.60)
	65-74	81.56	(80.72,82.40)	79.13	(78.35,79.91)
	75+	80.38	(79.61,81.15)	79.26	(78.41,80.11)

CI: confidence interval

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 P1-2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found P2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported P3
Objectives	3	State specific objectives, including any prespecified hypotheses P4
Methods		
Study design	4	Present key elements of study design early in the paper P4-5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection P4-5
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 P4
		(*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 P6
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 P5
Bias	9	Describe any efforts to address potential sources of bias P5
Study size	10	Explain how the study size was arrived at P4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why P5-6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding P6
		(*b*) Describe any methods used to examine subgroups and interactions P6
		(*c*) Explain how missing data were addressed P6
		(*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 N/A
		(*e*) Describe any sensitivity analyses N/A

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	P7
		(b) Give reasons for non-participation at each stage	P7
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	P7
		(b) Indicate number of participants with missing data for each variable of interest	N/A
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	N/A
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	P7
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	P8
		(*b*) Report category boundaries when continuous variables were categorized	P6
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	P8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	P10
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	P15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	P10-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	P15
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	P19

*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.