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Keywords:	Ten-year period, cardiovascular risk factors, office-working population

Time trend of cardiovascular disease risk factors over a 10-year period in the office-working population in China

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Abstract

Objectives: Recent dramatic increases in cardiovascular disease (CVD) mortality in China can be mostly explained by adverse changes in major cardiovascular risk factors (CVRFs). Our study aimed to assess the trend of CVRFs by a ten-year lag in Nanjing, China. **Methods:** 8017 and 9379 subjects from multiple work units of Nanjing were included in the present study, who attended the routine health examination in 2008 and 2017 seperately. The trends of three medical conditions of hypertension, dyslipidemia and diabetes were analyzed. **Results:** From 2008 to 2017, the prevalence of hypertension declined, while the prevalence of dyslipidemia and diabetes increased. Besides, we found that the population in 2008 and 2017 had an average of 0.66 and 0.78 risk factors, respectively. And number of CVD risk factors increased with age. **Conclusion:** CVRFs are common in office-working people in Nanjing, China. Effective interventions and treatment against risk factors should be adopted in the high risk population.

Strength and limitations of this study

- We used the two independent large health check-up population with approximately 10,000 sample sizes, most of whom are office-working population to assess trends in cardiovascular risk factors over a 10-year period.
- The exposure distribution of all risk factors was estimated on the basis of original data.
- We only considered 4 factors (blood pressure, LDL, glucose and BMI), without considering any dietary factors and smoking, because of the lack of these parameters.
- The definitions of these conditions are continuously changing and may also be stratified.

Keywords: Ten-year period; cardiovascular risk factors; office-working population

Introduction

Cardiovascular disease (CVD) is highly prevalent and remains the predominant cause of premature mortality worldwide[1]. In China, estimated annual death due to CVD had increased to 2.7 million, which accounts for about 40% of all-cause mortality per year[2]. There are various of cardiovascular risk factors (CVRFs), known to increase the risk of CVD [3-8], including diabetes, hypertension, dyslipidemia, obesity and smoking. Data from the National Health Interview Survey (NHIS) found that approximately 26% of US adults had multiple (≥2) CVRFs[9]. Robust evidence supports that the presence of any form of combination of diabetes, hypertension and dyslipidemia, has an even higher risk for the development of cardiovascular diseases than each condition alone[10].

In recently years, a substantial increase was seen in the prevalence of overweight and diabetes mellitus worldwide[11, 12], whereas the prevalence of hypertension was reported to be stable over time[13-15] and the prevalence of hypercholesterolemia remained at almost epidemic levels[16-18]. In China, with the huge economic development and changes of lifestyles including higher calorie and cholesterol intake and reduced physical activities, the frequencies and profiles of CVRFs have changed even more dramatically. Given that fact that the ongoing deterioration of the CVRFs seems to be the major reason that induces the surge of CVD in China, CVRFs screening may detect and attenuate these modifiable factors earlier and thereby improve patients' life expectancy and functional status by reduction of CVD risks. However, to data, little was known about the time trend of CVRFs in China.

The present study aims to investigate the long-term trends of CVRFs in China by a 10 years time from 2008 and 2017 in the office-working population using a large health administrative database in Jiangsu, China.

Methods

Participants

This was an observational study for the office-working population conducted at the health manage center in Jiangsu Province Official Hospital (Nanjing, China). All the participants took a health check-up including a routine medical examination, anthropometric

measurements, and information on medical history in the year 2008 and 2017. After excluding those under 18 years or with missing information on diagnosis, a total of 8017 participants in 2008 and 9379 participants in 2017 were included for the final analysis. The study was approved by the Ethics Committee of Jiangsu Province Institute of Geriatrics. Written informed consent was obtained from all participants.

Clinical assessment

Demographic characteristics including age and sex were collected from all participants by trained nurses. Personal medical histories, including hypertension, diabetes and dyslipidemia, were reported by all participants. Body weight, height and blood pressure were measured using standard instruments and protocols by trained staff [19]. Body mass index (BMI) was calculated as weight in kilograms divided by the height in meters squared. Low-density lipoprotein cholesterol (LDL-C) and fasting plasma glucose (FPG) measured during an overnight fast of more than 8 hours. We defined the four CVD risk factors as the following (also see **Supplementary Table 1**): 1) Obesity: BMI≥28 kg/m^2; 2) Hypertension: Blood pressure≥140/90 mm Hg and/or self-reported history of hypertension; 3) Dyslipidemia: LDL-C ≥4.14 mmol/L and/or self-reported dyslipidemia; 4) Diabetes: FPG≥7.0 mmol/L and/or self-reported diabetes.

Statistical analysis

Comparisons between different years were conducted using Student's T-test for continuous variables and Chi-squared test for categorical variables. The standard prevalent rates were standardized by age and sex using the population composition from the 2010 Chinese census population. Data analyses were carried out by R software (Version 3.0.2, 2013-09-25; R Foundation for Statistical Computing, http://www.cran.r-project.org/). The significance level was set at $P< 0.05$ and P values were given for two-sided tests.

Patient and public involvement

The participants of this study represent a large office-working population in China. They were not involved neither in the study design, nor in the conduct of the study. However, they were informed that their physical examination data (including blood pressure, cholesterol levels,

blood glucose, etc) and baseline information may be in scientific study. And all scientific study results are continuously communicated to the participants by phone.

Results

The characteristics of the study population were shown in **Supplementary Table 2**. A total of 8017 and 9397 subjects were included in the analysis in 2008 and 2017. There was no significant difference in the distribution of sex. Compared to those of 2008, the percentage of older (age≥60), overweight and obese subjects increased by 9.89%, 2.42% and 3.26% separately in 2017. In addition, in 2017, more subjects had the history of the three medical conditions (systolic blood pressure, LDL-C and blood glucose).

The crude prevalence of hypertension, dyslipidemia and diabetes were all increased over the study period, from 37.87, 10.84 and 8.57% in 2008 to 39.14, 14.20 and 12.17% in 2017 (**Table 1)**. Interestingly, we found that after standardized by age and sex, the trend for hypertension was reversed with a decline in 2017. In age groups, a downward trend of hypertension was identified among subjects younger than 69 years old, after which a more rapid increase was observed in 2017 (**Figure 1A**). As expected, a significant increase was confirmed for dyslipidemia and diabetes in 2017 even adjusted for age and sex (P<0.001, **Table 1**). Besides, the age-specific analysis showed that the prevalent rates were higher in 2017 for these two conditions (**Figure 1B and C**). The overall prevalence for three medical factors were similar when stratified by gender and age (**Figure 2A and B**) for patients identified by examination or self-reported alone (**Supplementary Table 3**).

The distribution of CVRFs for 2008 and 2017 are displayed in **Table 2**. We found that 47.46%, 15.14% and 3.32% of the subjects had ≥1, ≥2 and ≥3 risk factors in 2008. In contrast, there was a gain in the percentage of risk factors in 2017 with 54.00%, 19.70% and 3.75%, respectively. The average numbers of CVD risk factors in 2008 and 2017 were 0.66 and 0.78 and increased with age (**Supplementary Figure 1**).

Discussion

To our knowledge, only a few previous studies have estimated future CVD burden in China before 2010[20, 21]. In the present study, we examined the prevalence of hypertension,

dyslipidemia and diabetes and the potential impact by a ten-year period in Nanjing, China. As the sampling frame covers almost all the government departments of Jiangsu, this study is a good reflect of office-working populations.

In the past 10 years, the percentage of overweight and obesity showed an upward trend, which is consistent with the result from 2010 China Chronic Disease Monitoring Program[22]. It has been reported that the worldwide ranking of obese populations in China has moved to second in 2014[23]. In addition to diets, changes in lifestyle have taken place. Chinese have become more sedentary, especially for working population in the agency [24]. Meanwhile, around 61% of rural households owned a motorcycle, and 19% of urban households owned a car in 2011.

Hypertension was reported to the most prominent CVRF among Chinese. From 1988 to 2008, there was an increasing trend of hypertension prevalence in Americans aged 40 years and older [25]; however, the prevalence of hypertension in Japan[26], Germany[27], Italy[28] and Korea [29] decreased. In our study, we found a significant decline in the prevalence trend for hypertension among Chinese adults in 2017 compared with 2008. As we all known, higher socioeconomic status could positively improve the awareness and control of hypertension, and people would also have a better compliance of medicine treatment. According to a survey in 13 provinces from 2009 to 2010, among 50,171 subjects aged at least 18 years, the awareness, treatment, and control rates as well as the treatment–control rate of hypertension were 42.6, 34.1, 9.3,and 27.4%, respectively, also higher than those in 2002 (30.2,24.7, 6.1, and 25.0%, respectively)[30].

High blood LDL cholesterol was the second leading risk factor for CVD. In agreement with previous Swiss[31], French[32] and German[33] studies, the prevalence of hypercholesterolemia increased significantly between 2008 and 2017. Diabetes is a growing epidemic in China, occurring at a relatively young age[34]. In the 1980s, diabetes was rare in China, with an estimated prevalence of 0.67%. In subsequent national surveys conducted in 1994[35], 2000 to 2001[36], 2007 to 2008[37], and 2010 to 2011[38], the prevalence was 2.5%, 5.5%, 9.7% and 11.6%, respectively. In this study, we found that the crude prevalence increased from 8.57% in 2008 to 12.17% in 2017. Those data imply that CVD events associated with high LDL and glucose will continue to increase in the further.

The main strength of this study was the use of the two independent large health check-up population with approximately 10,000 sample sizes. All measurements and data were collected with standardized methods over time. Secondly, the exposure distribution of all risk factors was estimated on the basis of original data. Previous disease-burden projects were on the basis of pooling exposure distributions from different studies. The original data-based estimation allowed us to account for potential residual confounding, although it could not be completely eliminated.

The findings in the present study are subject to several limitations. First, the definitions of these conditions are continuously changing and may also be stratified. For example, hypertension could be defined as BP ≥ 130/80 mmHg for diabetic subjects [39]. Secondly, we only considered 4 factors (blood pressure, LDL, glucose and BMI), without considering any dietary factors and smoking, because of the lack of these parameters.

In conclusion, high blood pressure stills remains the leading factor among CVRFs in China, despite of a significant decline by a ten-year period. Besides, increasing dyslipidemia and diabetes were also important in CVRFs. More intensive treatment regimens are needed for patients with the three medical conditions, in order to curb the cardiovascular endpoints expected in the near future.

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Contributors

YC completed the analyses and led the writing. ZX-S and LB-G initiated, conceived and supervised the study. HL-Y assisted with the study and analyses. HZ participated in the data collation. XH-L and GY managed the physical examination. LK-Z and HD participated in the implementation of physical examination. SP-Y and DH-Y checked the results of physical examination.

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Competing interests No potential conflicts of interest relevant to this article were reported.

Patient consent Not required.

Ethics approval The study was approved by the Ethics Committee of Jiangsu Province Institute of Geriatrics.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement All available data are included in this manuscript.

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hypertension and hypercholesterolemia in the United States. *Am J Cardiol* 2006; 98:204-208.

Table 1. The prevalence rates of hypertension, dyslipidemia and diabetes in 2008 and 2017 year based on the examination test and self-reported.

Disease	Survey year	No. of cases (n)	Prevalence (%)	Stand-prevalence (%)[a]	*P* value [b]
Hypertension	2008	3036	37.87	27.51	<0.001
	2017	3671	39.14	25.16	
Dyslipidemia	2008	869	10.84	8.25	<0.001
	2017	1332	14.2	11.95	
Diabetes	2008	687	8.57	5.40	<0.001
	2017	1141	12.17	6.68	

[a] Standardized prevalence; the prevalence rates were standardized by age and sex based on the 2010 Chinese census population.

[b] *P* value for standard prevalence between 2008 and 2017

Table 2. Details of the CVD risk factors among the check-up Chinese subjects in 2008 and 2017 years.

CVD risk factors	2008		2017		P
	N	%	N	%	
Obesity					
BMI≥28kg/m^2	725	9.04	1154	12.3	<0.001
Hypertension	3036	37.87	3671	39.14	0.09
Dyslipidemia	869	10.84	1332	14.2	<0.001
Diabetes	687	8.57	1141	12.17	<0.001
CVD risk factors					
≥ 1 risk factor	3805	47.46	5065	54	<0.001
≥ 2 risk factor	1214	15.14	1848	19.7	<0.001
≥ 3 risk factor	266	3.32	352	3.75	0.13

Figure legends

Figure 1. Age-specific prevalence in (A) hypertension, (B) hypercholesterolemia and (C) diabetes in 2008 and 2017.

Figure 2. The age-standardized prevalence rates of the three cardiovascular disease factors in males (A) and females (B) in 2008 and 2017.

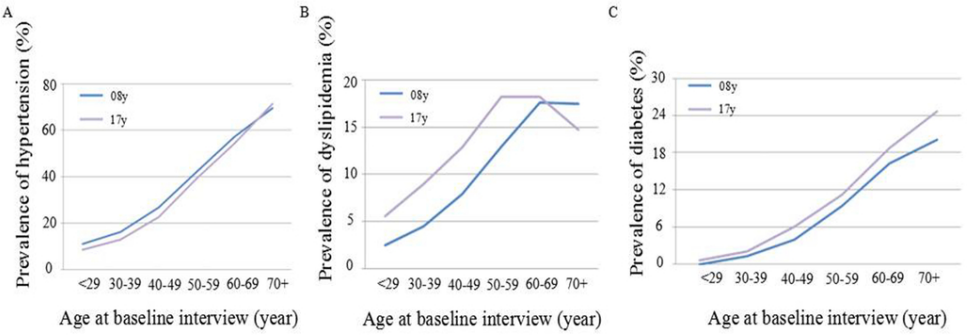


Figure 1. Age-specific prevalence in (A) hypertension, (B) hypercholesterolemia and (C) diabetes in 2008 and 2017.

90x90mm (300 x 300 DPI)

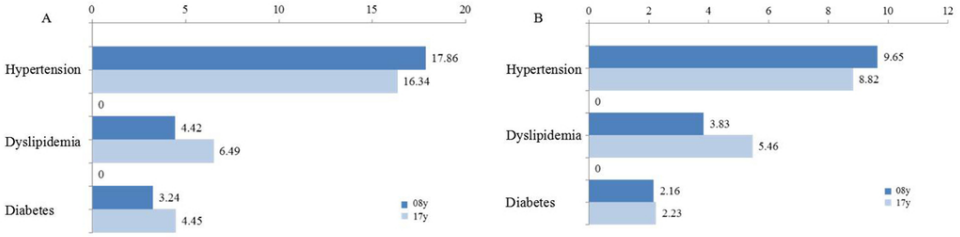


Figure 2. The age-standardized prevalence rates of the three cardiovascular disease factors in males (A) and females (B) in 2008 and 2017.

90x90mm (300 x 300 DPI)

Supplementary Table 1. The definitions of the four CVD risk factors of the study.

CVD risk factors	Definition
Obesity	BMI≥28kg/m^2
Hypertension	Blood pressure ≥ 140/90mmHg and/or self-reported disease
Dyslipidemia	LDL-C ≥ 4.14 mmol/L and/or self-reported disease
Diabetes	Fasting PG ≥ 7.0 mmol/L and/or self-reported disease

Supplementary Table 2. Clinical and laboratory characteristics of participants.

Variable	Survey Year		*P*
	2008 (n, %)	2017 (n, %)	
All	8017	9379	
Sex			
Man	5171(64.5)	5947(63.41)	0.14
Women	2846(35.5)	3432(36.59)	
Age	51.08±15.14	53.69±16.77	<0.001
<30	684(8.53)	836(8.91)	
30-40	1213(15.13)	1477(15.75)	
40-50	2016(25.15)	1354(14.44)	<0.001
50-60	1781(22.22)	2067(22.04)	
60-70	1142(14.24)	1832(19.53)	
70+	1181(14.73)	1813(19.33)	
BMI			
Thin (<18.5)	280(3.49)	229(2.44)	
Normal (18.5-24)	3948(49.25)	4184(44.61)	<0.001
Overweight (24-28)	3064(38.22)	3812(40.64)	
Obese (≥28)	725(9.04)	1154(12.3)	
Examination Index			
Systolic pressure	125.63±18.17	130.01±18.99	<0.001
Diastolic pressure	80.85±10.69	77.11±10.79	<0.001

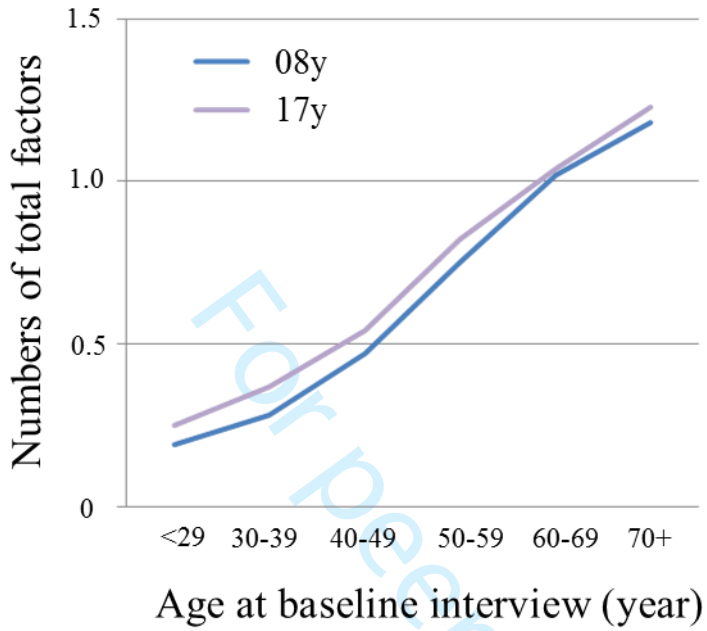
LDL-C	2.95±0.73	3.15±0.86	<0.001
Fasting blood glucose	5.52±1.12	5.99±1.32	<0.001

Supplementary Table 3. The prevalence rates of hypertension, hypercholesterolemia and diabetes in 2008 and 2017 year based on the examination test and self-reported separately.

Disease	Survey year	Examination test			Self-reported		
		No. of cases (n)	Prevalence (%)	Stand-prevalence (%)[a]	No. of cases (n)	Prevalence (%)	Stand-prevalence (%)[a]
Hypertension	2008	2420	30.19	22.31	1632	20.36	13.11
	2017	3042	32.43	21.40	1728	18.42	9.48
Dyslipidemia	2008	451	5.63	4.67	488	6.09	4.27
	2017	1140	12.15	10.88	220	2.35	1.27
Diabetes	2008	486	6.06	3.82	447	5.58	3.39
	2017	1004	10.7	6.02	494	5.27	2.43

[a] Stand-prevalence: standardized prevalence; the prevalence rates were standardized by age and sex based on the 2010 Chinese census population.

Supplementary Figure 1. Average number of total CVD risk factors by age in 2008 and 2017 years.



STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
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	4
Bias	9	Describe any efforts to address potential sources of bias	4
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4
		(*b*) Describe any methods used to examine subgroups and interactions	4
		(*c*) Explain how missing data were addressed	4
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	-
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	-
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	5
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	5
		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	5
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	7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	6
Generalisability	21	Discuss the generalisability (external validity) of the study results	7
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	8

*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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Time trend of cardio-metabolic risk factors over a 10-year period in the office-working population in China

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Time trend of cardio-metabolic risk factors over a 10-year period in the office-working population in China

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Abstract

Objectives: Recent dramatic increases in cardiovascular disease mortality in China can be mostly explained by adverse changes in hypertension, dyslipidemia, diabetes and obesity, known as cardio-metabolic risk factors. Our study aimed to assess the trend of these four signatures by a ten-year lag in Nanjing, China. **Methods:** 8017 subjects attended the routine health examination in 2008 and 9379 subjects in 2017, from multiple work units of Nanjing, were included in the present study. The prevalence and trend of four cardio-metabolic risk factors: hypertension, dyslipidemia, diabetes and obesity were analyzed. **Results:** From 2008 to 2017, the prevalence of hypertension declined, while the prevalence of dyslipidemia, diabetes and obesity increased. Besides, the population in 2008 and 2017 had an average of 0.66 and 0.78 risk factors, respectively. **Conclusion:** Cardio-metabolic risk factors are common for the staff in administrative agencies and institutions of Nanjing, China. Effective screening and interventions against these risk factors should be adopted in the high-risk population such as office-working populations in China.

Strength and limitations of this study

- We used the two independent large health check-up population with approximately 10,000 sample sizes, most of whom are office-working population to assess trends in cardiovascular risk factors over a 10-year period.
- The exposure distribution of all risk factors was estimated on the basis of original data.
- We only considered 4 factors (blood pressure, LDL, glucose and BMI), without considering any dietary factors and smoking, because of the lack of these parameters.
- The definitions of these conditions are continuously changing and may also be stratified.

Keywords: Ten-year period; cardio-metabolic risk factors; office-working population

Introduction

Cardiovascular disease (CVD) is highly prevalent and remains the predominant cause of premature mortality worldwide[1]. In China, estimated annual death due to CVD had increased to 2.7 million, which accounts for about 40% of all-cause mortality per year[2]. Obesity, diabetes, hypertension and dyslipidemia are established risk factors of CVD and contribute to the prevalence of CVD[3-8], which were also known as cardio-metabolic risk factors because of their close link with metabolic disorders, cancers and chronic respiratory diseases[9, 10].

In recently years, a substantial increase was seen in the prevalence of overweight and diabetes mellitus worldwide[11, 12], whereas the prevalence of hypertension was reported to be stable over time[13-15] and the prevalence of hypercholesterolemia remained at almost epidemic levels[16-18]. In China, with the huge economic development and changes of lifestyles including higher calorie and cholesterol intake and reduced physical activities, the frequencies and profiles of the four signatures have changed even more dramatically. Given the ongoing deterioration of these cardio-metabolic risk factors in China, which may greatly contribute to the surge of CVD, more understanding to these factors may be quite important. However, to data, little was known about the time trend of these cardio-metabolic risk factors in China.

The present study aims to investigate the long-term trends of cardio-metabolic risk factors in office-working population in China by a 10-year lag from 2008 and 2017, using a large health administrative database in Jiangsu, China. The office-working population has shown to be “high risk group” for metabolic diseases [19] due to their life styles, as most of them perform their daily work mainly in the office with low amount of physical activity.

Methods

Participants

This was an observational study using the health check-up data from the health manage center in Geriatric Hospital of Nanjing Medical University (Nanjing, China). Subjects included in the study came from dozens of work units including government offices, scientific research

institutions, banks and so on in the major urban districts of Nanjing, which is the capital of Jiangsu Province and located in the east of China. Most of them perform their daily work mainly in the office with low amount of physical activity. Totally, 9665 subjects in 2008 and 15200 subjects in 2017 who taking a routine annual health check-up in the health manage center were included, including a medical examination, anthropometric measurements, and information on medical history. Both currently employed and retired individuals were included in our study. There was no difference in the design and recruitment between 2008 and 2017.

After excluding those participants with missing data on height (n=450), systolic pressure (n=29), low-density lipoprotein cholesterol (LDL-C) (n=938) or information of prior history of hypertension, dyslipidemia and diabetes (n=231), 8017 individuals were eligible for analysis as baseline in 2008. Similarly, a population of 9379 individuals was remained for analysis in 2017 after excluding those who under 18 years old (n=21), or with missing data on height (n=1476), systolic pressure (n=128), blood glucose (n=312), LDL-C (n=3001) or information of prior history of hypertension, dyslipidemia and diabetes (n=883). The study was approved by the Ethics Committee of Geriatric Hospital of Nanjing Medical University. Written informed consent was obtained from all participants.

Clinical assessment

Demographic characteristics including age and sex were collected from all participants by trained nurses. Personal medical histories, including hypertension, diabetes and dyslipidemia, were reported by all participants. Body weight, height and blood pressure were measured using standard instruments and protocols by trained staff [20]. Body mass index (BMI) was calculated as weight in kilograms divided by the height in meters squared. Low-density lipoprotein cholesterol (LDL-C) and fasting plasma glucose (FPG) measured during an overnight fast of more than 11 hours. We defined the four cardio-metabolic risk factors as the following, same in both 2008 and 2017(also see **Supplementary Table 1**): 1)Obesity: BMI≥28 kg/m^2[21-23]; 2)Hypertension: Blood pressure≥140/90 mm Hg and/or self-reported history of hypertension[24]; 3) Dyslipidemia: LDL-C ≥4.14 mmol/L and/or self-reported dyslipidemia[25]; 4)Diabetes: FPG≥7.0 mmol/L and/or self-reported diabetes [26].

Statistical analysis

Comparisons between different years were conducted using Student's T-test for continuous variables and Chi-squared test for categorical variables. Comparison between prevalence data of 2008 and 2017 was performed on the basis of standardized mortality rate (SMR) calculations and by applying the indirect standardization technique, using reference-specific prevalent rates of hypertension, dyslipidemia and diabetes by age and gender using the population composition from the Chinese census population (aged from 19 to 96 years) [27]. Data analyses were carried out by R software (Version 3.0.2, 2013-09-25; R Foundation for Statistical Computing, http://www.cran.r-project.org/). The significance level was set at $P<0.05$ and P values were given for two-sided tests.

Patient and public involvement

The participants of this study represent a large office-working population in China. They were not involved neither in the study design, nor in the conduct of the study. However, they were informed that their physical examination data (including blood pressure, cholesterol levels, blood glucose, etc) and baseline information may be in scientific study. And all scientific study results are continuously communicated to the participants by phone.

Results

The characteristics of the study population were shown in **Supplementary Table 2**. A total of 8017 and 9397 subjects were included in the analysis in 2008 and 2017. There was no significant difference in the distribution of sex. Compared to those of 2008, the percentage of older (age≥60), overweight and obese subjects increased by 9.89%, 2.42% and 3.26% separately in 2017. In addition, in 2017, more subjects had the history of the three medical conditions (systolic blood pressure, LDL-C and blood glucose).

The crude prevalence of hypertension, dyslipidemia, diabetes and obesity were all increased over the study period, from 37.87, 10.84, 8.57% and 9.04% in 2008 to 39.14, 14.20, 12.17% and 12.30% in 2017 (**Table 1)**. As expected, a significant increase was confirmed for dyslipidemia, diabetes and obesity in 2017 even standardized by age and sex (dyslipidemia: 8.25% in 2008 and 11.95% in 2017, $P<0.001$; diabetes: 5.40% in 2008 and 6.68% in 2017, $P<0.001$; obesity: 7.44% in 2008 and 11.33% in 2017, $P<0.001$, **Table 1**). Interestingly, we

found that after standardized by age and sex, the trend for hypertension was reversed with a slight decline in 2017 from 27.51% (26.53%-28.49%) to 25.16% (24.28%-26.04%). When subjects were stratified by age, a constant downward trend of hypertension was identified among subjects younger than 70 years old from 2008 to 2017 (**Figure 1A**). The prevalent rates for dyslipidemia, diabetes and obesity were higher in 2017 in each age subgroups (**Figure 1B-D**). Especially, the prevalence of obesity in younger groups in 2017 were dramatically increased as compared to those in 2008 (**Figure 1D**). In contrast, the overall prevalence for the four signatures were similar when stratified by gender (**Figure 2A and B**) or for patients identified by examination or self-reported alone (**Supplementary Table 3**).

Changes in the four signatures stratified by gender among different age groups were further analyzed and presented in **Figure 3**. It shows the prevalence for male or women population was similar in 2008 and 2017 respectively for all but dyslipidemia and obesity (**Figure 3**). Similar results were seen for patients identified by examination or self-reported alone (**Supplementary Table 4**).

The distribution and numbers of cardio-metabolic risk factors for 2008 and 2017 are shown in **Table 2**. We found that 47.46%, 15.14% and 3.32% of the subjects had ≥1, ≥2 and ≥3 risk factors in 2008. In contrast, there was a gain in the percentage of risk factors in 2017 with 54.00%, 19.70% and 3.75%, respectively. The average numbers of cardio-metabolic risk factors in 2008 and 2017 were 0.66 and 0.78 (P<0.001), respectively. And the number of cardio-metabolic risk factors significantly increased with age (**Supplementary Figure 1**).

Discussions

To our knowledge, only a few previous studies have estimated cardio-metabolic risk factors and future CVD burden in China before 2010[28, 29]. In the present study, we examined the prevalence of hypertension, dyslipidemia and diabetes and the potential impact by a ten-year lag in Nanjing, China, in office-working populations.

In the past 10 years, the percentage of overweight and obesity showed an upward trend, which is consistent with the results from 2010 China Chronic Disease Monitoring Program[30]. The worldwide ranking of obese populations of China has moved to the second in 2014[31]. During the last decades, Chinese have become more sedentary, especially for

working population in the agency [32].

Hypertension was reported to the most prominent cardio-metabolic risk factors among Chinese [33, 34]. From 1988 to 2008, there was an increasing trend of hypertension prevalence in Americans aged 40 years and older [35]; however, the prevalence of hypertension in Japan[36], Germany[37], Italy[38] and Korea[39] decreased. In our study, we found a significant decline in the prevalence trend for hypertension among Chinese adults in 2017 compared with 2008. As we all known, higher socioeconomic status could positively improve the awareness and control of hypertension, and people would also have a better compliance of medicine treatment. According to a survey in 13 provinces from 2009 to 2010, among 50,171 subjects aged at least 18 years, the awareness, treatment, and control rates as well as the treatment–control rate of hypertension were 42.6, 34.1, 9.3,and 27.4%, respectively, also higher than those in 2002 (30.2,24.7, 6.1, and 25.0%, respectively)[40].

High blood LDL cholesterol was the second leading risk factor for CVD. In agreement with previous Swiss[41], French[42] and German[43] studies, the prevalence of hypercholesterolemia increased significantly between 2008 and 2017. Diabetes is a growing epidemic in China, occurring at a relatively young age[44]. In the 1980s, diabetes was rare in China, with an estimated prevalence of 0.67%. In subsequent national surveys conducted in 1994[45], 2000 to 2001[46], 2007 to 2008[47], and 2010 to 2011[48], the prevalence was 2.5%, 5.5%, 9.7% and 11.6%, respectively. In this study, we found that the crude prevalence increased from 8.57% in 2008 to 12.17% in 2017. Those data imply that CVD events associated with high LDL and glucose will continue to increase in the further.

The main strength of this study was the use of the two independent large health check-up population with approximately 10,000 sample size. All measurements and data were collected with standardized methods over time. Secondly, the exposure distribution of all risk factors was estimated on the basis of original data. The original data-based estimation allowed us to account for potential residual confounding, although it could not be completely eliminated.

The findings in the present study are subject to several limitations. First, we only considered 4 factors (blood pressure, LDL, glucose and BMI), without considering any dietary factors and smoking, because of the lack of these parameters. Secondly, this study was carried out in cohorts only comprises Chinese individuals from office-working units in

Nanjing. Our results may not be generalizable to the entire populations. More studies are expected to confirm our finding.

In conclusion, high blood pressure remains the leading factor among cardio-metabolic risk factors in China, although a slight downward trend of this condition was observed from 2008 to 2017 after standardized by age and sex. However, significant increases dyslipidemia, diabetes and obesity in 2017 were confirmed in the present study. More intensive screening and treatment regimens are needed for patients with these conditions, in order to curb the cardiovascular endpoints expected in the near future.

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Contributors

YC completed the analyses and led the writing. ZX-S and LB-G initiated, conceived and supervised the study. SC guided the analysis and modified the article. HL-Y assisted with the study and analyses. HZ participated in the data collation. XH-L and GY managed the physical examination. LK-Z and HD participated in the implementation of physical examination. SP-Y and DH-Y checked the results of physical examination.

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Competing interests No potential conflicts of interest relevant to this article were reported.

Patient consent Not required.

Ethics approval The study was approved by the Ethics Committee of Geriatric Hospital of Nanjing Medical University.

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Data sharing statement All available data are included in this manuscript.

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Table 1. The prevalence rates of hypertension, dyslipidemia, diabetes and obesity in 2008 and 2017 year based on the examination test and self-reported.

Disease	Survey year	No. of subjects	No. of cases	Prevalence (95%CI) (%)	Standard prevalence (95%CI)(%)[a]	*P* value [b]
Hypertension	2008	8017	3036	37.87(36.81-38.93)	27.51(26.53-28.49)	<0.001
	2017	9379	3671	39.14(38.15-40.13)	25.16(24.28-26.04)	
Dyslipidemia	2008	8017	869	10.84(10.16-11.52)	8.25(7.65-8.85)	<0.001
	2017	9379	1332	14.2(13.49-14.91)	11.95(11.29-12.61)	
Diabetes	2008	8017	687	8.57(7.96-9.18)	5.40(4.91-5.89)	<0.001
	2017	9379	1141	12.17(11.51-12.83)	6.68(6.17-7.19)	
Obesity	2008	8017	725	9.04(8.41-9.67)	7.44(6.87-8.01)	<0.001
	2017	9379	1154	12.3(11.64-12.96)	11.33(10.69-11.97)	

[a] Standardized prevalence; the prevalence rates were standardized by age and sex based on the 2010 Chinese census population.

[b] *P* value for standard prevalence between 2008 and 2017.

Table 2. Details of the cardio-metabolic risk factors among the check-up Chinese subjects in 2008 and 2017 years.

Cardio-metabolic risk factors	2008 (8017)		2017 (9379)		P
	N	%	N	%	
Obesity					
BMI≥28kg/m^2	725	9.04	1154	12.3	<0.001
Hypertension	3036	37.87	3671	39.14	0.09
Dyslipidemia	869	10.84	1332	14.2	<0.001
Diabetes	687	8.57	1141	12.17	<0.001
Cardio-metabolic risk factors					
≥ 1 risk factor	3805	47.46	5065	54	<0.001
≥ 2 risk factor	1214	15.14	1848	19.7	<0.001
≥ 3 risk factor	266	3.32	352	3.75	0.13

Figure legends

Figure 1. Age-specific prevalence in (A) hypertension, (B) dyslipidemia, (C) diabetes and (D) obesity in 2008 and 2017.

Figure 2. The age-standardized prevalence rates of the three cardiovascular disease factors in males (A) and females (B) in 2008 and 2017.

Figure 3. Age-specific prevalence among males and females in (A) hypertension, (B) dyslipidemia, (C) diabetes and (D) obesity in 2008 and 2017.

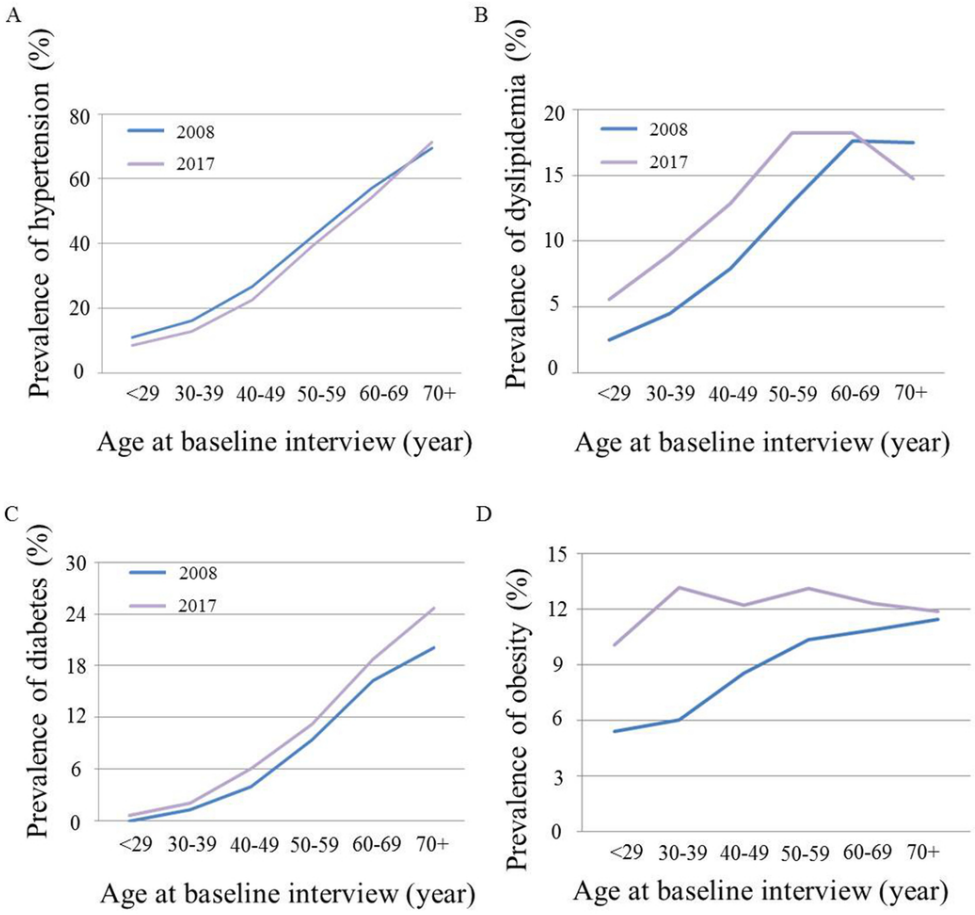


Figure 1. Age-specific prevalence in (A) hypertension, (B) dyslipidemia, (C) diabetes and (D) obesity in 2008 and 2017.

90x90mm (300 x 300 DPI)

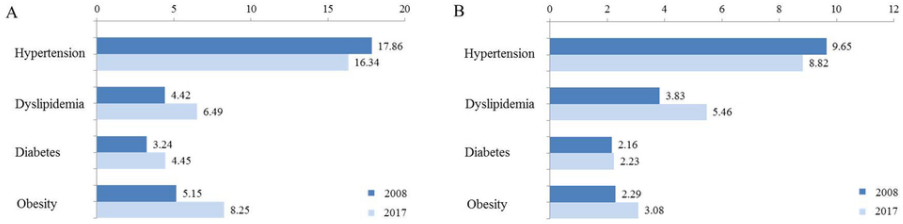


Figure 2. The age-standardized prevalence rates of the three cardiovascular disease factors in males (A) and females (B) in 2008 and 2017.

90x29mm (300 x 300 DPI)

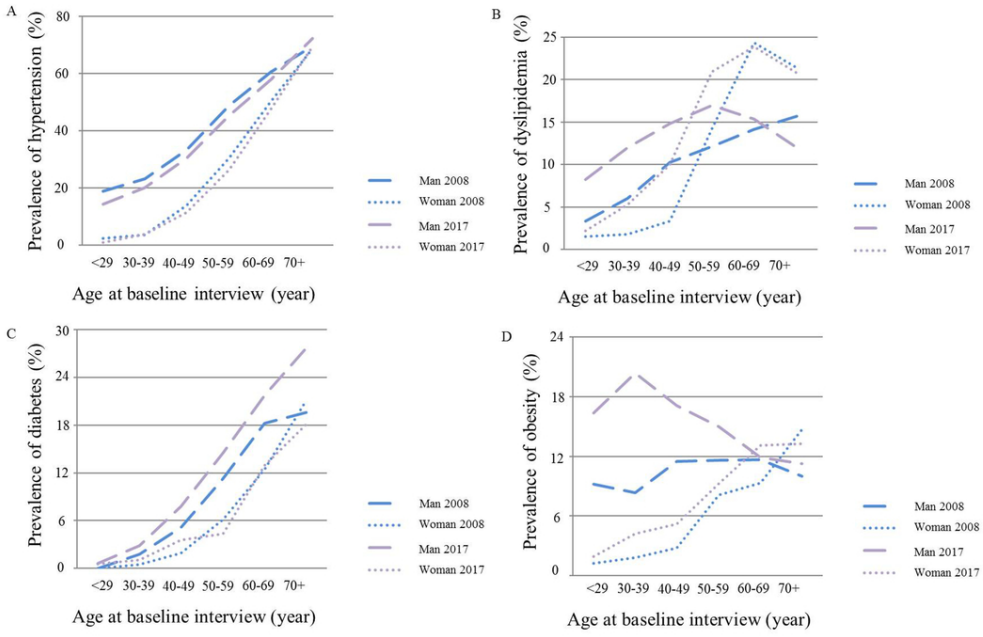


Figure 3. Age-specific prevalence among males and females in (A) hypertension, (B) dyslipidemia, (C) diabetes and (D) obesity in 2008 and 2017.

90x69mm (300 x 300 DPI)

Supplementary Table 1. The definitions of the four cardio-metabolic risk factors of the study.

Cardio-metabolic risk factors	**Definition**
Obesity	BMI≥28kg/m^2
Hypertension	Blood pressure ≥ 140/90mmHg and/or self-reported disease
Dyslipidemia	LDL-C ≥ 4.14 mmol/L and/or self-reported disease
Diabetes	Fasting PG ≥ 7.0 mmol/L and/or self-reported disease

Supplementary Table 2. Clinical and laboratory characteristics of participants.

Variable	Survey Year		*P*
	2008 (n, %)	2017 (n, %)	
All	8017	9379	
Sex			
Man	5171(64.5)	5947(63.41)	0.14
Women	2846(35.5)	3432(36.59)	
Age	51.08±15.14	53.69±16.77	<0.001
<30	684(8.53)	836(8.91)	
30-40	1213(15.13)	1477(15.75)	
40-50	2016(25.15)	1354(14.44)	<0.001
50-60	1781(22.22)	2067(22.04)	
60-70	1142(14.24)	1832(19.53)	
70+	1181(14.73)	1813(19.33)	
BMI			
Thin (<18.5)	280(3.49)	229(2.44)	
Normal (18.5-24)	3948(49.25)	4184(44.61)	<0.001
Overweight (24-28)	3064(38.22)	3812(40.64)	
Obese (≥28)	725(9.04)	1154(12.3)	
Examination Index			
Systolic pressure	125.63±18.17	130.01±18.99	<0.001
Diastolic pressure	80.85±10.69	77.11±10.79	<0.001

LDL-C	2.95±0.73	3.15±0.86	<0.001
Fasting blood glucose	5.52±1.12	5.99±1.32	<0.001

Supplementary Table 3. The prevalence rates of hypertension, hypercholesterolemia and diabetes in 2008 and 2017 year based on the examination test and self-reported separately.

Disease	Survey year	Examination test			Self-reported		
		No. of cases (n)	Prevalence (%)	Stand-prevalence (%)[a]	No. of cases (n)	Prevalence (%)	Stand-prevalence (%)[a]
Hypertension	2008	2420	30.19(29.19-31.19)	22.31(21.40-23.22)	1632	20.36(19.48-21.24)	13.11(12.37-13.85)
	2017	3042	32.43(31.48-33.38)	21.4(20.57-22.23)	1728	18.42(17.64-19.20)	9.48(8.89-10.07)
Dyslipidemia	2008	451	5.63(5.13-6.13)	4.67(4.21-5.13)	488	6.09(5.57-6.61)	4.27(3.83-4.71)
	2017	1140	12.15(11.49-12.81)	10.88(10.25-11.51)	220	2.35(2.04-2.66)	1.27(1.04-1.50)
Diabetes	2008	486	6.06(5.53-6.58)	3.82(5.54-6.58)	447	5.58(5.08-6.08)	3.39(2.99-3.79)
	2017	1004	10.70(10.07-11.33)	6.02(5.54-6.50)	494	5.27(4.82-5.72)	2.43(2.12-2.74)

[a] Stand-prevalence: standardized prevalence; the prevalence rates were standardized by age and sex based on the 2010 Chinese census population.

Supplementary Table 4. The prevalence rates of hypertension, dyslipidemia and diabetes in 2008 and 2017 years stratified by age and gender based on the examination test and self-reported separately.

Disease		Examination test							
		2008				2017			
		Man		Female		Man		Female	
	Age Group	No. of cases	Prevalence (%)	No. of cases	Prevalence (%)	No. of cases	Prevalence (%)	No. of cases	Prevalence (%)
Hypertension	<29	68	18.99	8	2.45	68	14.44	4	1.1
	30-39	170	21.88	14	3.21	161	19.73	22	3.33
	40-49	392	29.45	70	10.22	219	27.55	56	10.02
	50-59	453	40.16	139	21.29	499	35.72	136	20.3
	60-69	353	46.69	125	32.38	562	46.33	233	37.64
	70+	440	53.59	188	52.22	760	60.56	322	57.71
Dyslipidemia	<29	11	3.07	4	1.23	39	8.28	8	2.19

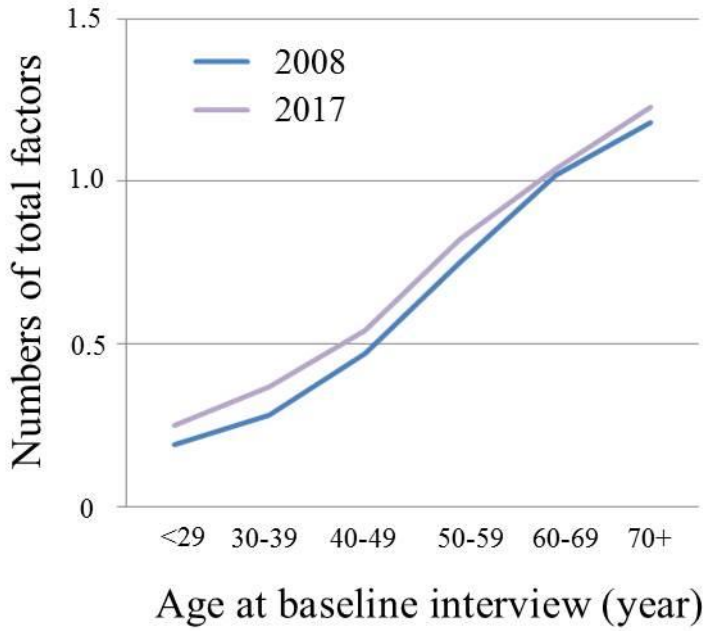
	30-39	30	3.86	7	1.61	98	12.01	35	5.3
	40-49	78	5.86	16	2.34	117	14.72	55	9.84
	50-59	57	5.05	64	9.8	196	14.03	132	19.7
	60-69	43	5.69	45	11.66	148	12.2	121	19.55
	70+	60	7.31	36	10	109	8.69	82	14.7
Diabetes	<29	0	0	0	0	3	0.64	2	0.55
	30-39	14	1.8	2	0.46	23	2.82	6	0.91
	40-49	61	4.58	11	1.61	60	7.55	20	3.58
	50-59	96	8.51	23	3.52	186	13.31	26	3.88
	60-69	105	13.89	26	6.74	235	19.37	66	10.66
	70+	103	12.55	45	12.5	295	23.51	82	14.7

Continued tables.

Disease		Self-reported							
		2008				2017			
		Man		Female		Man		Female	
	Age Group	No. of cases	Prevalence (%)	No. of cases	Prevalence (%)	No. of cases	Prevalence (%)	No. of cases	Prevalence (%)
Hypertension	<29	0	0	0	0	0	0	0	0
	30-39	33	4.25	4	0.92	9	1.1	4	0.9
	40-49	151	11.34	42	6.13	55	6.92	14	2.1
	50-59	295	26.15	115	17.61	308	22.05	71	10.6
	60-69	288	38.1	131	33.94	388	31.99	141	22.8
	70+	387	47.14	186	51.67	516	41.12	222	39.8
Dyslipidemia	<29	3	0.84	1	0.31	0	0	0	0

	30-39	18	2.32	1	0.23	0	0	0	0
	40-49	64	4.81	8	1.17	1	0.13	1	0.1
	50-59	93	8.24	39	5.97	46	3.29	12	1.7
	60-69	71	9.39	58	15.03	39	3.22	34	5.4
	70+	82	9.99	50	13.89	46	3.67	41	7.3
	<29	0	0	0	0	0	0	1	0.2
	30-39	2	0.26	1	0.23	2	0.25	1	0.1
	40-49	21	1.58	7	1.02	8	1.01	1	0.1
Diabetes									
	50-59	65	5.76	25	3.83	72	5.15	10	1.4
	60-69	94	12.43	38	9.84	123	10.14	36	5.8
	70+	135	16.44	59	16.39	183	14.58	57	10.2

Supplementary Figure 1. Average number of total cardio-metabolic risk factors by age in 2008 and 2017 years.



STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
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	4
Bias	9	Describe any efforts to address potential sources of bias	4
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4
		(*b*) Describe any methods used to examine subgroups and interactions	4
		(*c*) Explain how missing data were addressed	4
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	-
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	-
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	5
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	5
		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	5
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	7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	6
Generalisability	21	Discuss the generalisability (external validity) of the study results	7
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	8

*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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Time trend of cardio-metabolic risk factors over a 10-year period in the office-working population in China

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Secondary Subject Heading:	Epidemiology
Keywords:	Ten-year period, cardio-metabolic risk factors, office-working population

Time trend of cardio-metabolic risk factors over a 10-year period in the office-working population in China

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Yang Cheng and Hongli Yin contributed equally to this paper.

Abstract

Objectives: Recent dramatic increases in cardiovascular disease mortality in China can be mostly explained by adverse changes in hypertension, dyslipidemia, diabetes and obesity, known as cardio-metabolic risk factors. Our study aimed to assess the trend of these four signatures by a ten-year lag in Nanjing, China. **Methods:** 8017 subjects attended the routine health examination in 2008 and 9379 subjects in 2017, from multiple work units of Nanjing, were included in the present study. The prevalence and trend of four cardio-metabolic risk factors: hypertension, dyslipidemia, diabetes and obesity were analyzed. **Results:** From 2008 to 2017, the prevalence of hypertension declined, while the prevalence of dyslipidemia, diabetes and obesity increased. Besides, the population in 2008 and 2017 had an average of 0.66 and 0.78 risk factors, respectively. **Conclusion:** Cardio-metabolic risk factors are common for the staff in administrative agencies and institutions of Nanjing, China. Effective screening and interventions against these risk factors should be adopted in the high-risk population such as office-working populations in China.

Strength and limitations of this study

- We used the two independent large health check-up population with approximately 10,000 sample sizes, most of whom are office-working population to assess trends in cardiovascular risk factors over a 10-year period.
- The exposure distribution of all risk factors was estimated on the basis of original data.
- We only considered 4 factors (blood pressure, LDL, glucose and BMI), without considering any dietary factors and smoking, because of the lack of these parameters.
- The definitions of these conditions are continuously changing and may also be stratified.

Keywords: Ten-year period; cardio-metabolic risk factors; office-working population

Introduction

Cardiovascular disease (CVD) is highly prevalent and remains the predominant cause of premature mortality worldwide[1]. In China, estimated annual death due to CVD had increased to 2.7 million, which accounts for about 40% of all-cause mortality per year[2]. Obesity, diabetes, hypertension and dyslipidemia are established risk factors of CVD and contribute to the prevalence of CVD[3-8], which were also known as cardio-metabolic risk factors because of their close link with metabolic disorders, cancers and chronic respiratory diseases[9, 10].

In recently years, a substantial increase was seen in the prevalence of overweight and diabetes mellitus worldwide[11, 12], whereas the prevalence of hypertension was reported to be stable over time[13-15] and the prevalence of hypercholesterolemia remained at almost epidemic levels[16-18]. In China, with the huge economic development and changes of lifestyles including higher calorie and cholesterol intake and reduced physical activities, the frequencies and profiles of the four signatures such as obesity, diabetes, hypertension and dyslipidemia have changed even more dramatically. Given the ongoing deterioration of these cardio-metabolic risk factors in China, which may greatly contribute to the surge of CVD, more understanding to these factors may be quite important. However, to data, little was known about the time trend of these cardio-metabolic risk factors in China.

The present study aims to investigate the long-term trends of cardio-metabolic risk factors in office-working population in China by a 10-year lag from 2008 and 2017, using a large health administrative database in Jiangsu, China. The office-working population has shown to be “high risk group” for metabolic diseases [19] due to their life styles, as most of them perform their daily work mainly in the office with low amount of physical activity.

Methods

Participants

This was an observational study using the health check-up data from the health manage center in Geriatric Hospital of Nanjing Medical University (Nanjing, China). Subjects included in the study came from dozens of work units including government offices, scientific research

institutions, banks and so on in the major urban districts of Nanjing, which is the capital of Jiangsu Province and located in the east of China. Most of them perform their daily work mainly in the office with low amount of physical activity. And also we included both currently employed and retired individuals in our study. Totally, 9665 subjects in 2008 and 15200 subjects in 2017 who taking a routine annual health check-up in the health manage center were included, including a medical examination, anthropometric measurements, and information on medical history. There was no difference in the design and recruitment between 2008 and 2017.

After excluding those participants with missing data on height (n=450), systolic pressure (n=29), low-density lipoprotein cholesterol (LDL-C) (n=938) or information of prior history of hypertension, dyslipidemia and diabetes (n=231), 8017 individuals were eligible for analysis as baseline in 2008. Similarly, a population of 9379 individuals was remained for analysis in 2017 after excluding those who under 18 years old (n=21), or with missing data on height (n=1476), systolic pressure (n=128), blood glucose (n=312), LDL-C (n=3001) or information of prior history of hypertension, dyslipidemia and diabetes (n=883). The study was approved by the Ethics Committee of Geriatric Hospital of Nanjing Medical University. Written informed consent was obtained from all participants.

Clinical assessment

Demographic characteristics including age and sex were collected from all participants by trained nurses. Personal medical histories, including hypertension, diabetes and dyslipidemia, were reported by all participants. Body weight, height and blood pressure were measured using standard instruments and protocols by trained staff [20]. Body mass index (BMI) was calculated as weight in kilograms divided by the height in meters squared. Low-density lipoprotein cholesterol (LDL-C) and fasting plasma glucose (FPG) measured during an overnight fast of more than 11 hours. We defined the four signature for cardio-metabolic as the following, same in both 2008 and 2017(also see **Supplementary Table 1**): 1)Obesity: BMI≥28 kg/m^2[21-23]; 2)Hypertension: Blood pressure≥140/90 mm Hg and/or self-reported history of hypertension[24]; 3) Dyslipidemia: LDL-C ≥4.14 mmol/L and/or self-reported dyslipidemia[25]; 4)Diabetes: FPG≥7.0 mmol/L and/or self-reported diabetes [26].

Statistical analysis

Comparisons between different years were conducted using Student's T-test for continuous variables and Chi-squared test for categorical variables. Comparison between prevalence data of 2008 and 2017 was performed on the basis of standardized mortality rate (SMR) calculations and by applying the indirect standardization technique, using reference-specific prevalent rates of hypertension, dyslipidemia and diabetes by age and gender using the population composition from the Chinese census population (aged from 19 to 96 years) [27]. Data analyses were carried out by R software (Version 3.0.2, 2013-09-25; R Foundation for Statistical Computing, http://www.cran.r-project.org/). The significance level was set at $P< 0.05$ and P values were given for two-sided tests.

Patient and public involvement

The participants of this study represent a large office-working population in China. They were not involved neither in the study design, nor in the conduct of the study. However, they were informed that their physical examination data (including blood pressure, cholesterol levels, blood glucose, etc) and baseline information may be in scientific study. And all scientific study results are continuously communicated to the participants by phone.

Results

The characteristics of the study population were shown in **Supplementary Table 2**. A total of 8017 and 9397 subjects were included in the analysis in 2008 and 2017. There was no significant difference in the distribution of sex. Compared to those of 2008, the percentage of older (age≥60), overweight and obese subjects increased by 9.89%, 2.42% and 3.26% separately in 2017. In addition, in 2017, more subjects had the history of the three medical conditions (systolic blood pressure, LDL-C and blood glucose).

The crude prevalence of hypertension, dyslipidemia, diabetes and obesity were all increased over the study period, from 37.87, 10.84, 8.57% and 9.04% in 2008 to 39.14, 14.20, 12.17% and 12.30% in 2017 (**Table 1)**. As expected, a significant increase was confirmed for dyslipidemia, diabetes and obesity in 2017 even standardized by age and sex (dyslipidemia:

8.25% in 2008 and 11.95% in 2017, *P*<0.001; diabetes: 5.40% in 2008 and 6.68% in 2017, *P*<0.001; obesity: 7.44% in 2008 and 11.33% in 2017, *P*<0.001, **Table 1**). Interestingly, we found that after standardized by age and sex, the trend for hypertension was reversed with a slight decline in 2017 from 27.51% (26.53%-28.49%) to 25.16% (24.28%-26.04%). When subjects were stratified by age, a constant downward trend of hypertension was identified among subjects younger than 70 years old from 2008 to 2017 (**Figure 1A**). The prevalent rates for dyslipidemia, diabetes and obesity were higher in 2017 in each age subgroups (**Figure 1B-D**). Especially, the prevalence of obesity in younger groups in 2017 were dramatically increased as compared to those in 2008 (**Figure 1D**). In contrast, the overall prevalence for the four signatures were similar when stratified by gender (**Figure 2A and B**) or for patients identified by examination or self-reported alone (**Supplementary Table 3**).

Changes in the four signatures stratified by gender among different age groups were further analyzed and presented in Figure 3. It shows the prevalence for male or women population was similar in 2008 and 2017 respectively for all but dyslipidemia and obesity (**Figure 3**). Similar results were seen for patients identified by examination or self-reported alone (**Supplementary Table 4**).

The distribution and numbers of cardio-metabolic risk factors for 2008 and 2017 are shown in **Table 2**. We found that 47.46%, 15.14% and 3.32% of the subjects had ≥1, ≥2 and ≥3 risk factors in 2008. In contrast, there was a gain in the percentage of risk factors in 2017 with 54.00%, 19.70% and 3.75%, respectively. The average numbers of cardio-metabolic risk factors in 2008 and 2017 were 0.66 and 0.78 (*P*<0.001), respectively. And the number of cardio-metabolic risk factors significantly increased with age (**Supplementary Figure 1**).

Discussions

To our knowledge, only a few previous studies have estimated cardio-metabolic risk factors and future CVD burden in China before 2010[28, 29]. In the present study, we examined the prevalence of hypertension, dyslipidemia and diabetes and the potential impact by a ten-year lag in Nanjing, China, in office-working populations.

In the past 10 years, the percentage of overweight and obesity showed an upward trend, which is consistent with the results from 2010 China Chronic Disease Monitoring

Program[30]. The worldwide ranking of obese populations of China has moved to the second in 2014[31]. During the last decades, Chinese have become more sedentary, especially for working population in the agency or retired from the agency, who always maintained the state at work [32].

Hypertension was reported to the most prominent cardio-metabolic risk factors among Chinese [33, 34]. From 1988 to 2008, there was an increasing trend of hypertension prevalence in Americans aged 40 years and older [35]; however, the prevalence of hypertension in Japan[36], Germany[37], Italy[38] and Korea[39] decreased. In our study, we found a significant decline in the prevalence trend for hypertension among Chinese adults in 2017 compared with 2008. As we all known, higher socioeconomic status could positively improve the awareness and control of hypertension, and people would also have a better compliance of medicine treatment. According to a survey in 13 provinces from 2009 to 2010, among 50,171 subjects aged at least 18 years, the awareness, treatment, and control rates as well as the treatment–control rate of hypertension were 42.6, 34.1, 9.3,and 27.4%, respectively, also higher than those in 2002 (30.2,24.7, 6.1, and 25.0%, respectively)[40].

High blood LDL cholesterol was the second leading risk factor for CVD. In agreement with previous Swiss[41], French[42] and German[43] studies, the prevalence of hypercholesterolemia increased significantly between 2008 and 2017. Diabetes is a growing epidemic in China, occurring at a relatively young age[44]. In the 1980s, diabetes was rare in China, with an estimated prevalence of 0.67%. In subsequent national surveys conducted in 1994[45], 2000 to 2001[46], 2007 to 2008[47], and 2010 to 2011[48], the prevalence was 2.5%, 5.5%, 9.7% and 11.6%, respectively. In this study, we found that the crude prevalence increased from 8.57% in 2008 to 12.17% in 2017. Those data imply that CVD events associated with high LDL and glucose will continue to increase in the further.

The main strength of this study was the use of the two independent large health check-up population with approximately 10,000 sample size. All measurements and data were collected with standardized methods over time. Secondly, the exposure distribution of all risk factors was estimated on the basis of original data. The original data-based estimation allowed us to account for potential residual confounding, although it could not be completely eliminated.

The findings in the present study are subject to several limitations. First, we only

considered 4 factors (blood pressure, LDL, glucose and BMI), without considering any dietary factors and smoking, because of the lack of these parameters. Secondly, this study was carried out in cohorts only comprises Chinese individuals from office-working units in Nanjing. Our results may not be generalizable to the entire populations. More studies are expected to confirm our finding.

In conclusion, high blood pressure remains the leading factor among cardio-metabolic risk factors in China, although a slight downward trend of this condition was observed from 2008 to 2017 after standardized by age and sex. However, significant increases dyslipidemia, diabetes and obesity in 2017 were confirmed in the present study. More intensive screening and treatment regimens are needed for patients with these conditions, in order to curb the cardiovascular endpoints expected in the near future.

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Contributors

YC completed the analyses and led the writing. ZX-S and LB-G initiated, conceived and supervised the study. SC guided the analysis and modified the article. HL-Y assisted with the study and analyses. HZ participated in the data collation. XH-L and GY managed the physical examination. LK-Z and HD participated in the implementation of physical examination. SP-Y and DH-Y checked the results of physical examination.

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Competing interests No potential conflicts of interest relevant to this article were reported.

Patient consent Not required.

Ethics approval The study was approved by the Ethics Committee of Geriatric Hospital of Nanjing Medical University.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement All available data are included in this manuscript.

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Table 1. The prevalence rates of hypertension, dyslipidemia, diabetes and obesity in 2008 and 2017 year based on the examination test and self-reported.

Disease	Survey year	No. of subjects	No. of cases	Prevalence (95%CI) (%)	Standard prevalence (95%CI)(%)[a]	*P* value [b]
Hypertension	2008	8017	3036	37.87(36.81-38.93)	27.51(26.53-28.49)	<0.001
	2017	9379	3671	39.14(38.15-40.13)	25.16(24.28-26.04)	
Dyslipidemia	2008	8017	869	10.84(10.16-11.52)	8.25(7.65-8.85)	<0.001
	2017	9379	1332	14.2(13.49-14.91)	11.95(11.29-12.61)	
Diabetes	2008	8017	687	8.57(7.96-9.18)	5.40(4.91-5.89)	<0.001
	2017	9379	1141	12.17(11.51-12.83)	6.68(6.17-7.19)	
Obesity	2008	8017	725	9.04(8.41-9.67)	7.44(6.87-8.01)	<0.001
	2017	9379	1154	12.3(11.64-12.96)	11.33(10.69-11.97)	

[a] Standardized prevalence; the prevalence rates were standardized by age and sex based on the 2010 Chinese census population.

[b] *P* value for standard prevalence between 2008 and 2017.

Table 2. Details of the cardio-metabolic risk factors among the check-up Chinese subjects in 2008 and 2017 years.

Cardio-metabolic risk factors	2008 (8017)		2017 (9379)		P
	N	%	N	%	
Obesity					
BMI≥28kg/m^2	725	9.04	1154	12.3	<0.001
Hypertension	3036	37.87	3671	39.14	0.09
Dyslipidemia	869	10.84	1332	14.2	<0.001
Diabetes	687	8.57	1141	12.17	<0.001
Cardio-metabolic risk factors					
≥ 1 risk factor	3805	47.46	5065	54	<0.001
≥ 2 risk factor	1214	15.14	1848	19.7	<0.001
≥ 3 risk factor	266	3.32	352	3.75	0.13

Figure legends

Figure 1. Age-specific prevalence in (A) hypertension, (B) dyslipidemia, (C) diabetes and (D) obesity in 2008 and 2017.

Figure 2. The age-standardized prevalence rates of the three cardiovascular disease factors in males (A) and females (B) in 2008 and 2017.

Figure 3. Age-specific prevalence among males and females in (A) hypertension, (B) dyslipidemia, (C) diabetes and (D) obesity in 2008 and 2017.

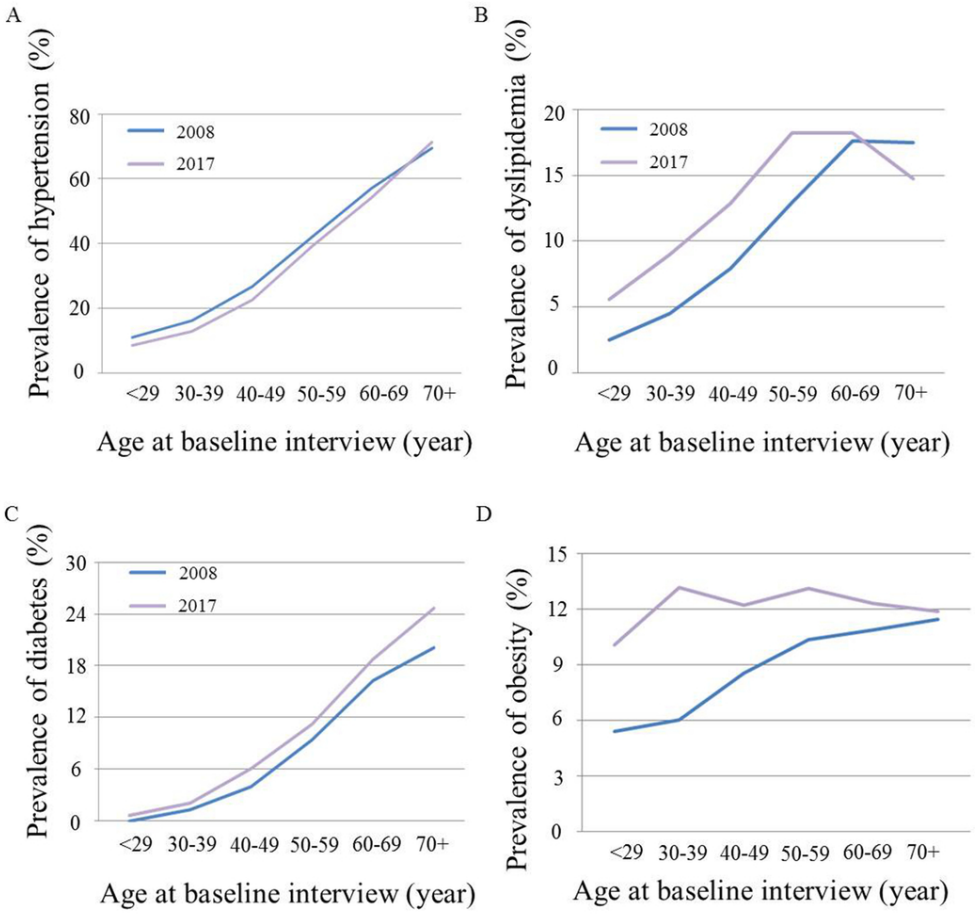

Figure 1. Age-specific prevalence in (A) hypertension, (B) dyslipidemia, (C) diabetes and (D) obesity in 2008 and 2017.

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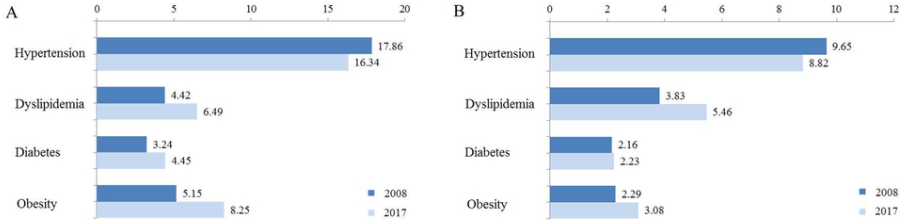

Figure 2. The age-standardized prevalence rates of the three cardiovascular disease factors in males (A) and females (B) in 2008 and 2017.

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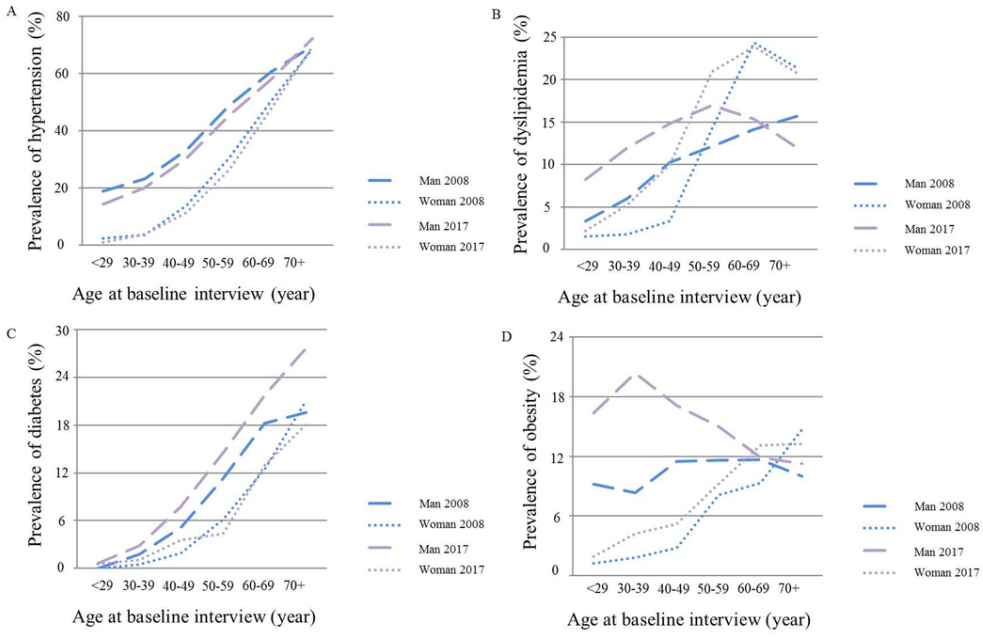


Figure 3. Age-specific prevalence among males and females in (A) hypertension, (B) dyslipidemia, (C) diabetes and (D) obesity in 2008 and 2017.

90x69mm (300 x 300 DPI)

Supplementary Table 1. The definitions of the four cardio-metabolic risk factors of the study.

Cardio-metabolic risk factors	**Definition**
Obesity	BMI≥28kg/m^2
Hypertension	Blood pressure ≥ 140/90mmHg and/or self-reported disease
Dyslipidemia	LDL-C ≥ 4.14 mmol/L and/or self-reported disease
Diabetes	Fasting PG ≥ 7.0 mmol/L and/or self-reported disease

Supplementary Table 2. Clinical and laboratory characteristics of participants.

Variable	Survey Year		*P*
	2008 (n, %)	2017 (n, %)	
All	8017	9379	
Sex			
Man	5171(64.5)	5947(63.41)	0.14
Women	2846(35.5)	3432(36.59)	
Age	51.08±15.14	53.69±16.77	<0.001
<30	684(8.53)	836(8.91)	
30-40	1213(15.13)	1477(15.75)	
40-50	2016(25.15)	1354(14.44)	<0.001
50-60	1781(22.22)	2067(22.04)	
60-70	1142(14.24)	1832(19.53)	
70+	1181(14.73)	1813(19.33)	
BMI			
Thin (<18.5)	280(3.49)	229(2.44)	
Normal (18.5-24)	3948(49.25)	4184(44.61)	<0.001
Overweight (24-28)	3064(38.22)	3812(40.64)	
Obese (≥28)	725(9.04)	1154(12.3)	
Examination Index			
Systolic pressure	125.63±18.17	130.01±18.99	<0.001
Diastolic pressure	80.85±10.69	77.11±10.79	<0.001

LDL-C	2.95±0.73	3.15±0.86	<0.001
Fasting blood glucose	5.52±1.12	5.99±1.32	<0.001

Supplementary Table 3. The prevalence rates of hypertension, hypercholesterolemia and diabetes in 2008 and 2017 year based on the examination test and self-reported separately.

Disease	Survey year	Examination test			Self-reported		
		No. of cases (n)	Prevalence (%)	Stand-prevalence (%)[a]	No. of cases (n)	Prevalence (%)	Stand-prevalence (%)[a]
Hypertension	2008	2420	30.19(29.19-31.19)	22.31(21.40-23.22)	1632	20.36(19.48-21.24)	13.11(12.37-13.85)
	2017	3042	32.43(31.48-33.38)	21.4(20.57-22.23)	1728	18.42(17.64-19.20)	9.48(8.89-10.07)
Dyslipidemia	2008	451	5.63(5.13-6.13)	4.67(4.21-5.13)	488	6.09(5.57-6.61)	4.27(3.83-4.71)
	2017	1140	12.15(11.49-12.81)	10.88(10.25-11.51)	220	2.35(2.04-2.66)	1.27(1.04-1.50)
Diabetes	2008	486	6.06(5.53-6.58)	3.82(5.54-6.58)	447	5.58(5.08-6.08)	3.39(2.99-3.79)
	2017	1004	10.70(10.07-11.33)	6.02(5.54-6.50)	494	5.27(4.82-5.72)	2.43(2.12-2.74)

[a] Stand-prevalence: standardized prevalence; the prevalence rates were standardized by age and sex based on the 2010 Chinese census population.

Supplementary Table 4. The prevalence rates of hypertension, dyslipidemia and diabetes in 2008 and 2017 years stratified by age and gender based on the examination test and self-reported separately.

Disease		Examination test							
		2008				2017			
		Man		Female		Man		Female	
	Age Group	No. of cases	Prevalence (%)	No. of cases	Prevalence (%)	No. of cases	Prevalence (%)	No. of cases	Prevalence (%)
Hypertension	<29	68	18.99	8	2.45	68	14.44	4	1.1
	30-39	170	21.88	14	3.21	161	19.73	22	3.33
	40-49	392	29.45	70	10.22	219	27.55	56	10.02
	50-59	453	40.16	139	21.29	499	35.72	136	20.3
	60-69	353	46.69	125	32.38	562	46.33	233	37.64
	70+	440	53.59	188	52.22	760	60.56	322	57.71
Dyslipidemia	<29	11	3.07	4	1.23	39	8.28	8	2.19

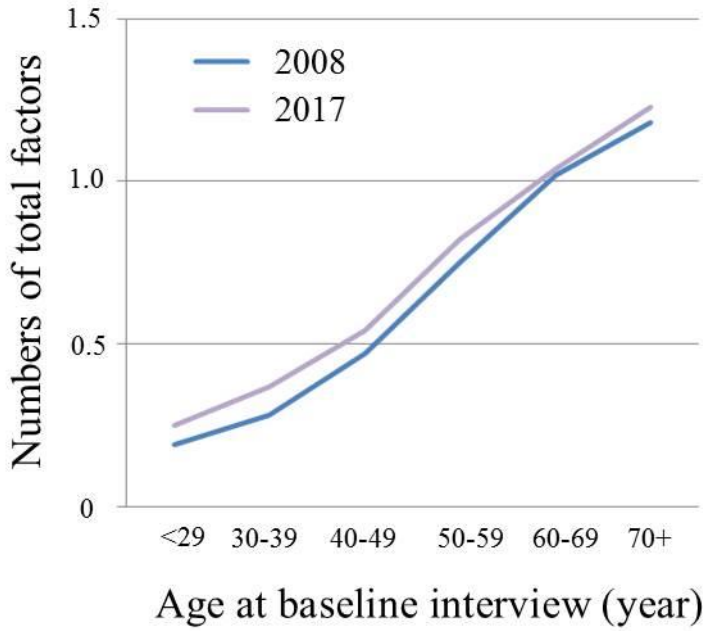
	30-39	30	3.86	7	1.61	98	12.01	35	5.3
	40-49	78	5.86	16	2.34	117	14.72	55	9.84
	50-59	57	5.05	64	9.8	196	14.03	132	19.7
	60-69	43	5.69	45	11.66	148	12.2	121	19.55
	70+	60	7.31	36	10	109	8.69	82	14.7
Diabetes	<29	0	0	0	0	3	0.64	2	0.55
	30-39	14	1.8	2	0.46	23	2.82	6	0.91
	40-49	61	4.58	11	1.61	60	7.55	20	3.58
	50-59	96	8.51	23	3.52	186	13.31	26	3.88
	60-69	105	13.89	26	6.74	235	19.37	66	10.66
	70+	103	12.55	45	12.5	295	23.51	82	14.7

Continued tables.

Disease	Age Group	Self-reported							
		2008				2017			
		Man		Female		Man		Female	
		No. of cases	Prevalence (%)	No. of cases	Prevalence (%)	No. of cases	Prevalence (%)	No. of cases	Prevalence (%)
Hypertension	<29	0	0	0	0	0	0	0	0
	30-39	33	4.25	4	0.92	9	1.1	4	0.9
	40-49	151	11.34	42	6.13	55	6.92	14	2.1
	50-59	295	26.15	115	17.61	308	22.05	71	10.6
	60-69	288	38.1	131	33.94	388	31.99	141	22.8
	70+	387	47.14	186	51.67	516	41.12	222	39.8
Dyslipidemia	<29	3	0.84	1	0.31	0	0	0	0

	30-39	18	2.32	1	0.23	0	0	0	0
	40-49	64	4.81	8	1.17	1	0.13	1	0.1
	50-59	93	8.24	39	5.97	46	3.29	12	1.7
	60-69	71	9.39	58	15.03	39	3.22	34	5.4
	70+	82	9.99	50	13.89	46	3.67	41	7.3
	<29	0	0	0	0	0	0	1	0.2
	30-39	2	0.26	1	0.23	2	0.25	1	0.1
	40-49	21	1.58	7	1.02	8	1.01	1	0.1
Diabetes									
	50-59	65	5.76	25	3.83	72	5.15	10	1.4
	60-69	94	12.43	38	9.84	123	10.14	36	5.8
	70+	135	16.44	59	16.39	183	14.58	57	10.2

Supplementary Figure 1. Average number of total cardio-metabolic risk factors by age in 2008 and 2017 years.



STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
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	4
Bias	9	Describe any efforts to address potential sources of bias	4
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	4
		(*b*) Describe any methods used to examine subgroups and interactions	4
		(*c*) Explain how missing data were addressed	4
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	-
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	-
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	5
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	5
		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	5
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	7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	6
Generalisability	21	Discuss the generalisability (external validity) of the study results	7
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	8

*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.