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# Prevalence of obesity and overweight and associated factors among adult residents in northeast China: a cross-sectional study

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# Prevalence of obesity and overweight and associated factors among adult residents in northeast China: a cross-sectional study

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#### Abstract

*Objectives:* This study aims to determine the prevalence of overweight and obesity and find out the potential influencing factors among adults in northeast China.

*Methods:* A cross-sectional survey was conducted in Jilin Province, northeast China, in 2012. A total of 9,873 men and 10,960 women aged 18–79 years from the general population were included by a multistage stratified random cluster sampling design. Data were obtained from physical examination and face-to-face interview. After being weighted according to complex sampling scheme, the sample was used to describe the prevalence of overweight (BMI: 24–27.9 kg/m<sup>2</sup>) and obesity (BMI>28 kg/m<sup>2</sup>) of Jilin province, and analyze the influencing factors through the corresponding statistical methods based on complex sampling design behaviors.

*Results:* The prevalence of overweight and obesity in Jilin province was 34.3% and 16.3% of men, 30.2% and 12.8% of women. The prevalence of overweight and obesity of men were higher than women (P<0.001). The influencing factors of overweight and obesity included gender, age, marriage, occupation, smoking, drinking, diets and hours of sleep (P<0.05).

*Conclusions*: This study suggested the prevalence of overweight and obesity among adult residents in Jilin province, northeast China, were at a high level. Main influencing factors for overweight and obesity included gender, age, marriage, occupation, smoking, drinking, diets and hours of sleep (P<0.05). The results of this study should inform policy makers in developing education and publicity to prevent and control the occurrence of overweight and obesity.

Keywords: overweight, obesity, influencing factors, northeast China

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## Introduction

Getting overweight and obesity has been shown to be related to multiple chronic conditions, which brings heavy economic burden for families and increasing cost for society in each country. [1-3] According to the World Health Organization(WHO) report,[4] obesity means the Body Mass Index (BMI) greater than or equal to 30 kg/m<sup>2</sup>, overweight means the BMI between 25 and 29.9 of an individual. Among Chinese people, obesity suggests BMI greater than or equal to 28 kg/m<sup>2</sup> and overweight indicates BMI between 24 and 27.9.[5] In 2013, the American Medical Association classified obesity as a disease to make physicians pay more attention to this condition .[6]

China is the largest developing country, meanwhile, has the largest population in the world. The rapid economic growth and enviable development performance in China have contributed to changes in lifestyle such as dietary habit and physical activity.[7] During the past decades, China witness the obesity epidemic as a considerable cause of various diseases especially the chronic ones. Overweight and obesity have become a major public health problem in China although China has a lower prevalence of obesity compared with the developed countries.[4 8 9] Previous research suggested there was significant increase in the prevalence of obesity in United States and Canada over the past years,[10] the same scenario played out in China recently as well, there is no doubt that rapidly increasing overweight and obesity in China will continue to push up the prevalence of chronic diseases.[11-13] Therefore, understanding the influencing factors associated with overweight and

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obesity can be very useful and significant for policy makers in formulating corresponding policies to diminish the rate and control its related comorbid conditions.

Jilin province is located in northeast China who has a large population of about 27 million.[14] In 2012, Jilin Department of Health and Jilin University jointly conducted the Jilin Provincial Chronic Disease Survey, which is the first large representative population-based survey of chronic disease in this area. Data in our study were obtained from this survey. In this article, we described the prevalence of overweight/obesity and explored the potential influencing factors among adult residents in northeast China, aiming to provide useful information for policy makers in making informed decisions and reversing the increasing trends.

### **Methods**

This population-based cross-sectional survey is part of the Project on Present Situation and Change Forecast of Disease Spectrum in Jilin Province of China in 2012. Face-to-face health interview and physical examination were performed in the Jilin Provincial Chronic Disease Survey among residents aged from18 to 79 years who lived in Jilin province for more than 6 months. We used the multistage stratified cluster sampling method to select the study sample. There were 9 areas (Changchun, Jilin, Siping, Liaoyuan, Tonghua, Baishan, Songyuan, Baicheng, and Yanbian), 32 districts or counties, 95 towns or communities, and 45 units in Jilin Province selected. 116 uniformly trained investigators conducted the face-to-face interviews after pre-interview. The detailed implementation process and quality control were reported elsewhere previously. [14 15]

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The questionnaire included information on demographics and life style habits. In the interview, weight and height were determined by standardized protocol and measured in light indoor clothing without shoes. The grading standards for Chinese adult have been mentioned above: Body Mass Index(BMI)= weight/ height<sup>2</sup>(kg/m<sup>2</sup>),  $24 \leq BMI \leq 28$  is overweight; BMI  $\geq 28$  is obesity, we used the criterion: BMI  $\geq 24$  as the assessment standard of excessive weight.

We used post-stratification adjustment according to the distribution of regional, urban/rural, age, and gender groups in the 2010census of the adult population in Jilin Province to make the sample represent the population of the whole province. Rao-Scott Chi-square tests were used to compare the prevalence of overweight and obesity in different groups. To adjust for potential confounding effects, multiple regression analyses were carried out to explore independent factors associated with overweight and obesity. All Statistical analysis was conducted using the complex sampling function by SPSS 20.0 statistical software and  $p \le 0.05$  level of significance was selected.

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#### Result

In this survey, we interviewed 23,050 residents aged over 18 years, 2,211 residents were excluded because of lacking efficient information and other potential bias. 20,839 residents were contained finally, resulting in a response rate of 82.6% (replacement rate: 9.5%). Of the 20,839 subjects, there were 9,873 men (47.4%) and 10,960 women (52.6%) in our analysis, the age ranged from 18 to 79(mean $\pm$ S.D.: 47.27 $\pm$ 13.34). According to the BMI classification for Chinese people mentioned

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above, the overall prevalence of overweight was 32.3% (male: 34.3%, female: 30.2%), and the prevalence of obesity was 14.6% (male: 16.3%, female: 12.8%) in Jilin province as shown in Table 1.

				Overweigh	t		Obesity	
Characteristi		n	PR(%)	$\chi^2$	Р	PR(%)	$\chi^2$	Р
Urban	City	10733	32.9	4.250	0.088	14.6	< 0.001	0.996
	Country	10106	31.6			14.6		
Gender	Male	9873	34.3	40.576	< 0.001	16.3	50.815	< 0.001
	Female	10966	30.2			12.8		
Age	18~	1128	14.5	694.270	< 0.001	7.8	130.162	< 0.001
	25~	2787	27.1			15.8		
	35~	4749	34.3			15.5		
	45~	5627	39.8			16.5		
	55~	4483	40.5			15.7		
	65~79	2065	37.0			13.9		
Education	Primary school and below	6143	34.5	27.811	<0.001	15.3	7.794	0.171
	Junior middle school	5977	31.1			15.1		
	Senior middle school	5349	33.5			14.1		
	Under graduate and above	3370	30.1			13.6		
Marriage	Unmarried	1569	16.7	393.117	< 0.001	10.2	56.945	< 0.001
	Married	17861	34.8			15.4		

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	Separated/Divorced/Widowed	1409	37.4			14.1		
Occupation	Manual	11689	32.0	3.090	0.364	14.2	33.609	< 0.001
	Intelligence	4078	32.1			12.9		
	Others	5072	33.4			17.0		

Note: PR=Prevalence rate. Complex weighted computation was used in the statistical analysis.

From the age-stratified result in Table 2, for men, the prevalence of overweight increased with age, peaking at 45-54, while such trend was not seen in the prevalence of obesity. For women, both the prevalence increased with age, peaking at group 55-64 and 61-79 respectively. Moreover male have a higher prevalence of overweight than female from age 18 to 54, and a higher prevalence of obesity from age 18 to 44.

A ge -	Over	weight	Obesity			
Age	Male	Female	Male	Female		
18~	18.0	11.1	11.4	4.2		
25~	31.6	21.3	21.1	8.9		
35~	37.9	30.6	18.5	12.3		
45~	41.0	38.5	15.9	17.2		
55~	39.5	41.6	13.8	17.6		
65~79	33.9	40.0	9.8	17.7		
Total	34.3	30.2	16.3	12.8		

Table.2 The prevalence of overweight and obesity between male and female in different age groups

Table 3 describes the influence of the factors below all have statistic significance: gender, age, education, marriage, occupation, smoking, drinking, diet and sleep

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quality(P < 0.001). We thus put all these significant factors into the model of multivariate logistic regression.

Characteristic	PR(%) Waldy <sup>2</sup>		D	OD	95%CI for OR		
Characteristic	PK(%)	waldχ	Р	OR -	Lower	Upper	
Area		2.394	0.122				
City	47.5			1.000	-	-	
Country	46.2			0.947	0.885	1.015	
Gender		78.149	< 0.001				
Female	43.0			1.000	-	-	
Male	50.6			1.359	1.269	1.454	
Age		77.409	< 0.001				
18~	22.4			1.000	-	-	
25~	42.9			2.604	2.162	3.138	
35~	49.8			3.441	2.889	4.098	
45~	56.3			4.467	3.758	5.310	
55~	56.2			4.458	3.739	5.316	
65~79	50.9			3.594	2.946	4.384	
Education		8.253	< 0.001				
Primary school and below	49.8			1.000	-	-	
Junior middle school	46.2			0.863	0.790	0.943	
Senior middle school	47.6			0.915	0.836	1.002	

Table.3 Univariate analysis of correlates of overweight & obesity of residents in Jilin Province

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Under graduate and above	43.7			0.780	0.704	0.865
Marriage		101.705	<0.001			
Unmarried	26.9			1.000	-	-
Married	50.2			2.742	2.385	3.152
Separated/ Divorced/ Widowed	51.2			2.850	2.378	3.415
Occupation		9.226	<0.001			
Manual	46.2			1.000	-	-
Intelligence	45.0			0.950	0.872	1.037
others	50.4			1.179	1.080	1.287
Smoke		53.371	< 0.001			
No	46.0			1.000	-	-
Yes	45.2			0.968	0.898	1.044
Ever	61.4			1.862	1.646	2.105
Drink		32.985	<0.001			
Yes	50.4			1.000	-	-
No	45.1			0.808	0.751	0.869
Diets		24.060	< 0.001			
Balance	46.7			1.000		-
Meat more	56.0			1.451	1.279	1.645
Vegetable more	44.4			0.910	0.846	0.980
Sleep (h/d)		33.511	< 0.001			
<7	51.6			1.000	-	-

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7~	45.2	0.774	0.720	0.832
9~	41.8	0.675	0.599	0.760

Table 4 provides the results of logistic regression models comparing the prevalence of potential risk factors, including gender, age, level of education, status of marriage, occupation, smoking, drinking, diet and hours of sleep. The result of multivariate logistic regression revealed male adults are more likely to get overweight and obesity than female(OR=1.502, 95%CI: 1.370-1.646). We categorized age into six groups which clearly showed the increasing age is a risk factor for overweight/obesity. Participants who have married (OR=1.436, 95%CI: 1.185-1.740) or separated/ divorced/ widowed (OR=1.442, 95%OR: 1.143-1.821) are more likely to be overweight/obesity than who haven't married. In addition to the above demographic characteristics, Cigarette smokers (OR=0.702, 95%CI: 0.640-0.770) were less likely to get overweight and obesity than non-smokers and ever-smokers (OR: 1.228, 95%CI: 1.073-1.404). Participants who drink were more likely than those who never or rarely drink to wearing weight (OR=1.109, 95%CI: 1.016-1.210). Compared with people with balance diet, those who eat meat more (OR=1.474, 95%CI: 1.292-1.682) are more likely to put on weight than who eat vegetable more (OR: 0.827, 95%CI: 0.766-0.893). Overweight and obesity are more common among those sleep less than 7 hours compared with who sleep over 7 hours(OR=0.887, 95%CI: 0.823-0.957) and 9 hours(OR=0.834, 95%CI: 0.739-0.941).

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	<del></del>	D	0			95%CI for OR		
Characteristic	Wald <sub>x</sub> -	Р	β	S.E.	OK	Lower	Upper	
Gender								
Female	-	-	-	-	1.000	-	-	
Male	75.044	< 0.001	0.407	0.047	1.502	1.370	1.646	
Age								
18~	-	-	-	-	1.000	-	-	
25~	47.708	< 0.001	0.788	0.114	2.200	1.759	2.751	
35~	79.054	<0.001	1.051	0.118	2.862	2.270	3.608	
45~	118.04	<0.001	1.295	0.119	3.650	2.890	4.61	
55~	101.00	<0.001	1.234	0.123	3.437	2.701	4.372	
65~79	49.603	<0.001	0.954	0.135	2.595	1.990	3.384	
Education								
Primary school and below	-	-	-	2	1.000	-	-	
Junior middle school	2.762	0.097	-0.082	0.049	0.921	0.837	1.015	
Senior middle school	1.041	0.308	-0.053	0.052	0.949	0.857	1.050	
Under graduate and above	0.010	0.921	0.007	0.069	1.007	0.879	1.154	
Marriage								
Unmarried	-	-	-	-	1.000	-	-	
Married	13.597	< 0.001	0.362	0.098	1.436	1.185	1.740	
Separated/ Divorced/	9.502	0.002	0.366	0.119	1.442	1.143	1.82	

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Widowed							
Occupation							
Manual	-	-	-	-	1.000	-	-
Intelligence	0.589	0.443	-0.042	0.055	0.959	0.861	1.067
others	26.157	< 0.001	0.250	0.049	1.284	1.167	1.413
Smoke							
No	-	-	-	-	1.000	-	-
Yes	56.485	< 0.001	-0.354	0.047	0.702	0.640	0.770
Ever	8.956	0.003	0.205	0.069	1.228	1.073	1.404
Drink	5.327	0.021	0.103	0.045	1.109	1.016	1.210
Diets							
Balance	-	-	0	-	1.000	-	-
Meat more	33.301	<0.001	0.388	0.067	1.474	1.292	1.682
Vegetable more	23.531	< 0.001	-0.190	0.039	0.827	0.766	0.893
Sleep (h/d)							
<7	-	-	-	-	1.000	-	-
7~	9.673	0.002	-0.120	0.038	0.887	0.823	0.957
9~	8.635	0.003	-0.181	0.062	0.834	0.739	0.941
Constant	83.776	< 0.001	4.961	0.457	-	-	-

# Discussion

For all we know, this was the first large population-based face-to-face survey to

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investigate the prevalence of overweight and obesity in Jilin Province, northeast China. We found that the prevalence of both overweight and obesity was at a high level. From the data of China chronic disease surveillance conducted by Chinese Center for Disease Control and Prevention, the prevalence of overweight among Chinese adults (age: 18-64) was 23.8%, 26.6%, 30.6% (male: 23.0%, 27.4%, 32.1%; female: 24.7%, 25.7%, 29.1%), and the prevalence of obesity was 7.2%, 7.7%, 12.1% (male: 6.3%, 6.7%, 12.5%; female: 8.1%, 8.7%, 11.1%) in 2004,2007,2010.[16] The prevalence of overweight and obesity in Jilin Province is 39.43% (male: 40.07%, female: 38.84%) and 15.57% (male: 15.79%, female: 15.37%) in 2010.[17] Our cross-sectional study indicated the prevalence of overweight and obesity among adults in northeast China was 32.3% (male: 34.3%, female: 30.2%) and 14.6% (male: 16.3%, female: 12.8%) in 2012. Compared with the prevalence of the national level, this study got a higher prevalence in both genders, but compared with the provincial level, the prevalence of overweight and obesity presented a downward trend. This phenomenon implies overweight and obesity are more common in northeast China than other areas, while some effective actions might have been taken to control the uptrend. [18-20]

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Multivariate logistic regression analysis suggested several factors have association with the prevalence of overweight and obesity. Males have a higher prevalence of overweight than females from age 18 to 54, and a higher prevalence of obesity from age 18 to 44, which was in line with the previous studies that reported gender difference associated with BMI.[21] For women, both the prevalence of overweight and obesity increased with age, peaking at 55-64 years old. The possible explanations for the results are the change of hormone level inside body according to

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previous studies.[22 23] A recent review revealed different marital transitions changed body weight for both genders in US: transitions into marriage appear to be associated with weight gain whereas transitions out of marriage are associated with weight loss.[24] This study acquired a slightly different result that both transitions into married and out of marriage are risk factors for getting overweight and obesity among adults in northeast China. This might be due to racial differences, the exact mechanism was not clear, further research thus was needed to illustrate this phenomenon among different marriage status.

Except for the demographic characteristics mentioned above, behaviors and life-style such as smoking, drinking, diet habits and hours of sleep also have association with body weight. In this study we have found that smoking is a protective factor for both overweight and obesity which is consistence with the studies conducted in India, Sweden, Australia and Tianjin China. [25-28]

To the best of our knowledge, diet is one of the most important determinants of body weight, we have observed that drinking and eating meat more are risk factors for being overweight and obese, which is in conformity with previous studies.[28] Some recent studies demonstrated that poor sleep quality affect on BMI significantly, and the result of this study supported this conclusion as well.[29 30] However, education level, occupation and area distribution in this study showed no significant effect on body weight. Because we used a cross-sectional design in this study, our ability to determine causal inference is limited, therefore, we were unable to explain why these factors have association with overweight and obesity or not. Further research is needed to better understand why these association have occurred, why the observed disparities

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exist and how to reverse these trends.

The main strengths of this study are its large sample size and precise physical measurement which improved the validity of our results. However, there still some potential limitations existed in this cross-sectional study. Self-reported information was used, and recall bias may affect the validity of results.

### **Conclusion:**

To sum up, this study suggested the prevalence of overweight and obesity among adult residents in Jilin province, northeast China was at a high level. Main influencing factors for overweight and obesity included gender, age, marriage status, occupation, smoking, drinking, diet habits and sleep quality(P<0.05).

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The results of this study should inform policy makers in developing education and publicity to prevent and control the occurrence of overweight and obesity.

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## **Author Contributions**

Rui Wang, Peng Zhang, Chunshi Gao, Xinlv, Yuanyuan Song, Zhijun Li, Yaqin Yu and Bo Li designed the study; Rui Wang, Peng Zhang performed the study; Rui Wang analyzed the data and drafted the manuscript; Rui Wang, Peng Zhang, Chunshi Gao, Xinlv and Yuanyuan Song participated amending the manuscript together. All authors approved the final version of the manuscript.

# **Conflicts of Interest**

The authors declare no conflict of interest.

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# Data sharing statement

No additional unpublished data are available.

# Reference

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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(page 1)
		(b) Provide in the abstract an informative and balanced summary of what was done
		and what was found(page2)
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being
		reported(page3)
Objectives	3	State specific objectives, including any prespecified hypotheses(page4)
Methods		
Study design	4	Present key elements of study design early in the paper(page4)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment,
		exposure, follow-up, and data collection(page4-5)
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(page4-5)
		(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(page5)
Data sources/	8*	For each variable of interest, give sources of data and details of methods of
measurement		assessment (measurement). Describe comparability of assessment methods if there
		is more than one group(page5)
Bias	9	Describe any efforts to address potential sources of bias(page5)
Study size	10	Explain how the study size was arrived at(page4)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable,
	10	describe which groupings were chosen and why(page5)
Statistical methods	12	(a) Describe all statistical methods, including those used to control for $f = \frac{1}{2} \left( \frac{1}{2} - \frac{1}{2} \right)$
		<u>confounding(pages)</u>
		(b) Describe any methods used to examine subgroups and interactions
		(c) Explain now missing data were addressed(page4)
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed
		<i>Case-control study</i> —II applicable, explain how matching of cases and controls was
		auticsscu
		cross-sectional study—in applicable, describe analytical methods taking account of
		samping suarcy(pages)
		(e) Describe any sensitivity analyses

Continued on next page

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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(page5)
		(b) Give reasons for non-participation at each stage(page5)
		(c) Consider use of a flow diagram
Descriptive	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information
data		on exposures and potential confounders(page5-7)
		(b) Indicate number of participants with missing data for each variable of interest
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	Cohort study—Report numbers of outcome events or summary measures over time
		Case-control study-Report numbers in each exposure category, or summary measures of
		exposure
		Cross-sectional study—Report numbers of outcome events or summary measures(page7-10)
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
		(b) Report category boundaries when continuous variables were categorized(page7-10)
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful
		time period
Other analyses	17	Report other analyses done-eg analyses of subgroups and interactions, and sensitivity
		analyses(page10-12)
Discussion		
Key results	18	Summarise key results with reference to study objectives(page12-13)
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(page15)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity
		of analyses, results from similar studies, and other relevant evidence(page13-15)
Generalisability	21	Discuss the generalisability (external validity) of the study results(page15)
Other informatio	n	
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(page16)

\*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 of obesity and overweight and some associated factors among adult residents in northeast China: a cross-sectional study

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Prevalence of obesity and overweight and some associated factors among adult
residents in northeast China: a cross-sectional study
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#### Abstract

*Objectives:* This study aims to estimate the prevalence of overweight and obesity and find out the potential influencing factors among adults in northeast China. To provide useful information for policy makers in making informed decisions and reversing the increasing trends.

Methods: A cross-sectional survey was conducted in Jilin Province, northeast China, in 2012. A total of 9,873 men and 10,960 women aged 18–79 years from the general population were included by a multistage stratified random cluster sampling design. Data were obtained from face-to-face interview and physical examination. After being weighted according to complex sampling scheme, the sample was used to estimate the prevalence of overweight (BMI: 24–27.9 kg/m<sup>2</sup>) and obesity (BMI>28 kg/m<sup>2</sup>) of Jilin province, and analyze the influencing factors through the corresponding statistical methods based on complex sampling design behaviors.

*Results:* The overall prevalence of overweight was 32.3% (male: 34.3%, female: 30.2%), and the prevalence of obesity was 14.6% (male: 16.3%, female: 12.8%) in Jilin province. The prevalence of overweight and obesity of men were higher than women (P<0.001). The influencing factors of overweight and obesity included sex, age, marriage, occupation, smoking, drinking, diets and hours of sleep (P<0.05).

*Conclusions*: This study estimated the prevalence of overweight and obesity among adult residents in Jilin province, northeast China, were at a high level. The results of this study will be submit to Health Department of Jilin Province and other relevant departments as a reference, which should inform policy makers in developing education and publicity to prevent and control the occurrence of overweight and obesity.

Keywords: overweight, obesity, influencing factors, northeast China

#### Strengths and limitations of this study

The main strengths of this study are its large sample size and precise physical measurement which improved the validity of our results. However, there still some potential limitations existed in this cross-sectional study. Self-reported data and the nature of cross-sectional data may lead to recall and reporting biases, which may have affected the accuracy of the results. The results of this study were from Jilin Province only, which couldn't generalize the whole northeast China.



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#### Introduction

Getting overweight and obesity has been shown to be related to multiple chronic conditions, which brings heavy economic burden for families and increasing cost for society in each country. [1-3] According to the World Health Organization (WHO) report,[4] obesity means the Body Mass Index (BMI) greater than or equal to 30 kg/m<sup>2</sup>, overweight means the BMI between 25 and 29.9 of an individual. Among Chinese people, obesity suggests BMI greater than or equal to 28 kg/m<sup>2</sup> and overweight indicates BMI between 24 and 27.9.[5] In 2013, the American Medical Association classified obesity as a disease to make physicians pay more attention to this condition.[6]

China is the largest developing country, meanwhile, has the largest population in the world. The rapid economic growth and enviable development performance in China have contributed to changes in lifestyle such as dietary habit and physical activity.[7] During the past decades, China witness the obesity epidemic as a considerable cause of various diseases especially the chronic ones. Overweight and obesity have become a major public health problem in China although China has a lower prevalence of obesity compared with the developed countries.[4 8 9] Previous research suggested there was significant increase in the prevalence of obesity in United States and Canada over the past years,[10] the same scenario played out in China recently as well, there is no doubt that rapidly increasing overweight and obesity in China will continue to push up the prevalence of chronic diseases.[11-13] Therefore, understanding the influencing factors associated with overweight and obesity can be very useful and significant for policy makers in formulating corresponding policies to diminish the rate and control its related comorbid conditions.

Jilin province is located in northeast China who has a large population of about 27 million.[14] In 2012, Jilin Department of Health and Jilin University jointly conducted the Jilin Provincial Chronic Disease Survey, which is the first large representative population-based survey of chronic disease in this area. Data in our study were obtained from this survey. In this article, we estimated the prevalence of overweight/obesity and

#### **BMJ Open**

explored the potential influencing factors among adult residents in northeast China. The result of this study will be considered as a reference for policy makers in making informed decisions and reversing the increasing trends.

#### Methods

#### Study design and population

This population-based cross-sectional survey is part of the Project on Present Situation and Change Forecast of Disease Spectrum in Jilin Province of China in 2012. Face-to-face health interview and physical examination were performed in the Jilin Provincial Chronic Disease Survey among residents aged from18 to 79 years, all the subjects included were who had lived in Jilin province for more than 6 months. The sample size calculation of this survey was used to estimate prevalence of overweight and obesity in Jilin province. The ultimate target sample size was established at 25 240, accounting for about 1% of the total adult population in Jilin Province.

We used the multistage stratified cluster sampling method to select the study sample. Firstly, we stratified Jilin province into 9 regions (Changchun, Jilin[city], Siping, Liaoyuan, Tonghua, Baishan, Songyuan, Baicheng, and Yanbian) that cover all of Jilin. These regions are all primarily responsible for the administration of health care services. Secondly, from each of the 9 regions, we selected clusters of 4 districts or countries randomly. There were 32 districts or counties, 95 towns or communities, and 45 units in Jilin Province selected. Finally, each participant was selected randomly from each household of the sites mentioned above. [14 15]

This study was approved by the Ethics Committee of Jilin University School of Public Health (Reference Number: 2012-R-011), and written informed consents were obtained from all the subjects in the survey.

#### Data collection

The formal survey was launched on July 5, 2012, which lasted 34 days. The survey contained two parts: face-to-face interview and physical examination. Before the formal survey, we conducted a pre-survey to explore the feasibility of the questionnaire. After

the pre-interview, 116 uniformly trained investigators conducted the face-to-face interviews and physical examination at local health stations or community clinics. All the participants' identities were confirmed by investigators. During the investigation, each answered questionnaire was examined by two investigators respectively to ensure the validity and consistency. After the fieldwork, data were manipulated by parallel double entry, and we also performed three verifications to check for incomplete and inconsistent response.

Questionnaire provided demographics, life style habits and other related information on health. Height and weight were determined by standardized protocol and measured in light indoor clothing without shoes. Height was measured to the nearest 0.1 cm, and weight was measured to the nearest 0.1 kg.

#### **Definition of major Variables**

 The grading standards for Chinese adult have been mentioned above: Body Mass Index(BMI)= weight/ height<sup>2</sup>(kg/m<sup>2</sup>),  $24 \le BMI \le 28$  is overweight; BMI  $\ge 28$  is obesity, we used the criterion: BMI  $\ge 24$  as the assessment standard of excessive weight. We defined smoker as a person who smoked at least one cigarette per day in the past 30 days. Drinker was defined as a person who consumed more than one alcoholic drink per week, included any forms of alcohol. Participants who were classified as "eat meat more" were defined as persons who eat more animal-based foods than vegetables during meals in the past 30 days.

#### Statistical analyses

We used post-stratification adjustment according to the distribution of regional, urban/rural, age, and sex groups in the 2010 census of the adult population in Jilin Province to make the sample estimate the population of the whole province. Frequency distribution was used to present characteristics of the subjects', and data presented in percentage were used to describe the prevalence ratio (PR). Rao-Scott Chi-square tests were used to compare the prevalence of overweight and obesity in different groups. To adjust for potential confounding effects, multiple regression analyses were carried out to explore independent factors associated with overweight and obesity. Odds ratio (OR) was used for the risk analysis with its confidence intervals (95%).All Statistical analysis

was conducted using the complex sampling function by SPSS 20.0 statistical software and  $p \le 0.05$  level of significance was selected. The map was drawn by MapInfo Professional 7.0 software.

#### Result

In this survey, we interviewed 23,050 residents aged over 18 years, 2,211 residents were excluded because of lacking efficient information and other potential bias. 20,839 residents were contained finally, resulting in a response rate of 82.6% (replacement rate: 9.5%). Of the 20,839 subjects, there were 9,873 men (47.4%) and 10,960 women (52.6%) in our analysis, the age ranged from 18 to 79(mean $\pm$ S.D.: 47.27 $\pm$ 13.34). According to the BMI classification for Chinese people mentioned above, the overall prevalence of overweight was 32.3% (male: 34.3%, female: 30.2%), and the prevalence of obesity was 14.6% (male: 16.3%, female: 12.8%) in Jilin province as shown in Table 1.

	Table.1 The prevalence of	f overweight and	obesity between	different demograp	hic characteristic
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Characteristic			Overweight			Obesity		
		n	PR(%)	χ <sup>2</sup>	Р	PR(%)	$\chi^2$	Р
Area	City	1073 3	32.9	4.25	0.088	14.6	<0.001	0.996
	Country	1010 6	31.6			14.6		
Sex	Male	9873	34.3	40.58	< 0.001	16.3	50.82	< 0.001
	Female	1096 6	30.2			12.8		
Age	18~	1128	14.5	694.27	< 0.001	7.8	130.16	< 0.001
	25~	2787	27.1			15.8		
	35~	4749	34.3			15.5		
	45~	5627	39.8			16.5		
	55~	4483	40.5			15.7		

	65~79	2065	37.0			13.9		
Education	Primary school and below	6143	34.5	27.81	< 0.001	15.3	7.79	0.171
	Junior middle school	5977	31.1			15.1		
	Senior middle school	5349	33.5			14.1		
	Under graduate and above	3370	30.1			13.6		
Marriage	Unmarried Married	1569	16.7	393.12	< 0.001	10.2	56.95	< 0.001
		1786	34.8			15.4		
		1				15.4		
Occupation	Separated/Divorced/Widowe d	1409	37.4			14.1		
	Manual	11689	32.0	3.09	0.364	14.2	33.61	< 0.001
	Intelligence	4078	32.1			12.9		
	Others	5072	33.4			17.0		

Note: PR=Prevalence rate. Complex weighted computation was used in the statistical analysis.

Figure 1. the geographical position of Jilin province in northeast China

From the age-stratified result in Table 2, for men, the prevalence of overweight increased with age, peaking at 45-54, while such trend was not seen in the prevalence of obesity. For women, both the prevalence increased with age, peaking at group 55-64 and 65-79 respectively. Moreover male have a higher prevalence of overweight than female from age 18 to 54, and a higher prevalence of obesity from age 18 to 44.

Table.2 The prevalence of overweight and obesity betwe	een male and female in different age groups
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A go	Overw	veight		Obes	Obesity			
Age	Male (%)	Female (%)	р	Male (%)	Female (%)	р		
18~	18.0	11.1	< 0.001	11.4	4.2	< 0.001		
25~	31.6	21.3		21.1	8.9			
35~	37.9	30.6		18.5	12.3			
45~	41.0	38.5		15.9	17.2			

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55~	39.5	41.6	13.8	17.6	
65~79	33.9	40.0	9.8	17.7	
Total	34.3	30.2	16.3	12.8	

We divided all the participants into two groups: normal and overweight & obesity. Table 3 describes the influence of the factors below all have statistic significance: sex, age, education, marriage, occupation, smoking, drinking, diet and sleep quality(P < 0.001).We thus put all these significant factors into the model of multivariate logistic regression.

Chamataristia	$\mathbf{DD}(\mathcal{O}_{1})$	$Walda^2$	р	or —	95%CI f	95%CI for OR	
Characteristic	PK(%)	%) walaz	Р		Lower	Upper	
Area		2.39	0.122				
City	47.5			1.00	-	-	
Country	46.2			0.95	0.89	1.02	
Gender		78.15	< 0.001				
Female	43.0			1.00	-	-	
Male	50.6			1.36	1.27	1.45	
Age		77.41	< 0.001				
18~	22.4			1.00	-	-	
25~	42.9			2.60	2.16	3.14	
35~	49.8			3.44	2.89	4.10	
45~	56.3			4.47	3.76	5.31	
55~	56.2			4.46	3.74	5.32	
65~79	50.9			3.59	2.95	4.38	
Education		8.25	< 0.001				
Primary school and below	49.8			1.00	-	-	
Junior middle school	46.2			0.86	0.79	0.94	
Senior middle school	47.6			0.92	0.84	1.00	

Table.3 Univariate analysis of correlates of overweight & obesity of residents in Jilin Province

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Under graduate and above	43.7			0.78	0.70	0.87
Marriage		101.71	< 0.001			
Unmarried	26.9			1.00	-	-
Married	50.2			2.74	2.39	3.15
Separated/ Divorced/ Widowed	51.2			2.85	2.38	3.42
Occupation		9.23	< 0.001			
Manual	46.2			1.00	-	-
Intelligence	45.0			0.95	0.87	1.04
others	50.4			1.18	1.08	1.29
Smoke		53.37	< 0.001			
No	46.0			1.00	-	-
Yes	45.2			0.97	0.90	1.04
Ever	61.4			1.86	1.65	2.11
Drink		32.99	< 0.001			
Yes	50.4			1.00	-	-
No	45.1			0.81	0.75	0.87
Diets		24.06	< 0.001			
Balance	46.7			1.00	-	-
Meat more	56.0			1.45	1.28	1.65
Vegetable more	44.4			0.91	0.85	0.98
Sleep (h/d)		33.51	< 0.001			
<7	51.6			1.00	-	-
7~	45.2			0.77	0.72	0.83
9~	41.8			0.68	0.60	0.76

Table 4 shown the results of logistic regression models comparing the prevalence of potential risk factors, including gender, age, level of education, status of marriage, occupation, smoking, drinking, diet and hours of sleep. The result of multivariate logistic regression revealed male adults are more likely to get overweight and obesity

than female(OR=1.50, 95%CI: 1.37-1.65).We categorized age into six groups which clearly showed the increasing age is a risk factor for overweight/obesity. Participants who have married (OR=1.44, 95%CI: 1.19-1.74) or separated/ divorced/ widowed (OR=1.44, 95%OR: 1.14-1.82) are more likely to be overweight/obesity than who haven't married. In addition to the above demographic characteristics, Cigarette smokers (OR=0.70, 95%CI: 0.64-0.77) were less likely to get overweight and obesity than non-smokers and ever-smokers (OR: 1.23, 95%CI: 1.07-1.40). Participants who drink were more likely than those who never or rarely drink to wearing weight (OR=1.11, 95%CI: 1.02-1.21). Compared with people with balance diet, those who eat meat more (OR=1.47, 95%CI: 1.29-1.68) are more likely to put on weight than who eat vegetable more (OR: 0.83, 95%CI: 0.77-0.89). Overweight and obesity are more common among those sleep less than 7 hours compared with who sleep over 7 hours(OR=0.89, 95%CI: 0.82-0.96) and 9 hours(OR=0.83, 95%CI: 0.74-0.94).

Table.4 Multivariate regression	of correlates	of over	weight &	obesity of	f residents ir	Jilin Province
			0			

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Characteristic	W-14.2	<b>D</b> 0		S E		95%CI for OR	
Characteristic	waiaχ	P	р	3.E.	UK ·	Lower	Upper
Gender							
Female	-	-	-		1.00	-	-
Male	75.04	< 0.001	0.41	0.05	1.50	1.37	1.65
Age							
18~	-	-	-	-	1.00	-	-
25~	47.71	< 0.001	0.79	0.11	2.20	1.76	2.75
35~	79.05	< 0.001	1.05	0.12	2.86	2.27	3.61
45~	118.0	< 0.001	1.30	0.12	3.65	2.89	4.61
55~	101.00	< 0.001	1.23	0.12	3.44	2.70	4.37
65~79	49.60	< 0.001	0.95	0.14	2.60	1.99	3.38
Education							
Primary school and below	-	-	-	-	1.00	-	-

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Junior middle school	2.76	0.097	-0.08	0.05	0.92	0.84	1.02
Senior middle school	1.04	0.308	-0.05	0.05	0.95	0.86	1.05
Under graduate and above	0.01	0.921	0.01	0.07	1.01	0.88	1.15
Marriage							
Unmarried	-	-	-	-	1.00	-	-
Married	13.60	< 0.001	0.36	0.10	1.44	1.19	1.74
Separated/ Divorced/ Widowed	9.50	0.002	0.37	0.12	1.44	1.14	1.82
Occupation							
Manual	-	-	-	-	1.00	-	-
Intelligence	0.59	0.443	-0.04	0.06	0.96	0.86	1.07
others	26.16	< 0.001	0.25	0.05	1.28	1.17	1.41
Smoke							
No	-	-	-	-	1.00	-	-
Yes	56.49	< 0.001	-0.35	0.05	0.70	0.64	0.77
Ever	8.96	0.003	0.21	0.07	1.23	1.07	1.40
Drink	5.33	0.021	0.10	0.05	1.11	1.02	1.21
Diets							
Balance	-	-	Q	-	1.00	-	-
Meat more	33.30	< 0.001	0.39	0.07	1.47	1.29	1.68
Vegetable more	23.53	< 0.001	-0.19	0.04	0.83	0.77	0.89
Sleep (h/d)							
<7	-	-	-	-	1.00	-	-
7~	9.67	0.002	-0.12	0.04	0.89	0.82	0.96
9~	8.64	0.003	-0.18	0.06	0.83	0.74	0.94
Constant	83.78	< 0.001	4.96	0.46	-	-	-

#### Discussion

For all we know, this was the first large population-based face-to-face survey to

investigate the prevalence of overweight and obesity in Jilin Province, northeast China. We found that the prevalence of both overweight and obesity was at a high level. From the data of China chronic disease surveillance conducted by Chinese Center for Disease Control and Prevention, the prevalence of overweight among Chinese adults (age: 18-64) for 2004, 2007, and 2010 was 23.8%, 26.6% and 30.6%, respectively (male: 23.0%, 27.4%, and 32.1%; female: 24.7%, 25.7%, and 29.1%), and the prevalence of obesity was 7.2%, 7.7%, 12.1%, respectively (male: 6.3%, 6.7%, and 12.5%; female: 8.1%, 8.7%, and 11.1%). [16] Our cross-sectional study indicated the prevalence of overweight and obesity among adults in northeast China was 32.3% (male: 34.3%, female: 30.2%) and 14.6% (male: 16.3%, female: 12.8%) in 2012. Compared with the prevalence of the national level, this study got a higher prevalence in both sexes. This phenomenon implies overweight and obesity are more common in northeast China than other areas, while some effective actions might have been taken to control the uptrend. [17-19]

Multivariate logistic regression analysis suggested several factors have association with the prevalence of overweight and obesity. Males have a higher prevalence of overweight than females from age 18 to 54, and a higher prevalence of obesity from age 18 to 44, which was in line with the previous studies that reported gender difference associated with BMI.[20] For women, both the prevalence of overweight and obesity increased with age, peaking at 55-64 years old. The possible explanations for the results are the change of hormone level inside body according to previous studies.[21 22] A recent review revealed different marital transitions changed body weight for both genders in US: transitions into marriage appear to be associated with weight gain whereas transitions out of marriage are associated with weight loss.[23] This study acquired a slightly different result that both transitions into marriage and out of marriage are risk factors for getting overweight and obesity among adults in northeast China. This might be due to racial differences, the exact mechanism was not clear, further research thus was needed to illustrate this phenomenon among different marriage status.

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Except for the demographic characteristics mentioned above, behaviors and life-style such as smoking, drinking, diet habits and hours of sleep also have association

with body weight. In this study we have found a lower prevalence of overweight and obesity in smokers compared with non-smokers, which is consistence with the studies conducted in India, Sweden and Tianjin China. [24-26] As many studies have reported before, tobacco use has relationship with various chronic diseases and body disorders, which may affect the digestive and absorptive function of alimentary system.[27] [28]Additionally, some research has also suggest that smoking increase energy expenditure and might suppress appetite.[29]

To the best of our knowledge, diet is one of the most important determinants of body weight, we have observed that drinking and eating meat more are risk factors for being overweight and obese. which is in conformity with previous studies.[26]Animal-based foods contain more fat than other foods, and regular consumption of high-fat foods will lead to weight gain. Some recent studies demonstrated that poor sleep quality affect on BMI significantly, and the result of this study supported this conclusion as well.[30 31] A plausible explanation was that the sleep disturbances, rather than sleep duration might contribute to overweight and obesity, thus the further studies of biological mechanisms are needed.

However, education level, occupation and area distribution in this study showed no significant effect on body weight. Because we used a cross-sectional design in this study, our ability to determine causal inference is limited, therefore, we were unable to explain why these factors have association with overweight and obesity or not. Further research are needed to better understand why these association have occurred, why the observed disparities exist and how to reverse these trends.

The result of this study is significant part of Disease Spectrum in Jilin Province of China, which will be submit to the Health Department of Jilin Province and other relevant departments as a reference. These departments should pay enough attention to the high prevalence of overweight and obesity in Jilin province and provide effective guidelines that help control the development trend.

The main strengths of this study are its large sample size and precise physical measurement which improved the validity of our results. However, there still some potential limitations existed in this cross-sectional study. Self-reported data and the

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nature of cross-sectional data may lead to recall and reporting biases, which may have affected the accuracy of the results. The results of this study were from Jilin Province only, which couldn't generalize the whole northeast China.

#### **Conclusion:**

To sum up, this study suggested the prevalence of overweight and obesity among adult residents in Jilin province, northeast China was at a high level. Main influencing factors for overweight and obesity included gender, age, marriage status, occupation, smoking, drinking, diet habits and sleep quality.

The results of this study will be submit to Health Department of Jilin Province and other relevant departments as a reference, which should inform policy makers in developing education and publicity to prevent and control the occurrence of overweight and obesity.

#### Acknowledgements

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#### **Author Contributions**

Rui Wang, Peng Zhang, Chunshi Gao, Xinlv, Yuanyuan Song, Zhijun Li, Yaqin Yu and Bo Li designed the study; Rui Wang, Peng Zhang performed the study; Rui Wang analyzed the data and drafted the manuscript; Rui Wang, Peng Zhang, Chunshi Gao, Xinlv and Yuanyuan Song participated amending the manuscript together. All authors approved the final version of the manuscript.

#### **Conflicts of Interest**

The authors declare no conflict of interest.

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#### Data sharing statement

No additional unpublished data are available.

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Figure1. the geographical position of Jilin province in northeast China 104x86mm (300 x 300 DPI)

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

	Item No	Recommendation
Title and abstract	1	( <i>a</i> ) Indicate the study's design with a commonly used term in the title or the
		abstract(page 1)
		(b) Provide in the abstract an informative and balanced summary of what was done
		and what was found(page2)
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being
		reported(page3)
Objectives	3	State specific objectives, including any prespecified hypotheses(page4)
Methods		
Study design	4	Present key elements of study design early in the paper(page4)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment,
		exposure, follow-up, and data collection(page4-5)
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(page4-6)
		(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(page6)
Data sources/	8*	For each variable of interest, give sources of data and details of methods of
measurement		assessment (measurement). Describe comparability of assessment methods if there
		is more than one group(page6)
Bias	9	Describe any efforts to address potential sources of bias(page5-6)
Study size	10	Explain how the study size was arrived at(page4)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable,
		describe which groupings were chosen and why(page5)
Statistical methods	12	(a) Describe all statistical methods, including those used to control for
		confounding(page5)
		(b) Describe any methods used to examine subgroups and interactions
		(c) Explain how missing data were addressed(page4)
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed
		<i>Case-control study</i> —If applicable, explain how matching of cases and controls was
		addressed
		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of
		sampling strategy(page6-/)
		( <u>e</u> ) Describe any sensitivity analyses

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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(page7)
		(b) Give reasons for non-participation at each stage(page5)
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders(page7-8)
		(b) Indicate number of participants with missing data for each variable of interest
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	Cohort study—Report numbers of outcome events or summary measures over time
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures(page7-13)
Main results	16	( <i>a</i> ) 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
		(b) Report category boundaries when continuous variables were categorized(page7-12)
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses(page10-12)
Discussion		
Key results	18	Summarise key results with reference to study objectives(page15)
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(page15)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity
		of analyses, results from similar studies, and other relevant evidence(page15)
Generalisability	21	Discuss the generalisability (external validity) of the study results(page15)
Other informati	on	
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(page16)

\*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 of overweight and obesity and some associated factors among adult residents in northeast China: a cross-sectional study

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#### Abstract

*Objectives:* This study aims to estimate the prevalence of overweight and obesity and find out the potential influencing factors among adults in northeast China.

*Methods:* A cross-sectional survey was conducted in Jilin Province, northeast China, in 2012. A total of 9,873 men and 10,960 women aged 18–79 years from the general population were included by a multistage stratified random cluster sampling design. Data were obtained from face-to-face interview and physical examination. After being weighted according to complex sampling scheme, the sample was used to estimate the prevalence of overweight (BMI: 24–27.9 kg/m<sup>2</sup>) and obesity (BMI>28 kg/m<sup>2</sup>) of Jilin province, and analyze the influencing factors through the corresponding statistical methods based on complex sampling design behaviors.

*Results:* The overall prevalence of overweight was 32.3% (male: 34.3%, female: 30.2%), and the prevalence of obesity was 14.6% (male: 16.3%, female: 12.8%) in Jilin province. The prevalence of overweight and obesity of men were higher than women (P<0.001). The influencing factors of overweight and obesity included sex, age, marriage, occupation, smoking, drinking, diets and hours of sleep (P<0.05).

*Conclusions*: This study estimated the prevalence of overweight and obesity among adult residents in Jilin province, northeast China, were at a high level. The results of this study will be submit to Health Department of Jilin Province and other relevant departments as a reference, which should inform policy makers in developing education and publicity to prevent and control the occurrence of overweight and obesity.

Keywords: overweight, obesity, influencing factors, northeast China

#### Strengths and limitations of this study

The main strengths of this study are its large sample size and precise physical measurement which improved the validity of our results. However, there still some potential limitations existed in this cross-sectional study. Self-reported data and the nature of cross-sectional data may lead to recall and reporting biases, which may have affected the accuracy of the results. The results of this study were from Jilin Province only, which couldn't generalize the whole northeast China.



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#### Introduction

Getting overweight and obesity has been shown to be related to multiple chronic conditions, which brings heavy economic burden for families and increasing cost for society in each country. [1-3] According to the World Health Organization (WHO) report,[4] obesity means the Body Mass Index (BMI) greater than or equal to 30 kg/m<sup>2</sup>, overweight means the BMI between 25 and 29.9 of an individual. Among Chinese people, obesity suggests BMI greater than or equal to 28 kg/m<sup>2</sup> and overweight indicates BMI between 24 and 27.9.[5] In 2013, the American Medical Association classified obesity as a disease to make physicians pay more attention to this condition.[6]

China is the largest developing country, meanwhile, has the largest population in the world. The rapid economic growth and enviable development performance in China have contributed to changes in lifestyle such as dietary habit and physical activity.[7] During the past decades, China witness the obesity epidemic as a considerable cause of various diseases especially the chronic ones. Overweight and obesity have become a major public health problem in China although China has a lower prevalence of obesity compared with the developed countries.[4 8 9] Previous research suggested there was significant increase in the prevalence of obesity in United States and Canada over the past years,[10] the same scenario played out in China recently as well, there is no doubt that rapidly increasing overweight and obesity in China will continue to push up the prevalence of chronic diseases.[11-13] Therefore, understanding the influencing factors associated with overweight and obesity can be very useful and significant for policy makers in formulating corresponding policies to diminish the rate and control its related comorbid conditions.

Jilin province is located in northeast China who has a large population of about 27 million.[14] In 2012, Jilin Department of Health and Jilin University jointly conducted the Jilin Provincial Chronic Disease Survey, which is the first large representative population-based survey of chronic disease in this area. Data in our study were obtained from this survey. In this article, we estimated the prevalence of overweight/obesity and

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explored the potential influencing factors among adult residents in northeast China. The result of this study will be considered as a reference for policy makers in making informed decision.

#### Methods

#### Study design and population

This population-based cross-sectional survey is part of the Project on Present Situation and Change Forecast of Disease Spectrum in Jilin Province of China in 2012. Face-to-face health interview and physical examination were performed in the Jilin Provincial Chronic Disease Survey among residents aged from18 to 79 years, all the subjects included were who had lived in Jilin province for more than 6 months. The sample size calculation of this survey was used to estimate prevalence of overweight and obesity in Jilin province. The ultimate target sample size was established at 25 240, accounting for about 1‰ of the total adult population in Jilin Province.

We used the multistage stratified cluster sampling method to select the study sample. Firstly, we stratified Jilin province into 9 regions (Changchun, Jilin[city], Siping, Liaoyuan, Tonghua, Baishan, Songyuan, Baicheng, and Yanbian) that cover all of Jilin. These regions are all primarily responsible for the administration of health care services. Secondly, from each of the 9 regions, we selected clusters of 4 districts or countries randomly. There were 32 districts or counties, 95 towns or communities, and 45 units in Jilin Province selected. Finally, each participant was selected randomly from each household of the sites mentioned above. [14 15]

#### Data collection

The formal survey was launched on July 5, 2012, which lasted 34 days. The survey contained two parts: face-to-face interview and physical examination. Before the formal survey, we conducted a pre-survey to explore the feasibility of the questionnaire. After the pre-interview, 116 uniformly trained investigators conducted the face-to-face interviews and physical examination at local health stations or community clinics. All the participants' identities were confirmed by investigators. During the investigation,

each answered questionnaire was examined by two investigators respectively to ensure the validity and consistency. After the fieldwork, data were manipulated by parallel double entry, and we also performed three verifications to check for incomplete and

Questionnaire provided demographics, life style habits and other related information on health. Height and weight were determined by standardized protocol and measured in light indoor clothing without shoes. Height was measured to the nearest 0.1 cm, and weight was measured to the nearest 0.1 kg.

#### **Definition of Variables**

inconsistent response.

According to the National Bureau of Statistics of China, each selected district or county in this survey was divided into urban and rural areas. [16] The grading standards for Chinese adult have been mentioned above: Body Mass Index(BMI)= weight/ height<sup>2</sup>(kg/m<sup>2</sup>), 24≤ BMI  $\leq 28$  is overweight; BMI  $\geq 28$  is obesity, we used the criterion: BMI  $\geq 24$  as the assessment standard of excessive weight. Education was classified into four levels: primary school and below (including those who never attended school and those attained elementary schooling only); junior school; high school (including those who attained a 3-year secondary vocational schooling); the undergraduate and above levels of education. Manual labor included farmers, service workers, and production workers. Occupation of Intelligence included office and other technical staffs. Other occupations included students, unemployed, full-time wives and retirees.[14] We defined smoker as a person who smoked at least one cigarette per day in the past 30 days. Drinker was defined as a person who consumed more than one alcoholic drink per week, included any forms of alcohol. Participants who were classified as "eat meat more" were defined as persons who eat more animal-based foods than vegetables during meals in the past 30 days, "balance diet" refers to participants who eat animal-based foods equally to vegetables during meals in the past 30 days. Participants who were classified as "sleep < 7 hours" were defined as persons who slept less than 7 hours over 3 days a week, and those who slept more than 9 hours over 3 days a week were defined as "sleep > 9 hours".

#### Statistical analyses

We used post-stratification adjustment according to the distribution of regional, urban/rural, age, and sex groups in the 2010 census of the adult population in Jilin

Province to make the sample estimate the population of the whole province. Frequency distribution was used to present characteristics of the subjects', and data presented in percentage were used to describe the prevalence ratio (PR). Rao-Scott Chi-square tests were used to compare the prevalence of overweight and obesity in different groups. To adjust for potential confounding effects, multiple regression analyses were carried out to explore independent factors associated with overweight and obesity. Odds ratio (OR) was used for the risk analysis with its confidence intervals (95%). All Statistical analysis was conducted using the complex sampling function by SPSS 20.0 statistical software and  $p \le 0.05$  level of significance was selected. The map was drawn by MapInfo Professional 7.0 software.

#### Ethnic approved

This study was approved by the Ethics Committee of Jilin University School of Public Health (Reference Number: 2012-R-011), and written informed consents were obtained from all the subjects in the survey.

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#### Result

In this survey, we interviewed 23,050 residents aged over 18 years, 2,211 residents were excluded because of lacking efficient information and other potential bias. 20,839 residents were contained finally, resulting in a response rate of 82.6% (replacement rate: 9.5%). Of the 20,839 subjects, there were 9,873 men (47.4%) and 10,960 women (52.6%) in our analysis, the age ranged from 18 to 79(mean±S.D.: 47.27±13.34). According to the BMI classification for Chinese people mentioned above, the overall prevalence of overweight was 32.3% (male: 34.3%, female: 30.2%), and the prevalence of obesity was 14.6% (male: 16.3%, female: 12.8%) in Jilin province as shown in Table 1.

	Table.1 The prevalence of overweight and obesity between uniferent demographic enaracteristic							
	Characteristic		Overweight			Obesity		
	Characteristic	n	PR(%)	$\chi^2$	Р	PR(%)	$\chi^2$	р
Area	Urban	10733	32.9	4.25	0.088	14.6	< 0.001	0.996

Table 1. The prevalence of overweight and obesity between different demographic characteristic

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	Rural	10106	31.6			14.6		
Sex	Male	9873	34.3	40.58	< 0.001	16.3	50.82	< 0.001
	Female	10966	30.2			12.8		
Age	18~	1128	14.5	694.27	< 0.001	7.8	130.16	< 0.001
	25~	2787	27.1			15.8		
	35~	4749	34.3			15.5		
	45~	5627	39.8			16.5		
	55~	4483	40.5			15.7		
	65~79	2065	37.0			13.9		
Education	Primary school and below	6143	34.5	27.81	< 0.001	15.3	7.79	0.171
	Junior middle school	5977	31.1			15.1		
	Senior middle school	5349	33.5			14.1		
	Under graduate and above	3370	30.1			13.6		
Marriage	Unmarried	1569	16.7	393.12	< 0.001	10.2	56.95	< 0.001
	Married	17861	34.8			15.4		
	Separated/Divorced/Wido wed	1409	37.4			14.1		
Occupation	Manual	11689	32.0	3.09	0.364	14.2	33.61	< 0.001
	Intelligence	4078	32.1			12.9		
	Others	5072	33.4			17.0		

Note: PR=Prevalence rate. Complex weighted computation was used in the statistical analysis.

Figure1. the geographical position of Jilin province in northeast China

From the age-stratified result in Table 2, for men, the prevalence of overweight increased with age, peaking at 45-54, while such trend was not seen in the prevalence of obesity. For women, both the prevalence increased with age, peaking at group 55-64 and 65-79 respectively. Moreover male have a higher prevalence of overweight than female from age 18 to 54, and a higher prevalence of obesity from age 18 to 44.

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Table.2 The prevalence of overweight and obesity between male and female in different age groups

<b>A</b> co	Overw	Overweight		Obe		
Age	Male (%)	Female (%)	Р	Male (%)	Female (%)	Р
18~	18.0	11.1	< 0.001	11.4	4.2	< 0.001
25~	31.6	21.3		21.1	8.9	
35~	37.9	30.6		18.5	12.3	
45~	41.0	38.5		15.9	17.2	
55~	39.5	41.6		13.8	17.6	
65~79	33.9	40.0		9.8	17.7	
Total	34.3	30.2		16.3	12.8	

We divided all the participants into two groups: the normal group and the overweight & obesity group. Table 3 describes the influence of the factors below all have statistic significance: sex, age, education, marriage, occupation, smoking, drinking, diet and sleep quality (P < 0.001). We thus put all these significant factors into the model of multivariate logistic regression.

Table.3 Univariate analysis of correlates of overw	veight & obesity of residents in Jilin Province
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	<b>DD</b> (0/)	HV 112	H 11 <sup>2</sup> D		95%CI for OR		
Characteristic	PK(%)	<i>w</i> αιαχ	Р	UK .	Lower	Upper	
Area		2.39	0.122	2			
Urban	47.5			1.00	-	-	
Rural	46.2			0.95	0.89	1.02	
Sex		78.15	< 0.001				
Female	43.0			1.00	-	-	
Male	50.6			1.36	1.27	1.45	
Age		77.41	< 0.001				
18~	22.4			1.00	-	-	
25~	42.9			2.60	2.16	3.14	
35~	49.8			3.44	2.89	4.10	

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45~	56.3			4.47	3.76	5.31
55~	56.2			4.46	3.74	5.32
65~79	50.9			3.59	2.95	4.38
Education		8.25	< 0.001			
Primary school and below	49.8			1.00	-	-
Junior middle school	46.2			0.86	0.79	0.94
Senior middle school	47.6			0.92	0.84	1.00
Under graduate and above	43.7			0.78	0.70	0.87
Marriage		101.71	< 0.001			
Unmarried	26.9			1.00	-	-
Married	50.2			2.74	2.39	3.15
Separated/ Divorced/ Widowed	51.2			2.85	2.38	3.42
Occupation		9.23	< 0.001			
Manual	46.2			1.00	-	-
Intelligence	45.0			0.95	0.87	1.04
others	50.4			1.18	1.08	1.29
Smoke		53.37	< 0.001			
No	46.0			1.00	-	-
Yes	45.2			0.97	0.90	1.04
Ever	61.4			1.86	1.65	2.11
Drink		32.99	< 0.001			
Yes	50.4			1.00	-	-
No	45.1			0.81	0.75	0.87
Diets		24.06	< 0.001			
Balance diet	46.7			1.00	-	-
Meat more	56.0			1.45	1.28	1.65
Vegetable more	44.4			0.91	0.85	0.98
Sleep (h/d)		33.51	< 0.001			
<7	51.6			1.00	_	-

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7~	45.2	0.77	0.72	0.83
9~	41.8	0.68	0.60	0.76

Table 4 shown the results of logistic regression models comparing the prevalence of potential risk factors, including sex, age, level of education, status of marriage, occupation, smoking, drinking, diet and hours of sleep. The result of multivariate logistic regression revealed male adults are more likely to get overweight and obesity than female(OR=1.50, 95%CI: 1.37-1.65). We categorized age into six groups which clearly showed the increasing age is a risk factor for overweight/obesity. Participants who have married (OR=1.44, 95%CI: 1.19-1.74) or separated/ divorced/ widowed (OR=1.44, 95%OR: 1.14-1.82) are more likely to be overweight/obesity than who haven't married. In addition to the above demographic characteristics, Cigarette smokers (OR=0.70, 95%CI: 0.64-0.77) were less likely to get overweight and obesity than non-smokers and ever-smokers (OR: 1.23, 95%CI: 1.07-1.40). Participants who drink were more likely than those who never or rarely drink to wearing weight (OR=1.11, 95%CI: 1.02-1.21). Compared with people with balance diet, those who eat meat more (OR=1.47, 95%CI: 1.29-1.68) are more likely to put on weight than who eat vegetable more (OR: 0.83, 95%CI: 0.77-0.89). Overweight and obesity are more common among those sleep less than 7 hours compared with who sleep over 7 hours(OR=0.89, 95%CI: 0.82-0.96) and 9 hours(OR=0.83, 95%CI: 0.74-0.94).

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Chamatoristic	W-14.2		0	S.E.	OR -	95%CI for OR		
Characteristic	w alax	Γ	р			Lower	Upper	
Sex								
Female	-	-	-	-	1.00	-	-	
Male	75.04	< 0.001	0.41	0.05	1.50	1.37	1.65	
Age								
18~	-	-	-	-	1.00	-	-	

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25~	47.71	< 0.001	0.79	0.11	2.20	1.76	2.75
35~	79.05	< 0.001	1.05	0.12	2.86	2.27	3.61
45~	118.0	< 0.001	1.30	0.12	3.65	2.89	4.61
55~	101.00	< 0.001	1.23	0.12	3.44	2.70	4.37
65~79	49.60	< 0.001	0.95	0.14	2.60	1.99	3.38
Education							
Primary school and below	-	-	-	-	1.00	-	-
Junior middle school	2.76	0.097	-0.08	0.05	0.92	0.84	1.02
Senior middle school	1.04	0.308	-0.05	0.05	0.95	0.86	1.05
Under graduate and above	0.01	0.921	0.01	0.07	1.01	0.88	1.15
Marriage							
Unmarried	-	-	-	-	1.00	-	-
Married	13.60	< 0.001	0.36	0.10	1.44	1.19	1.74
Separated/ Divorced/ Widowed	9.50	0.002	0.37	0.12	1.44	1.14	1.82
Occupation							
Manual	-	-	-	-	1.00	-	-
Intelligence	0.59	0.443	-0.04	0.06	0.96	0.86	1.07
others	26.16	< 0.001	0.25	0.05	1.28	1.17	1.41
Smoke							
No	-	-	-	-	1.00	-	-
Yes	56.49	< 0.001	-0.35	0.05	0.70	0.64	0.77
Ever	8.96	0.003	0.21	0.07	1.23	1.07	1.40
Drink	5.33	0.021	0.10	0.05	1.11	1.02	1.21
Diets							
Balance diet	-	-	-	-	1.00	-	-
Meat more	33.30	< 0.001	0.39	0.07	1.47	1.29	1.68
Vegetable more	23.53	< 0.001	-0.19	0.04	0.83	0.77	0.89
Sleep (h/d)							
<7	-	-	-	-	1.00	-	-

7~	9.67	0.002	-0.12	0.04	0.89	0.82	0.96
9~	8.64	0.003	-0.18	0.06	0.83	0.74	0.94
Constant	83.78	< 0.001	4.96	0.46	-	-	-

#### Discussion

For all we know, this was the first large population-based face-to-face survey to investigate the prevalence of overweight and obesity in Jilin Province, northeast China. We found that the prevalence of both overweight and obesity was at a high level. From the data of China chronic disease surveillance conducted by Chinese Center for Disease Control and Prevention, the prevalence of overweight among Chinese adults (age: 18-64) for 2004, 2007, and 2010 was 23.8%, 26.6% and 30.6%, respectively (male: 23.0%, 27.4%, and 32.1%; female: 24.7%, 25.7%, and 29.1%), and the prevalence of obesity was 7.2%, 7.7%, 12.1%, respectively (male: 6.3%, 6.7%, and 12.5%; female: 8.1%, 8.7%, and 11.1%). [17] Our cross-sectional study indicated the prevalence of overweight and obesity among adults in northeast China was 32.3% (male: 34.3%, female: 30.2%) and 14.6% (male: 16.3%, female: 12.8%) in 2012. It is a relatively low level compared with the developed countries. [18 19] However, with the rapid development of economic recent years, the diet habit in China has changed from oriental diet structure to western diet structure gradually. [20 21] Compared with the prevalence of the national level, this study got a higher prevalence in both sexes. This phenomenon implies overweight and obesity are more common in northeast China than other areas, while some effective actions might have been taken to control the uptrend. [22-24]

Multivariate logistic regression analysis suggested several factors have association with the prevalence of overweight and obesity. Males have a higher prevalence of overweight than females from age 18 to 54, and a higher prevalence of obesity from age 18 to 44, which was in line with the previous studies that reported sex difference associated with BMI.[25] For women, both the prevalence of overweight and obesity

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increased with age, peaking at 55-64 years old. The possible explanations for the results are the change of hormone level inside body according to previous studies.[26 27]

A recent review revealed different marital transitions changed body weight for both sexes in US: transitions into marriage appear to be associated with weight gain whereas transitions out of marriage are associated with weight loss.[28] This study acquired a slightly different result that both transitions into married and out of marriage are risk factors for getting overweight and obesity among adults in northeast China. This might be due to racial differences, the exact mechanism was not clear, further research thus was needed to illustrate this phenomenon among different marriage status.

Except for the demographic characteristics mentioned above, behaviors and life-style were also found to be associated with body weight. In this study we have found a lower prevalence of overweight and obesity in smokers compared with non-smokers, which is consistence with the studies conducted in India, Sweden and Tianjin China. [29-31] As many studies have reported before, tobacco use has relationship with various chronic diseases and body disorders, which may affect the digestive and absorptive function of alimentary system.[32] [33]And some research has also suggest that smoking increase energy expenditure and might suppress appetite.[34] In addition, there are also some reports suggested that some youth use smoking as a method for weight control. They smoke more for the purpose of losing weight.[35 36] As the use of tobacco does more harm than good, we really do not recommend this way to lose weight.

To the best of our knowledge, diet is one of the most important determinants of body weight, we have observed that drinking and eating meat more are risk factors for being overweight and obese, which is in conformity with previous studies.[31]Animal-based foods contain more fat than other foods, and regular consumption of high-fat foods will lead to weight gain. Affected by the traditional culture of alcoholic beverages, especially the areas of northeast China, it is generally believed that the more you drink, the more emotion you invest into your friends and relatives. Wine has been an absent drink when people get together.

Some recent studies demonstrated that poor sleep quality affect on BMI

significantly, and the result of this study supported this conclusion as well.[37 38] A plausible explanation was that the sleep disturbances, rather than sleep duration might contribute to overweight and obesity, thus the further studies of biological mechanisms are needed. However, education level, occupation and area distribution in this study showed no significant effect on body weight. Because we used a cross-sectional design in this study, our ability to determine causal inference is limited, therefore, we were unable to explain why these factors have association with overweight and obesity or not. Further research are needed to better understand why these association have occurred, why the observed disparities exist and how to reverse these trends.

The result of this study is significant part of Disease Spectrum in Jilin Province of China, which will be submit to the Health Department of Jilin Province and other relevant departments as a reference. These departments should pay enough attention to the high prevalence of overweight and obesity in Jilin province and provide effective guidelines that help control the development trend. BMJ Open: first published as 10.1136/bmjopen-2015-010828 on 25 July 2016. Downloaded from http://bmjopen.bmj.com/ on June 10, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

The main strengths of this study are its large sample size and precise physical measurement which improved the validity of our results. However, there still some potential limitations existed in this cross-sectional study. Self-reported data and the nature of cross-sectional data may lead to recall and reporting biases, which may have affected the accuracy of the results. The results of this study were from Jilin Province only, which couldn't generalize the whole northeast China. In addition, we excluded the item "exercise" which always has been considered as an important factor for overweight and obesity. During the process of data collection, we found "exercise" was relevant with the item "occupation" which may have great impact on the results. As more than 30% of the participants were manual workers, they claimed that the heavy manual labor made them have no energy to take extra exercise, which resulting in the most of their answers to the item "exercise" were "rarely or never". But the real energy consumption of them should be at a high level. What's more, the same situation happened in full-time wives because of the housework especially in rural areas.

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#### **Conclusion:**

To sum up, this study suggested the prevalence of overweight and obesity among adult residents in Jilin province, northeast China was at a high level. Main influencing factors for overweight and obesity included sex, age, marriage status, occupation, smoking, drinking, diet habits and sleep quality.

The results of this study will be submit to Health Department of Jilin Province and other relevant departments as a reference, which should inform policy makers in developing education and publicity to prevent and control the occurrence of overweight and obesity.

#### Acknowledgements

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#### **Author Contributions**

Rui Wang, Peng Zhang, Chunshi Gao, Xinlv, Yuanyuan Song, Zhijun Li, Yaqin Yu and Bo Li designed the study; Rui Wang, Peng Zhang performed the study; Rui Wang analyzed the data and drafted the manuscript; Rui Wang, Peng Zhang, Chunshi Gao, Xinlv and Yuanyuan Song participated amending the manuscript together. All authors approved the final version of the manuscript.

#### **Conflicts of Interest**

The authors declare no conflict of interest.

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#### **BMJ Open**

Foundation of the Health Bureau of Jilin Province, China (2011Z116).

#### Data sharing statement

No additional unpublished data are available.

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Figure1. the geographical position of Jilin province in northeast China 104x86mm (300 x 300 DPI)

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

	Item No	Recommendation
Title and abstract	1	( <i>a</i> ) Indicate the study's design with a commonly used term in the title or the
		abstract(page 1)
		(b) Provide in the abstract an informative and balanced summary of what was done
		and what was found(page2)
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being
		reported(page3)
Objectives	3	State specific objectives, including any prespecified hypotheses(page4)
Methods		
Study design	4	Present key elements of study design early in the paper(page4)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment,
		exposure, follow-up, and data collection(page4-5)
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(page4-6)
		(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(page6)
Data sources/	8*	For each variable of interest, give sources of data and details of methods of
measurement		assessment (measurement). Describe comparability of assessment methods if there
		is more than one group(page6)
Bias	9	Describe any efforts to address potential sources of bias(page5-6)
Study size	10	Explain how the study size was arrived at(page4)
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable,
		describe which groupings were chosen and why(page5)
Statistical methods	12	(a) Describe all statistical methods, including those used to control for
		confounding(page5)
		(b) Describe any methods used to examine subgroups and interactions
		(c) Explain how missing data were addressed(page4)
		(d) Cohort study—If applicable, explain how loss to follow-up was addressed
		<i>Case-control study</i> —If applicable, explain how matching of cases and controls was
		addressed
		<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of
		sampling strategy(page6-/)
		( <u>e</u> ) Describe any sensitivity analyses

Continued on next page

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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(page7)
		(b) Give reasons for non-participation at each stage(page5)
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders(page7-8)
		(b) Indicate number of participants with missing data for each variable of interest
		(c) Cohort study—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	Cohort study—Report numbers of outcome events or summary measures over time
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures(page7-13)
Main results	16	( <i>a</i> ) 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
		(b) Report category boundaries when continuous variables were categorized(page7-12)
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses(page10-12)
Discussion		
Key results	18	Summarise key results with reference to study objectives(page15)
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(page15)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity
		of analyses, results from similar studies, and other relevant evidence(page15)
Generalisability	21	Discuss the generalisability (external validity) of the study results(page15)
Other informati	on	
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(page16)

\*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.