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Research Article

Study on the Risk of Coronary Heart Disease with Type 2 Diabetes in Young and Middle-aged People: Sex Differences

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Abstract

With the increase of incidence rate of type 2 diabetes worldwide and the shortening of the onset time, coronary heart disease (CHD) poses a major threat to young and middle-aged patients with type 2 diabetes (T2D), and cardiovascular events are the main cause of death in this population. Although established risk factors such as age, hypertension, and dyslipidemia can lead to CHD in T2D patients, their effects may vary by gender. However, gender specific studies on CHD risk in middle-aged and young T2D populations, particularly large-scale systematic analyses, are still limited. This study aimed to assess sex-specific differences in the risk of CHD among young and middle-aged individuals T2D. A total of 1071 adults with both CHD and T2D were recruited from the National Population Health Data Center, and weighted univariate and multiple logistic regression analyses were applied to calculate odds ratios (ORs) with 95% confidence intervals (CIs). The results showed an overall CHD prevalence of 35.29% in the T2D population, with slight sex differences: 36.47% in males and 32.49% in females. Notably, CHD prevalence increased with body mass index (BMI), reaching 33.22% in the <25 kg/m^2 group, 34.69% in the 25–<30 kg/m^2 group, and 41.83% in the ≥30 kg/m^2 group. Weighted logistic regression analyses identified age, hypertension, triglycerides (TG), high-density lipoprotein (HDL), and C-reactive protein (CRP) as significant correlates of CHD in males with T2D. In contrast, only age and hypertension showed significant associations with CHD in females. These findings confirm sex disparities in CHD risk factors among young and middle-aged T2D patients, emphasizing the need for sex-specific strategies in CHD prevention and management for this population.

Keywords

Coronary Heart Disease, Type 2 Diabetes, Young and Middle-aged People, Sex Differences

1. Introduction

Coronary heart disease (CHD) and type 2 diabetes (T2D) are both major global public health challenges [1]. Research has shown that the risk of cardiovascular disease in T2D patients is significantly higher than that in the general population, and cardiovascular events have become the main cause of death in T2D patients [2]. With the acceleration of global urbanization and lifestyle changes, the incidence of T2D is showing a trend towards younger age groups [3]. The prevention and treatment of CHD in young and middle-aged T2D patients is becoming increasingly prominent, posing a serious

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threat to individual health and social medical burden [4, 5].

Existing research has confirmed that age, hypertension, and dyslipidemia are important risk factors for T2D patients to develop CHD, but the intensity of their effects may vary by gender [5, 6]. Gender, as a key regulatory factor in physiological and pathological processes, plays an important role in the pathogenesis, clinical manifestations, and prognosis of cardiovascular diseases [7, 8]. However, gender specific research on the risk of CHD in young and middle-aged T2D populations is still limited, especially the lack of systematic analysis based on large sample data, which makes it difficult for clinical prevention and treatment strategies to fully consider the risk characteristics of different genders.

In view of this, this study is based on large sample data from the National Population Health Data Center, focusing on young and middle-aged T2D patients, with the aim of evaluating gender differences in the risk of CHD, analyzing key influencing factors related to CHD in different gender groups, and providing theoretical basis for developing precise and gender specific strategies for the prevention and treatment of CHD, in order to reduce the cardiovascular disease burden of this population.

2. Materials and Methods

2.1. Participant Selection

The study subjects were selected from the National Population Health Data Center, including 1071 young and middle-aged adults with T2D. The inclusion criteria were: (1) meeting the diagnostic criteria for T2D (fasting blood glucose ≥7.0 mmol/L or glycosylated hemoglobin (HbA1c) ≥6.5% or typical diabetic symptoms combined with random blood glucose ≥11.1 mmol/L) [9]; (2) aged 18-65 years (young and middle-aged); (3) complete clinical data. The exclusion criteria were: (1) type 1 diabetes, gestational diabetes or other special types of diabetes; (2) severe liver, kidney dysfunction or malignant tumors; (3) incomplete clinical data.

2.2. Data Collection and Definition of Risk Factors

Demographic data (age, gender, ethnicity, marital status) and clinical indicators were collected through the National Population Health Data Center database. Anthropometric measurements included height and weight, and body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2), which was divided into three groups: <25 kg/m^2, 25-<30 kg/m^2, and ≥30 kg/m^2. Clinical indicators included blood pressure, blood lipids [total cholesterol (TC), triglycerides (TG), high-density lipoprotein (HDL), low-density lipoprotein (LDL)], serum uric acid (SUA), fasting blood glucose (FBG), C-reactive protein (CRP), and HbA1c. Hypertension was defined as systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg, or a history of hypertension and currently taking antihypertensive drugs [10].

2.3. Statistical Analysis

Statistical analysis was performed using SPSS 26.0 software. Measurement data with normal distribution were expressed as mean ± standard deviation, and the comparison between groups was performed by t-test. Count data were expressed as n (%), and the comparison between groups was performed by chi-square test. Weighted univariate and multiple logistic regression analyses were used to evaluate the association between variables and the risk of CHD in T2D patients, and the odds ratios (OR) and 95% confidence intervals (CI) were calculated. $P < 0.05$ was considered statistically significant.

3. Results

3.1. Description and Clinical Characteristics of Participants

Table 1 shows the demographic and clinical characteristics of T2D patients with and without CHD. The age of patients with CHD (56.38±6.53 years) was significantly higher than that of patients without CHD (52.13±8.43 years), with a statistically significant difference ($p < 0.001$). There was no significant difference in sex, ethnicity, marital status, or BMI distribution between the two groups ($p > 0.05$).

In terms of clinical indicators, the proportion of patients with hypertension in the CHD group (75.66%) was significantly higher than that in the non-CHD group (51.08%), with a statistically significant difference ($p < 0.001$). The levels of TC (4.21±1.14 mmol/L vs 4.71±1.29 mmol/L), TG (1.89±1.13 mmol/L vs 2.28±1.78 mmol/L), LDL (2.56±0.92 mmol/L vs 2.90±0.98 mmol/L), and CRP (1.09±2.28 mg/L vs 1.52±2.34 mg/L) in the CHD group were significantly lower than those in the non-CHD group ($p < 0.05$), while the HDL level in the CHD group (1.00±0.26 mmol/L) was significantly lower than that in the non-CHD group (1.06±0.31 mmol/L) ($p = 0.002$). There was no significant difference in SUA, FBG, or HbA1c levels between the two groups ($p > 0.05$).

Table 1. Demographic and clinical characteristics of all participants in this study.

Group	CHD with T2DM		p-value
	no	yes	
Age (year)	52.13±8.43	56.38±6.53	<0.001
Sex (n, %)			
male	479 (69.12%)	275 (72.75%)	0.213
female	214 (30.88%)	103 (27.25%)	
Nation (n, %)			0.664
han	648 (93.51%)	356 (94.18%)	
minority	45 (6.49%)	22 (5.82%)	
Marital (n, %)			0.385
married	681 (98.27%)	374 (98.94%)	
unmarried	12 (1.73%)	4 (1.06%)	
BMI (n, %)			0.171
<25 kg/m^2	203 (29.29%)	101 (26.72%)	
25 to <30 kg/m^2	401 (57.86%)	213 (56.35%)	
≥30 kg/m^2	89 (12.84%)	64 (16.93%)	
Hypertension (n, %)			<0.001
Yes	354 (51.08%)	286 (75.66%)	
No	339 (48.92%)	92 (24.34%)	
TC (mmol/L)	4.71±1.29	4.21±1.14	<0.001
TG (mmol/L)	2.28±1.78	1.89±1.13	<0.001
HDL (mmol/L)	1.06±0.31	1.00±0.26	0.002
LDL (mmol/L)	2.90±0.98	2.56±0.92	<0.001
SUA (μmol/L)	324.16±102.64	326.11±91.36	0.757
FBG (mmol/L)	8.19±3.79	8.42±3.75	0.352
CRP (mg/L)	1.52±2.34	1.09±2.28	0.004
HbA1c (%)	7.45±1.61	7.49±1.49	0.690

3.2. Prevalence of CHD in T2D Patients by Demographic Characteristics

Table 2 presents the prevalence of CHD in T2D patients according to different demographic characteristics. The overall prevalence of CHD in T2D patients was 35.29% (95%CI: 32.59%-38.09%). The prevalence of CHD in males was 36.47% (95%CI: 32.89%-39.79%), which was slightly higher than that in females (32.49%, 95%CI: 27.44%-37.54%), but the difference was not statistically significant (p = 0.213).

The prevalence of CHD increased with BMI: 33.22% (95%CI: 27.97%-38.49%) in the BMI <25 kg/m^2 group, 34.69% (95%CI: 30.78%-38.76%) in the 25-<30 kg/m^2 group, and 41.83% (95%CI: 34.64%-49.67%) in the ≥30 kg/m^2 group, but the difference was not statistically significant (p = 0.171).

The prevalence of CHD in T2D patients with hypertension (44.69%, 95%CI: 41.09%-48.90%) was significantly higher than that in those without hypertension (21.35%, 95%CI: 17.87%-25.29%), with a statistically significant difference (p < 0.001). There was no significant difference in CHD prevalence among different ethnic groups or marital statuses (p > 0.05).

Table 2. The prevalence of coronary heart disease with type 2 diabetes according to demographic characteristics.

Variable	Total (N)	Case (N)	Prevalence (%)	95%CI	p-value
Gender (n, %)					0.213
male	754	275	36.47	32.89-39.79	
female	317	103	32.49	27.44-37.54	
Nation (n, %)					0.664
han	1004	356	35.46	32.67-38.35	
minority	67	22	32.84	22.39-44.78	
Marital (n, %)					0.385
married	1055	374	35.45	32.61-38.39	
unmarried	16	4	25.00	6.25-50.00	
BMI (n, %)					0.171
<25 kg/m^2	304	101	33.22	27.97-38.49	
25 to <30 kg/m^2	614	213	34.69	30.78-38.76	
≥30 kg/m^2	153	64	41.83	34.64-49.67	
Hypertension (n, %)					<0.001
Yes	640	286	44.69	41.09-48.90	
No	431	92	21.35	17.87-25.29	
Overall	1071	378	35.29	32.59-38.09	

3.3. Multivariate Logistic Regression Analysis of CHD Risk Factors in T2D Patients

Table 3 shows the results of multivariate logistic regression analysis of CHD risk factors in young and middle-aged T2D patients. For males, age (OR = 1.07, 95%CI: 1.04-1.09, p < 0.001), hypertension (OR = 2.20, 95%CI: 1.56-3.10, p < 0.001), TG (OR = 0.80, 95%CI: 0.66-0.97, p = 0.021), HDL (OR = 0.28, 95%CI: 0.13-0.61, p = 0.001), and CRP (OR = 0.89, 95%CI: 0.82-0.97, p = 0.009) were significantly associated with CHD.

For females, only age (OR = 1.11, 95%CI: 1.06-1.16, p < 0.001) and hypertension (OR = 3.93, 95%CI: 2.18-7.07, p < 0.001) were significantly associated with CHD, while TG, TC, HDL, LDL, and CRP showed no significant association (p > 0.05).

Table 3. Multivariate Logistic regression analysis of the risk of coronary heart disease with type 2 diabetes in young and middle-aged people.

Variable	OR (male)	95%CI	p-value	OR (female)	95%CI	p-value
Age (year)	1.07	1.04-1.09	<0.001	1.11	1.06-1.16	<0.001
Hypertension (n, %)	2.20	1.56-3.10	<0.001	3.93	2.18-7.07	<0.001
TG (mmol/L)	0.80	0.66-0.97	0.021	0.73	0.49-1.10	0.131
TC (mmol/L)	1.12	0.75-1.68	0.584	0.91	0.33-2.47	0.847
HDL (mmol/L)	0.28	0.13-0.61	0.001	0.50	0.15-1.71	0.271
LDL (mmol/L)	0.68	0.44-1.06	0.088	0.83	0.28-2.42	0.732
CRP (mg/L)	0.89	0.82-0.97	0.009	0.87	0.76-1.01	0.060

4. Discussion

Through large sample data analysis, this study revealed gender differences in the risk of CHD in young and middle-aged patients with T2D, providing an important reference for clinical prevention and treatment. The study found that the overall prevalence of CHD in T2D patients was 35.29%, and that in men (36.47%) was slightly higher than in women (32.49%), which was consistent with the trend of generally higher incidence rate of cardiovascular diseases in men in previous studies. The possible reason is that men are more exposed to bad living habits (such as smoking and drinking), and the influence of androgen level fluctuations on lipid metabolism may increase the risk of atherosclerosis [11]. At the same time, the incidence of CHD increases with BMI, further confirming the role of obesity as an important risk factor for cardiovascular disease, which may be related to insulin resistance, enhanced inflammatory response, and endothelial dysfunction [12].

The core finding of this study is the gender specificity of the association between risk factors and CHD. In male T2D patients, age, hypertension, TG, HDL, and CRP are all independent risk factors for CHD, while in females, only age and hypertension are significantly associated. This difference may be related to the gender related physiological mechanism: women are protected by estrogen before menopause, their vascular endothelial function is more stable, and lipid metabolism disorders (such as TG increase, HDL decrease) have a weak role in promoting atherosclerosis [13]. Men experience metabolic abnormalities earlier, and the chronic inflammatory state reflected by CRP plays a more important role in the onset of CHD [14]. In addition, hypertension is a strong risk factor in both male and female populations, indicating the universal value of blood pressure control in the primary prevention of CHD in T2D patients [15].

From a clinical perspective, the results of this study support the necessity of "gender specific prevention and treatment strategies". For young and middle-aged male T2D patients, in addition to controlling blood pressure, it is also necessary to focus on monitoring blood lipids (TG, HDL) and inflammatory markers (CRP), and improve metabolic status through lifestyle interventions such as low-fat diet and regular exercise [16, 17]. Female T2D patients should prioritize strengthening blood pressure management and pay attention to the risk accumulation brought by aging [18-20]. This is consistent with the concept of "individualized cardiovascular risk assessment" emphasized in international guidelines, which helps to improve the efficiency of prevention and treatment [21].

The strength of our study is as follows. First, the data source is authoritative, based on a large sample from the National Population Health Data Center. Weighted regression analysis was used to control for sampling bias, and the results are highly representative. Second, this study focuses for the first time on the gender differences in CHD risk among young and middle-aged T2D patients, filling the gap in segmented research for this age group. Third, incorporating multidimensional risk factors (physiological indicators, biochemical indicators, inflammatory factors), independent associated factors were identified through multivariate analysis with rigorous logic.

This study has several limitations. Firstly, the study is a cross-sectional design and cannot determine the causal relationship and temporal sequence between risk factors and CHD. Secondly, further validation is needed to determine whether elevated CRP is a cause or a result of CHD. Thirdly, the behavioral and disease characteristic variables such as smoking, drinking, and the course of diabetes were not included, and some confounding factors may be omitted. Finally, the sample is only from a single data center and may have geographical limitations. Therefore, caution should be exercised when extrapolating the results to other populations.

5. Conclusions

There are significant gender differences in the risk of CHD between young and middle-aged T2D patients, and the role of related influencing factors also varies by gender. This suggests that in the prevention and treatment of CHD in young and middle-aged T2D patients, gender differences should be fully considered, and more targeted prevention and control strategies should be developed to improve the effectiveness of CHD prevention and treatment and enhance the health outcomes of patients.

Abbreviations

CHD	Coronary Heart Disease
T2D	Type 2 Diabetes
ORs	Odds Ratios
CIs	Confidence Intervals
TG	Triglycerides
HDL	High-density Lipoprotein
CRP	C-reactive Protein
HbA1c	Glycosylated Hemoglobin
TC	Total Cholesterol
TG	Triglycerides
HDL	High-density Lipoprotein
LDL	Low-density Lipoprotein
SUA	Serum Uric Acid
FBG	Fasting Blood Glucose
CRP	C-reactive Protein

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Author Contribution

Can Liu: Conceptualization, Formal analysis, Investigation, Methodology, Validation, Writing – original draft

Shen Yao: Data curation, Software

Congwei Li: Data curation, Software

Weidong Zhang: Data curation, Software

Jingmin Cheng: Conceptualization, Supervision, Writing – review & editing

Conflicts of Interest

The authors declare that they have no competing interests.

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