Original Article

Risk factors for cardiovascular disease from a population-based screening study in Tianjin, China: a cohort study of 36,215 residents

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Background: Cardiovascular disease (CVD) is a harmful disease that poses a serious threat to human life. By effectively controlling its risk factors, the occurrence and development of CVD can be reduced, and people's health status and quality of life can be improved.

Methods: A total of 36,215 participants were collected from participants of the Early Screening and Comprehensive Intervention Program for High Risk Population of Cardiovascular Disease in Tianjin on July 31, 2017. We analyzed the relationship between CVD risk and personal information, personal and family medical history, biochemical index, and physical fitness index using Pearson's chi-squared test with and without Yates's correction for continuity, and Fisher's exact test. CVD risk-related factors were examined through logistic regression and decision tree analysis.

Results: A personal history of hypertension and apoplexy had a contingency coefficient with CVD risk of more than 0.3. A higher risk of CVD was also found to be associated with biochemical markers of cholesterol, low-density lipoprotein cholesterol, and blood sugar. Logistic regression analysis revealed 12 indicators to be influencing factors of CVD, including age, systolic blood pressure (SBP), diastolic blood pressure (DBP), and the number of people aged >90 in the family. Hypertension, SBP, BMI, cholesterol, and blood glucose were associated with five or more other indicators.

Conclusions: The prevalence of CVD risk factors in Tianjin residents is relatively high. Family disease history and individual physical fitness indicators need to be taken into account during CVD screening and intervention, to reduce the risk of CVD.

Keywords: Cardiovascular diseases (CVDs); risk factor; family disease history; physical indicators

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Introduction

Cardiovascular disease (CVD), sometimes called the "silent disease", is an ischemic or hemorrhagic disorder of the heart and systemic tissues (1). CVD is caused by bloody lesions and, with no obvious clinical symptoms, is characterized by the secretive, progressive, and systemic manner in which it inflicts damage on the body. CVD is one of the most serious threats to human health worldwide today, especially for middle-aged and older people over the age of 50 (2-5), and its morbidity and mortality have surpassed those of cancer. By 2030, nearly 23.6 million people will die of CVD every year, with only heart disease and stroke causing more fatalities (5).

In China, there are currently 290 million patients with CVD, but with the influence of population increase and aging, the number of patients with CVD is expected to increase by more than 50% by 2030 (6). In recent years, CVD has accounted for 40% of deaths in China, with about 2.6 million people dying from CVD each year (7). This has seen CVD claim its place as the top cause of death and top threat to health in China. Furthermore, the average age of onset of CVD shows a downward trend (8), with more people developing the disease at a younger age. The high incidence of CVD and its impact on quality of life have brought a heavy economic and psychological burden to society, families, and the individuals who suffer with the disease (9).

CVDs include a range of conditions, such as coronary heart disease (heart attack), cerebrovascular disease (stroke), peripheral vascular disease, rheumatic heart disease, and cardiomyopathy. The majority (80%) of patients with CVD are died from heart disease and strokes. The occurrence of CVD is the result of long-term interaction between various adverse factors. Hypertension, diabetes, dyslipidemia, smoking, and obesity are currently recognized as the five major risk factors for CVD (10-12). Related studies have shown that the above-mentioned CVD risk factors have increased in recent decades among the Chinese population, and the accumulation of multiple risk factors is more likely to increase the risk of CVD (13,14). There is evidence that shows that the prevention of risk factors and early screening and diagnosis can greatly reduce the morbidity and mortality of CVD (15).

This study set out to establish a better understanding of CVD risk factors among residents of Tianjin, China, and to provide new insight into the prevention of CVD. This will enable us to effectively control the risk factors of CVD and reduce occurrence and development of the disease in the future.

Methods

Data sources

The data were collected from participants of the Early Screening and Comprehensive Intervention Program for High Risk Population of Cardiovascular Disease in Tianjin on July 31, 2017. A total of 36,215 participants were recruited including 25,494 classified as non-high risk and 10,721 classified as high risk. The criteria for assessing high-risk CVD were CVD history, hypertension, dyslipidemia, WHO risk assessment, and a risk of ≥20% in special subjects.

Data analysis

The information of each participant included personal information, personal and family medical history, biochemical indicators and physical indicators. Personal information included age (one level every five years), gender, ethnicity, household registration, marital status, education, family income, recent smoking status, and drinking status in the past year. Personal medical history took into account hypertension, diabetes, myocardial infarction, stroke, chronic obstructive pulmonary disease, dyslipidemia, bypass surgery, or percutaneous coronary intervention. Family medical history referred to: the number of people in the participant's family aged >90; the number of family members who had died of myocardial infarction, stroke, cancer, or sudden death; and family members who had received heart bypass surgery, stent implantation, valve replacement, radiofrequency ablation, implantation of automatic defibrillator, heart transplantation, or surgery for congenital heart disease. Biochemical indicators contain cholesterol, low density lipoprotein cholesterol (LDL-C), high density lipoprotein cholesterol (HDL-C), blood glucose, triglyceride, proteinuria, ketone bodies, and occult blood. Physical indicators included body mass index (BMI), heart rate, systolic blood pressure (SBP), diastolic blood pressure (DBP), and waist circumference.

Statistical analysis

According to the data type, Pearson's chi-squared test, with and without Yates's continuity correction, and Fisher's

exact test were used to analyze the relationship between personal information, personal and family medical history, biochemical and physical indicators, and the relationship between CVD risk and these indicators. The correlation between the indicators was expressed using the number of column connections, and the hierarchical data of two independent samples were analyzed using the Mann-Whitney test.

Logistic regression analysis was conducted to explore related indicators in four categories: personal information, family medical history, biochemical indicators, and physical indicators. Variables were screened using a conditional parameter estimation likelihood ratio test, with an inclusion criterion of P<0.05 and a rejection criterion of P>0.1.

All analyses were performed using SPSS 21.0 (IBM Corporation, America) and R 3.4.4 (the Institute for Statistics and Mathematics of WU, Austria). The network map was drawn using Cytoscape. Statistical significance was considered to exist when P<0.05.

Results

Personal information

There were significant differences found in age, gender, marital status, education level, household income, and smoking and drinking habits between the non-high-risk group and high-risk group (P<0.001), and all the contingency coefficients were within 0.1 [except for age (0.262)], which indicated a certain relationship between these factors and CVD (*Table 1*). There were no significant differences between ethnicity or household registration and CVD risk (*Table 1*).

Personal and family medical history

With the exception of chronic obstructive pulmonary disease, all other personal medical history indicators were associated with CVD risk, and had significant difference (P<0.001). Among these indicators, hypertension or stroke had a contingency coefficient with CVD risk of more than 0.3 (*Table 2*). For diabetes, myocardial infarction, dyslipidemia, and percutaneous coronary intervention the contingency coefficient with CVD risk reached 0.15–0.30 (*Table 2*). Patients whose relatives who had undergone heart transplant and valve replacement surgery were also associated with CVD risk. Of the other family-related indicators, the number of relatives aged >90 (*Figure 1A*), and relatives with myocardial infarction, stroke, and

Table 1 The relationship between cardiovascular disease (CVD) risk and personal information

Indicators	Group	No. of non-high risk of CVD	No. of high risk of CVD	Statistics	P value	Contingency coefficient	P value
Age	Age (per 5 years)	25,598	10,617	−51.452	<0.001	0.262	<0.001
Gender	Men	9,531	4,532	90.506	<0.001	0.05	<0.001
	Women	16,005	6,085				
Ethnic group	Han	24,512	10,137	3.603	0.058	0.01	0.054
	Non-Han	943	437				
Hukou status	Agriculture	6,652	2,740	0.224	0.636	0.003	0.627
	Non-agriculture	18,870	7,873				
Marital status	Married	23,426	9,637	14.168	<0.001	0.02	<0.001
	Widowed, separated, divorced, or single	1,991	957				
Education level	Primary school or lower	4,454	2,581	−17.402	<0.001	0.095	<0.001
	Middle school	10,653	4,532				
	High school	6,737	2,492				
	College or above	3,509	993				

Table 1 (*continued*)

Table 1 (*continued*)

Indicators	Group	No. of non-high risk of CVD	No. of high risk of CVD	Statistics	P value	Contingency coefficient	P value
Household income (¥/year)	<10,000	2,015	1,040	−8.33	<0.001	0.064	<0.001
	10,000–25,000	6,770	3,241				
	25,001–50,000	8,367	3,093				
	50,001–100,000	6,242	2,622				
	100,001–200,000	801	211				
	>200,000	56	15				
Current smoking situation	No smoking	19,901	7,856	−8.574	<0.001	0.051	<0.001
	Occasional smoking	519	174				
	Smoking most of the time	137	52				
	Smoking every day	4,944	2,527				
Drinking in the past year	Never	18,947	7,435	−9.715	<0.001	0.068	<0.001
	<1 time a month	1,801	748				
	2–4 times a month	1,388	540				
	2–3 times a week	962	411				
	>4 times a week	2,326	1,450				

Table 2 The relationship between cardiovascular disease (CVD) risk and personal disease history

Indicators	Group	No. of non-high risk of CVD	No. of high risk of CVD	Statistics	P value	Contingency coefficient	P value
Hypertension	No	19,475	4,603	3,660.366	<0.001	0.318	<0.001
	yes	6,042	6,011				
Diabetes	No	23,193	8,456	868.030	<0.001	0.155	<0.001
	yes	2,324	2,158				
Myocardial infarction	No	25,514	10,100	1,236.898	<0.001	0.185	<0.001
	yes	3	514				
Apoplexy	No	25,510	9,151	3,630.856	<0.001	0.317	<0.001
	yes	7	1,463				
Chronic obstructive pulmonary disease	No	25,483	10,595	0.782	0.376	0.005	0.301
	yes	34	19				
Dyslipidemia	No	24,468	9,498	544.511	<0.001	0.123	<0.001
	yes	1,049	1,116				
Bypass surgery	No	25,516	10,505	255.113	<0.001	0.085	<0.001
	yes	1	109				
Percutaneous coronary intervention	No	25,514	10,046	1,370.671	<0.001	0.195	<0.001
	yes	3	568				

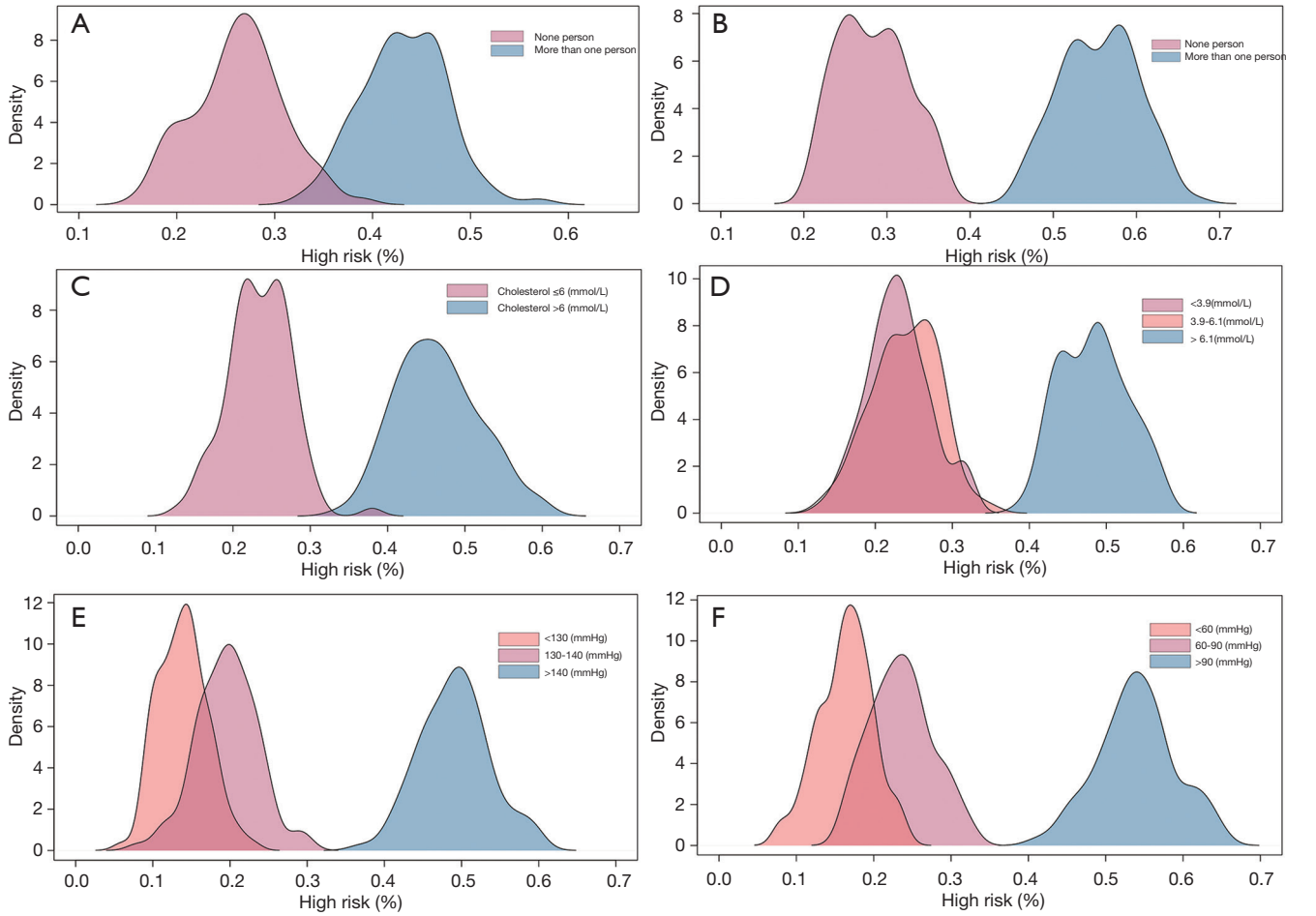

Figure 1 Density plots of high risk of CVD in all participants. Data are shown stratified by the number of family members over 90 years of age (A), the number of relatives with myocardial infarction (B), cholesterol (C), blood glucose (D), systolic blood pressure (E) and diastolic blood pressure (F). The density means estimated probability risk of CVD. The area under the curve is 1.

cancer, were associated with CVD risk with contingency coefficients higher than 0.15 (*Table 3*).

Biochemical index and physical fitness index

All the biochemical indicators apart from ketone bodies were significantly associated with CVD risk (*Figure 1B*). The contingency coefficient of cholesterol (*Figure 1C*), LDL-C, and blood glucose (*Figure 1D*) and the risk of CVD reached more than 0.2 (*Table 4*). The contingency coefficient between other indicators and CVD risk were low, but there were significant differences between the high-risk and non-high-risk groups (P<0.001). Among the physical indicators, the contingency coefficient of SBP and DBP and CVD risk in the high-risk and non-high-risk groups were 0.339 and 0.257, respectively, and the P value was less than 0.001 (*Table 4*, *Figure 1E,F*). There were meaningful differences in BMI, waist, and heart rate between the high-risk and non-high-risk groups, but the contingency coefficient with CVD risk was not high (*Table 4*).

Multi-factor logistic regression analysis

Our logistic regression model comprised 12 indicators with a predictive power of 78.6%. According to the results of regression analysis, the risk of CVD increased by 0.296 for every 5-year increase in age. Compared with patients with SBP >140 mmHg, the risk of CVD was only 0.344 and 0.310 in patients with SBP <130 and 130–140 mmHg, respectively. Compared with subjects with DBP >90 mmHg,

Table 3 The relationship between cardiovascular disease (CVD) risk and disease history of relatives

Indicators	Group	No. of non-high risk of CVD	No. of high risk of CVD	Statistics	P value	Contingency coefficient	P value
No. of relatives over 90 years old	0	21,402	7,647	−30.822	<0.001	0.292	<0.001
	1	3,897	1,565				
	2	1	1,091				
	Above 2	0	246				
The no. of myocardial infarction	0	24,829	9,776	−22.624	<0.001	0.148	<0.001
	1	631	538				
	2	1	226				
	Above 2	0	32				
The no. of apoplexy	0	24,421	9,352	−27.309	<0.001	0.187	<0.001
	1	1,037	780				
	2	4	378				
	Above 2	0	68				
The no. of cancer	0	23,883	9,431	−15.889	<0.001	0.155	<0.001
	1	1,571	800				
	2	2	278				
	Above 2	0	68				
The no. of sudden death	0	25,203	10,354	−8.686	<0.001	0.06	<0.001
	1	244	182				
	Two or more	1	40				
The no. of heart bypass surgery	0	25,355	10,337	−16.018	<0.001	0.089	<0.001
	1	135	209				
	Two or more	0	51				
The no. of stent implantation	0	25,174	10,143	−18.39	<0.001	0.105	<0.001
	1	314	383				
	Two or more	0	72				
The no. of valve replacement	0	25,431	10,562	1.175	0.278	0.006	0.229
	One or more	55	30				
The no. of radiofrequency ablation	0	25,467	10,575	4.530	0.033	0.012	0.021
	One or more	21	18				
The no. of embedded automatic defibrillator	0	25,477	10,582	6.149	0.013	0.014	0.006
	One or more	8	11				
The no. of heart transplant	0	25,485	10,588	–	0.065	0.011	0.045
	One or more	2	4				
The no. of surgery for congenital heart disease	0	25,462	10,570	4.757	0.029	0.012	0.019
	One or more	24	20				

Table 4 The relationship between cardiovascular disease (CVD) risk and biochemical index

Indicators	Group	No. of non-high risk of CVD	No. of high risk of CVD	Statistics	P value	Contingency coefficient	P value
Biochemical index							
Cholesterol (mmol/L)	<2.9	5	7	−41.953	<0.001	0.222	<0.001
	2.9-6	20,553	6,292				
	>6	4,958	4,314				
Low density lipoprotein cholesterol (mmol/L)	<2.1	11,216	3,172	−33.697	<0.001	0.219	<0.001
	2.1-3.1	11,448	5,209				
	>3.1	1,197	1,727				
High density lipoprotein cholesterol (mmol/L)	<1.14	2,518	1,221	−7.895	<0.001	0.042	<0.001
	1.14–1.76	16,333	7,011				
	>1.76	6,576	2,358				
Blood sugar (mmol/L)	<3.9	85	24	−42.989	<0.001	0.227	<0.001
	3.9-6.1	21,239	6,632				
	>6.1	4,176	3,944				
Triglyceride	<0.56	703	170	−16.372	<0.001	0.086	<0.001
	0.56–1.7	5,644	1,639				
	>1.7	19,063	8,773				
Urine protein	+	956	836	271.551	<0.001	0.087	<0.001
	−	24,469	9,736				
Ketone bodies	+	272	114	0.005	0.943	<0.001	0.943
	−	25,147	10,456				
Occult blood	+	3,659	1,608	3.988	0.046	0.011	0.046
	−	21,758	8,962				
Physical fitness index							
BMI (kg/m^2)	<18.5	259	45	−25.796	<0.001	0.136	<0.001
	18.5–24	7,874	2,117				
	24–28	11,189	4,739				
	>28	6,195	3,712				
Heart rate (beats per minute)	<60	1,187	617	−0.021	0.983	0.049	<0.001
	60–100	23,977	9,722				
	>100	353	275				
Systolic pressure (mmHg)	<130	12,221	1,994	−65.485	<0.001	0.339	<0.001
	130–140	5,343	1,297				
	>140	7,635	7,297				
Diastolic pressure (mmHg)	<60	441	84	−49.878	<0.001	0.257	<0.001
	60–90	21,721	6,664				
	>90	3,355	3,866				
Waist (cm)	<87.15	13,818	3,887	921.849	<0.001	0.16	<0.001
	>87.15	11,699	6,727				

Table 5 Multi-factor Logistic regression for cardiovascular disease (CVD) risk

Indicators	B	S. E.	Wald	P value	Exp (B)
Age	0.260	0.008	946.423	<0.001	1.297
Systolic pressure (mmHg)					
>140	–	–	1054.645	<0.001	–
<130	–1.068	0.040	719.093	<0.001	0.344
130–140	–1.141	0.043	694.265	<0.001	0.319
Diastolic pressure (mmHg)					
>90	–	–	914.341	<0.001	–
<60	–1.317	0.151	76.417	<0.001	0.268
60–90	–1.140	0.038	911.617	<0.001	0.320
Blood sugar (mmol/L)					
>6.1	–	–	470.107	<0.001	–
<3.9	0.124	0.288	0.185	0.667	1.132
3.9–6.1	–0.776	0.036	461.839	<0.001	0.460
Low density lipoprotein cholesterol (mmol/L)					
>3.1	–	–	463.795	<0.001	–
<2.1	–1.175	0.058	413.318	<0.001	0.309
2.1–3.1	–1.105	0.053	432.374	<0.001	0.331
Urine protein (–)	–0.382	0.062	38.042	<0.001	0.682
Number of relatives over 90 years old	1.121	0.027	1696.310	<0.001	3.069
Number of relatives of myocardial infarction	1.113	0.060	341.267	<0.001	3.042
Number of relatives of apoplexy	1.196	0.046	678.516	<0.001	3.307
Number of relatives of cancer	0.815	0.042	377.532	<0.001	2.259
Number of relatives underwent heart bypass surgery	1.008	0.129	60.934	<0.001	2.739
Number of relatives underwent stent implantation	0.984	0.091	116.513	<0.001	2.676
Constant	0.607	0.089	46.063	<0.001	1.834

subjects with DBP <60 mmHg and between 60 and 90 mmHg had only 0.268 and 0.320 risk of CVD, respectively. For every additional person in a subject's family who was >90 years old or had suffered a stroke, the risk of CVD was 2.69 times or 2.307 times higher, respectively, than that of normal people (*Table 5*).

Decision tree model analysis

Subjects with incomplete information were excluded, and the remaining 32,262 cases were randomly divided into two sets: 70% in the training set and 30% in the validation set. Firstly, focusing on the training set, we selected meaningful indicators (including personal information, family medical history, biochemical indicators, and physical indicators) to construct decision trees. The decision tree model had 17 nodes and 8 endpoints with a depth of 3 (*Figure 2*). In the decision tree, the first layer was SBP, indicating it had the strongest association with the risk of CVD. Participants with SBP >140 mmHg had higher incidence of CVD. In addition, having more than 2 family members aged >90 years had the most significant impact on the risk of CVD. When the SBP >140 mmHg and there were 0 or 1 family members >90 years of age, the participants with DBP >90 mmHg

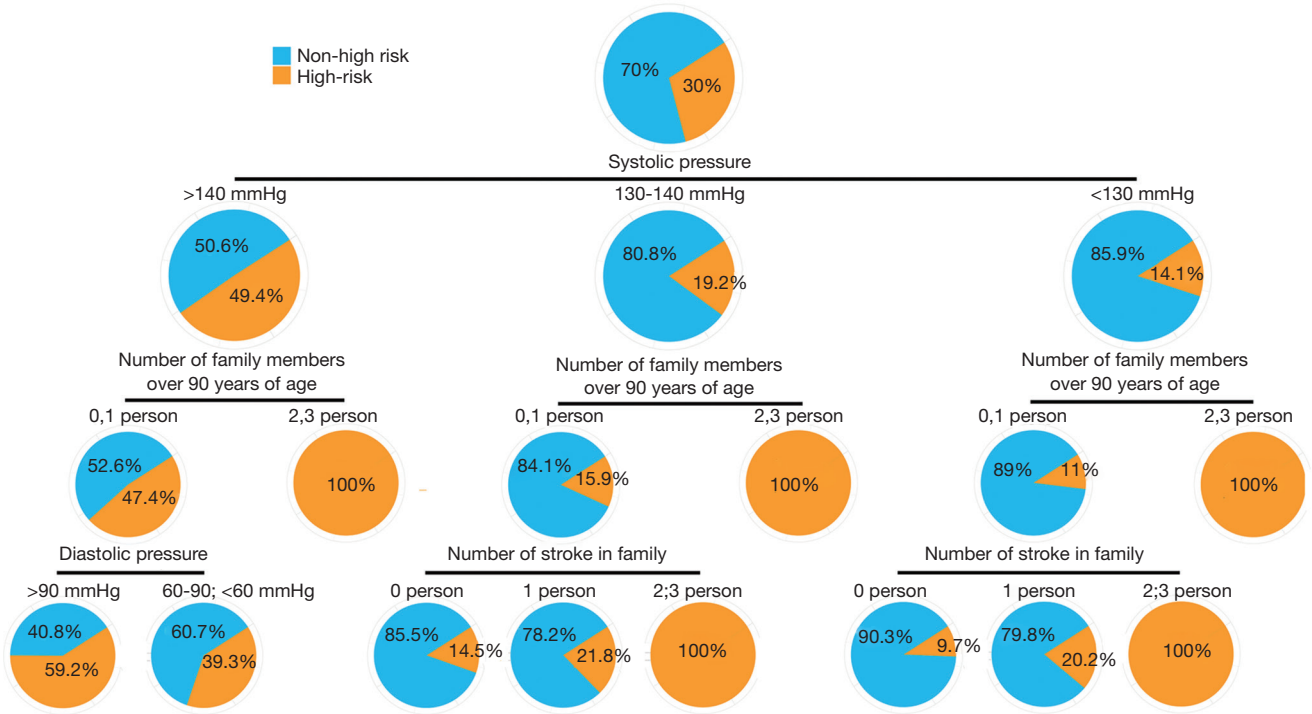

Figure 2 Tree diagram generated by decision tree model.

had a higher risk of CVD than those with <90 mmHg. Moreover, participants who had 2 or 3 family members >90 years old were part of high-risk group (*Figure 2*). The accuracy of the decision tree model on the training and validation sets was 77.4% and 77.3%, respectively.

Correlation analysis among factors

By analyzing the correlations among the various indicators, we filtered out the correlations with relative coefficient >0.2 to construct a network map. In the network, a correlation was identified between hypertension and seven indicators, including SBP, DBP, and BMI. Hypertension and SBP had the largest correlation. SBP had a correlation with six indicators, while BMI, cholesterol, and blood glucose were associated with five other indicators (*Figure 3*).

Discussion

The characteristics of CVD risk factors differ from region to region according to variations in diet and lifestyle. A large number of studies have analyzed the risk factors for CVD in different regions of China. This study provided a unique opportunity to analyze in detail the CVD risk factors to public health in Tianjin, China. In the present research, we focused on the correlation of various factors with CVD degrees, and displayed it through a network diagram. In this network, SBP, DBP, BMI, age, diabetes, waist circumference, and hypertension were all associated with CVD risk. BMI, cholesterol, and blood glucose were associated with five other indicators. These results allow us to understand the relationship between CVD and its risk factors, especially family disease history and physical indicators, and this is conducive to the design of reasonable strategies to control the morbidity of CVD.

A lot of research has been done on the risk factors for CVD. Yu *et al.* (16) studied CVD-related prevalence and demographic-related risk factors in Jilin Province, and pointed out that people who are elderly, or who have low-income or low-education should be targeted in the prevention of CVD. Based on the prevalence and risk factors of CVD in rural communities in Fangshan District of Beijing, He *et al.* (17) forecast that high-risk factors of CVD and population aging might become public health problems in developing rural areas. Xu *et al.* (18) found that hypertension, diabetes, overweight/obesity, dyslipidemia, and current smoking were major CVD risk factors in the Tibetan population. However, little exploration has been

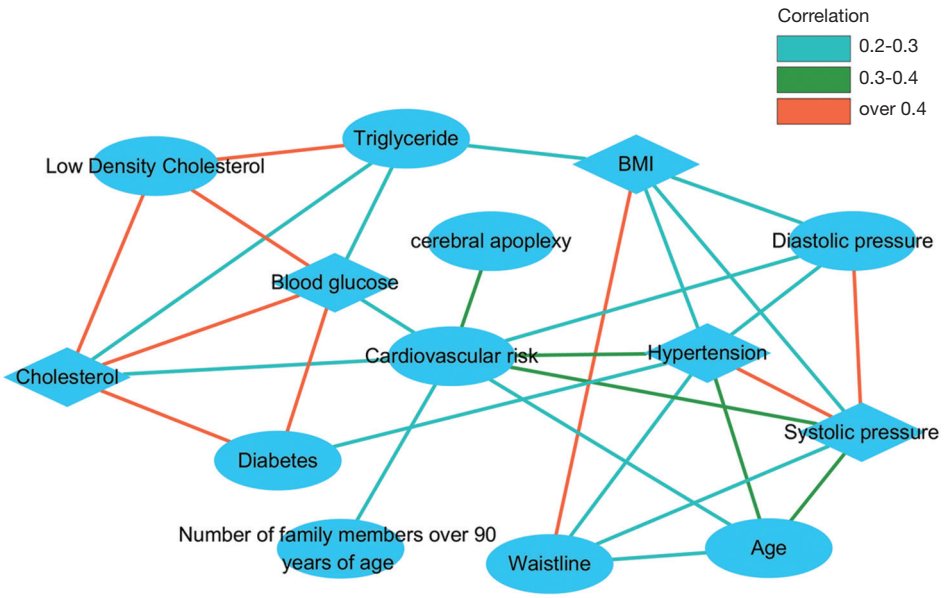

Figure 3 Correlation network between different indicators. Different colored lines indicate different correlation. The diamond indicates that the indicator had a correlation with more than five indicators.

carried out of the characteristics of CVD risk factors in Tianjin.

This study analyzed the statistical data of the Early Screening and Comprehensive Intervention Program for High Risk Population of Cardiovascular Disease, conducted by the National Cardiovascular Center in Tianjin. SBP, number of relatives over 90 years old, hypertension, and BMI were the major CVD risk factors in Tianjin residents. The predictive ability of the logistic regression model was 78.6%, indicating that this study has certain significance for guiding the prevention and intervention of CVD in Tianjin.

CVD risk factors can be divided into genetic and environmental risk factors, with the latter closely related to lifestyle and of greater importance. Smoking, obesity, hypertension, diabetes, unhealthy diet, and lack of physical activity are environmental risk factors, and eliminating or changing related behaviors can help to prevent CVD.

Hypertension is the most crucial and independent risk factor for CVD (19), and is currently one of the most common diseases in China (20). Hypertension can easily cause atherosclerosis, further damage to areas including the heart, cerebrovascular system, kidneys, and aorta, and the incidence of coronary heart disease can be enhanced (20). This study found that people with SBP >140 mmHg or DBP >90 mmHg showed an increased risk of CVD. An increased systolic and DBP heighten the risk of hypertension, which may further trigger CVD.

In addition, family history of CVD is a hereditary, unchangeable risk factor. Family history of CVD is a recognized risk factor, and multiple prospective studies have demonstrated consistent and independent associations between family history and CVD (21). A study has shown that family history of early coronary heart disease (CHD) is associated with a sustained increase in the risk of CHD and CVD death during long-term follow-up, resulting in a significant increase in lifetime risk assessment. A study by Ranthe *et al.* (22) concluded that the family history of early-onset CVD death is consistently and markedly associated with the risk of early-onset CVD, which indicates a genetic heart disease susceptibility. In our study, we demonstrated that participants who had a relative older than 90 or a stroke patient member in their family had a 2.069-fold and 2.307-fold increased risk of CVD, respectively. Additionally, SBP, DBP, the number of relatives aged over 90, and stroke patients in the family constituted the decision tree model. The accuracy of the decision tree model on the training set and test set was 77.4% and 77.3%, respectively. These four indicators in the model may be an important component of CVD screening and diagnosis.

Typically, each CVD patient has multiple risk factors. With societal advancements and improved living standards, everyone has increased exposure to CVD risk factors. The

accumulation of multiple CVD risk factors in the same individual poses a serious issue. Previous studies have found that the relative risks of coronary heart disease or stroke associated with 1, 2, 3, and ≥4 risk factors were 1.6 or 1.4, 2.2 or 1.9, 3.1 or 2.3, and 5.0 or 4.3, respectively (23). Reported by Yang *et al.* (23) compared with patients without risk factors, patients with 1, 2, 3 or ≥4 risk factors had an odds ratio of 2.36, 4.24, 4.88, and 7.22 for CVD, respectively. Many studies have revealed that the occurrence of CVD is the result of long-term interactions of multiple adverse factors. Our study considered the relationship between various risk factors in the CVD prevention and screening process, which is of great significance for the prevention of CVD and the improvement of public health awareness.

Conclusions

In conclusion, this study provided a scientific basis for the development of CVD prevention and control measures and strategies. By designing ongoing individualized coaching and support, better long-term clinical improvements in patients with CVD can be achieved.

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Footnote

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at http://dx.doi.org/10.21037/atm.2020.03.139). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The data for the research was obtained from an existing database containing details held by the Early Screening and Comprehensive Intervention Program for High Risk Population of Cardiovascular Disease.

References

1. Ridker PM, Cushman M, Stampfer MJ, et al. Inflammation, aspirin, and the risk of cardiovascular disease in apparently healthy men. N Engl J Med 1997;336:973-9.
2. Roever L, Tse G, Biondi-Zoccai G. Trends in cardiovascular disease in Australia and in the world. Eur J Prev Cardiol 2018;25:1278-9.
3. Sun HH, Tian F. Inflammatory bowel disease and cardiovascular disease incidence and mortality: a meta-analysis. Eur J Prev Cardiol 2018;25:1623-31.
4. Kosmas CE, Silverio D, Sourlas A, et al. Anti-inflammatory therapy for cardiovascular disease. Ann Transl Med 2019;7:147.
5. Xin X, Sun Y, Li S, et al. Age-related macular degeneration and the risk of all-cause and cardiovascular mortality: a meta-analysis of cohort studies. Retina 2018;38:497-507.
6. Han C, Liu F, Yang X, et al. Ideal cardiovascular health and incidence of atherosclerotic cardiovascular disease among Chinese adults: the China-PAR project. Sci China Life Sci 2018;61:504-14.
7. Shen C, Ge J. Epidemic of Cardiovascular Disease in China: Current Perspective and Prospects for the Future. Circulation 2018;138:342-4.
8. Andersson C, Vasan RS. Epidemiology of cardiovascular disease in young individuals. Nat Rev Cardiol 2018;15:230-40.
9. Tarride JE, Lim M, DesMeules M, et al. A review of the cost of cardiovascular disease. Can J Cardiol

2009;25:e195-e202.
10. Sowers JR, Epstein M, Frohlich ED. Diabetes, hypertension, and cardiovascular disease: an update. Hypertension 2001;37:1053-59.
11. Wilson PWF, D'agostino RB, Sullivan L, et al. Overweight and obesity as determinants of cardiovascular risk: the Framingham experience. Arch Intern Med 2002;162:1867-72.
12. Erhardt L. Cigarette smoking: an undertreated risk factor for cardiovascular disease. Atherosclerosis 2009;205:23-32.
13. Yang ZJ, Liu J, Ge JP, et al. Prevalence of cardiovascular disease risk factor in the Chinese population: the 2007-2008 China National Diabetes and Metabolic Disorders Study. Eur Heart J 2012;33:213-20.
14. Chen WW, Gao RL, Liu LS, et al. China cardiovascular diseases report 2015: a summary. J Geriatr Cardiol 2017;14:1-10.
15. Laslett LJ, Alagona P, Clark BA, et al. The worldwide environment of cardiovascular disease: prevalence, diagnosis, therapy, and policy issues: a report from the American College of Cardiology. J Am Coll Cardiol 2012;60:S1-S49.
16. Yu J, Ma Y, Yang S, et al. Risk factors for cardiovascular disease and their clustering among adults in Jilin (China). Int J Environ Res Public Health 2015;13:ijerph13010070.
17. He L, Tang X, Song Y, et al. Prevalence of cardiovascular disease and risk factors in a rural district of Beijing, China: a population-based survey of 58,308 residents. BMC Public Health 2012;12:34.
18. Xu S, Jiayong Z, Li B, et al. Prevalence and clustering of cardiovascular disease risk factors among Tibetan adults in China: a population-based study. PLoS One 2015;10:e0129966.
19. Garovic VD, Bailey KR, Boerwinkle E, et al. Hypertension in pregnancy as a risk factor for cardiovascular disease later in life. J Hypertens 2010;28:826-33.
20. Lewington S, Lacey B, Clarke R, et al. The burden of hypertension and associated risk for cardiovascular mortality in China. JAMA Intern Med 2016;176:524-32.
21. Lloyd-Jones DM, Nam BH, D'Agostino Sr RB, et al. Parental cardiovascular disease as a risk factor for cardiovascular disease in middle-aged adults: a prospective study of parents and offspring. JAMA 2004;291:2204-11.
22. Ranthe MF, Carstensen L, Øyen N, et al. Family history of premature death and risk of early onset cardiovascular disease. J Am Coll Cardiol 2012;60:814-21.
23. Yang ZJ, Liu J, Ge JP, et al. Prevalence of cardiovascular disease risk factor in the Chinese population: the 2007-2008 China National Diabetes and Metabolic Disorders Study. Eur Heart J 2012;33:213-20.

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