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Distribution and influencing factors of cardiovascular health among community inhabitants : Based on the scale of life's Essential 8

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ABSTRACT

Background: Cardiovascular disease remains the leading cause of morbidity and mortality globally. Cardiovascular health measurements are closely associated with cardiovascular outcomes. Cardiovascular health assessments can be significantly beneficial to health across whole life of individuals.
Objective: To investigate the cardiovascular health status, distribution, and influencing factors among community inhabitants of Nanjing City, and to inform the prevention and control of cardiovascular disease.
Methods: From September 2022 to August 2024, a total of 45,901 community-dwelling residents aged 35–79 years in Nanjing City were selected using a multistage, stratified, cluster random sampling method. All participants underwent questionnaire surveys, physical examinations, and laboratory tests. Cardiovascular health was quantitatively assessed using the "Life's Essential 8" scoring standard, which includes four health behaviors (diet, physical activity, smoking, and sleep) and four health factors (BMI, blood lipids, blood glucose, and blood pressure). A score of <50 was defined as low cardiovascular health, 50–80 as moderate cardiovascular health, and >80 as high cardiovascular health.
Results: The overall cardiovascular health score of the study population was 66.9 ± 12.8. Higher scores were observed in women, married individuals, urban residents, and non–high-risk participants for cardiovascular diseases compared with men, unmarried individuals, rural residents, and high-risk participants ($P<0.05$). The overall score decreased with increasing age ($P<0.05$) and increased with higher educational levels ($P<0.05$). The mean scores of diet, physical activity, smoking, sleep, BMI, blood lipids, blood glucose, and blood pressure were 37.7 ± 31.0, 79.8 ± 38.8, 71.6 ± 40.3, 84.7 ± 24.0, 58.8 ± 31.4, 67.4 ± 29.5, 79.9 ± 25.4, and 45.8 ± 33.9, respectively. Among the study subjects, 7,524 (16.4%) had high cardiovascular health, 34,071 (74.2%) had moderate cardiovascular health, and 4,306 (9.4%) had low cardiovascular health. Multivariable logistic regression analysis showed that, compared with participants with low cardiovascular health, women, those aged 55–64 and 65–79 years, those with junior/senior high school or college and above education, other occupations, and non–high-risk participants were more likely to have moderate cardiovascular health, whereas labour workers, public service employees, administrative employees, and rural residents were less likely to have moderate cardiovascular health ($P<0.05$). Women, those with junior/senior high school or college and above education, other occupations, and non–high-risk participants were more likely to have high cardiovascular health, whereas participants aged 45–54 or 55–64 years and rural residents were less likely to have high cardiovascular health ($P<0.05$).
Conclusions: Cardiovascular health among community residents in Nanjing is at a moderate level. Males, older people, those with lower education levels, rural residents, and high-risk groups should be prioritized for targeted interventions. Comprehensive improvement in cardiovascular health can be achieved by strengthening interventions on diet, smoking, and blood pressure.

Introduction

Cardiovascular disease (CVD) remains the leading cause of morbidity and mortality worldwide[1] and primary cause of death in China in the context of population aging, urbanization, and lifestyle transitions.[2] The prevalence rate of CVD is still on the rise in China, with an estimated 330 million individuals currently affected.[3] To prevent and manage CVD at both individual and population levels, the American Heart Associa-

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tion (AHA) introduced the concept of cardiovascular health (CVH) in 2010, comprising diet, physical activity, smoking status, body mass index (BMI), blood lipids, blood glucose, and blood pressure[4]. Numerous epidemiological studies[5–7] demonstrated association between CVH scores and the incidence of CVD.

In 2022, the AHA refined the CVH model by incorporating sleep health and updating the scoring standard, developed Life's Essential 8 (LE8) with greater individual sensitivity and applicability across the life course.[8] While the LE8 was validated in Western populations, empirical evidence from Chinese cohorts remains limited.

The Nanjing City is characterized by rapid economic growth and advanced urbanization in China, reflects a high prevalence of CVD risk factor. The researchers conducted the current study in Nanjing City to identify CVH status and associated determinants, to design targeted health promotion interventions and evidence-based, localized CVD prevention strategies.

This study assesses the CVH status and identifies its influencing factors of community-dwelling adults aged 35–79 years in Nanjing City based on the data from Early Screening and Comprehensive Intervention Program for High-Risk Cardiovascular Populations in Jiangsu Province, to guide local public health policy and improve cardiovascular outcomes.

Materials and methods

Study objects

In the Early Screening and Comprehensive Intervention Program for High-Risk Cardiovascular Populations in Jiangsu Province from September 2022 to August 2024, conducted in Nanjing City, a multistage, stratified cluster random sampling method was employed to recruit participants.

First, six districts were selected from Nanjing City, stratified by geographical location, within each district, four communities or villages were systematically sampled from local subdistricts or townships based on population size. Subsequently, in each community or village, residential or village groups were formed with at least 60 households per group. From these, two residential/village groups were randomly selected using simple random sampling. In each of the selected groups, 60 households were visited. All eligible residents within those households completed questionnaire survey, and received physical examination and laboratory testing.

Inclusion and exclusion criteria

Inclusion criteria were as follows: (1) aged between 35 and 79 years; (2) Inhabited in Nanjing City for at least six months; (3) voluntary participation in the survey and provision of informed consent.

Exclusion criteria included: (1) pregnancy; (2) cognitive impairment; (3) severe illness or disabilities that could compromise the accuracy of survey responses or measurements.

This study was approved by the Ethics Committee of the Nanjing Center for Disease Control and Prevention (Approval No. PJ2020-B001-01). A total of 50,998 participants were initially enrolled, and 47,115 participants completed the survey, with a response rate of 92.4%. After excluding individuals with missing data on smoking status (n = 100), physical examination (n = 71), glycated hemoglobin (HbA1c) levels (n = 877), and cardiovascular risk assessment (n = 166), a final sample of 45,901 participants was included in the analysis.

Data collection

Questionnaire survey: demographic characteristics, behavioral and lifestyle factors, and medical history of participants.

Physical examination: height, weight, and blood pressure.

Investigations: fasting venous blood samples were collected to test fasting plasma glucose (FPG), HbA1c, total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C).

Quality control

Before the survey commenced, the survey staff received training covering the questionnaire content, requirements for questionnaire filling, questionnaire inquiry method, and standardized procedures for physical examinations.

A unified electronic questionnaire was used and completed face-to-face across all survey sites, accompanied by standardized instructions to ensure consistent data collection.

Uniform instruments were used for physical examinations according to standardized protocols by trained personnel, height was measured using metal column stadiometers, body weight was measured using calibrated electronic scales, and blood pressure was assessed using Omron electronic sphygmomanometers.

Fasting venous blood samples were collected and analyzed by a designated certified laboratory to ensure consistency. Biological specimens were transported under controlled conditions to maintain sample integrity and were tested in a timely manner. The Nanjing Center for Disease Control and Prevention conducted re-testing on a subset of samples and was responsible for the long-term storage of biological specimens.

Data entry and cleaning were carried out in a centralized and standardized manner to ensure data quality and integrity.

Definitions of variables

CVH scoring

CVH was measured in four health behavior indicators(diet, physical activity, smoking, and sleep) and four health indicators(BMI, blood lipids, blood glucose, and blood pressure). Each of the eight indicators was scored on a scale of 0 to 100, and the total CVH score was calculated as the unweighted arithmetic mean, yielding a possible range of 0–100 points. Diet was assessed using the Dietary Approaches to Stop Hypertension (DASH)-style scoring system recommended by the AHA[9], based on the types of foods consumed, frequency of intake, and average portion size. Physical activity was scored according to the total minutes of moderate-to-vigorous physical activity per week. Smoking status scoring incorporated current smoking status, cessation history, and exposure to secondhand smoke. Sleep status was evaluated based on average nightly sleep duration.

BMI was scored based on World Health Organization (WHO) recommendations tailored for Asian populations[8]. Blood lipids were assessed based on non–high-density lipoprotein cholesterol (non-HDL-C) levels and medication use. Blood glucose was evaluated based on fasting plasma glucose, HbA1c, and diabetes diagnosis. Blood pressure was scored using systolic and diastolic measurements, along with antihypertensive treatment status.

Classification of CVH status

Participants were categorized into Low CVH group($<$ 50 points), moderate CVH group(50–79 points) and High CVH group($\geq$80 points) based on their total average CVH score.[8]

Definition of high cardiovascular risk

Participants were defined high-cardiovascular-risk-population if met any one of the following four criteria:

Established CVD history, including myocardial infarction, percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG), or stroke.

Severe dyslipidemia, defined as fasting TC$\geq$7.2 mmol/L or LDL-C$\geq$4.9 mmol/L.

Table 1
Baseline characteristics of participants.

Variable	Male (N=21 366)	Female (N=24 535)	Total (N=45 901)
Age group (years)			
35-44	3 114 (14.6)	3 297 (13.4)	6 411 (14.0)
45-54	6 605 (30.9)	7 829 (31.9)	14 434 (31.4)
55-64	6 720 (31.5)	8 294 (33.8)	15 014 (32.7)
65-79	4 927 (23.0)	5 115 (20.9)	10 042 (21.9)
Educational level			
Primary school or below	6 221 (29.1)	12 843 (52.3)	19 064 (41.5)
Junior/senior high school	12 995 (60.8)	10 170 (41.5)	23 165 (50.5)
College or above	2 150 (10.1)	1 522 (6.2)	3 672 (8.0)
Marital status			
Married	20 198 (94.5)	22 867 (93.2)	43 065 (93.8)
Unmarried	1 168 (5.5)	1 668 (6.8)	2 836 (6.2)
Current occupation			
Labour workers	10 749 (50.3)	7 620 (31.1)	18 369 (40.0)
Public service employees	1 907 (8.9)	2 156 (8.8)	4 063 (8.9)
Administrative employees	3 361 (15.7)	1 548 (6.3)	4 909 (10.7)
Others*	5 349 (25.1)	13 211 (53.8)	18 560 (40.4)
Residence			
Urban	10 239 (47.9)	12 130 (49.4)	22 369 (48.7)
Rural	11 127 (52.1)	12 405 (50.6)	23 532 (51.3)
High risk of CVD			
Yes	5 859 (27.4)	4 664 (19.0)	10 523 (22.9)
No	15 507 (72.6)	19 871 (81.0)	35 378 (77.1)
Smoking			
Yes	11 403 (53.4)	209 (0.9)	11 612 (25.3%)
No	9 963 (46.6)	24 326 (99.1)	34 289 (74.7%)
Moderate/vigorous physical activity (min/w)			
≥150	14 863 (69.6)	19 631 (80.0)	34 494 (75.1)
<150	6 503 (30.4)	4 904 (20.0)	11 407 (24.9)
Night sleep duration (h/d)	7.2±1.4	7.0±1.4	7.1±1.4
BMI (kg/m$^{2)}$	25.1±3.3	24.7±3.4	24.9±3.3
Systolic blood pressure (mmHg)	134±18	131±20	132±19
Diastolic blood pressure (mmHg)	84±11	80±10	82±11
non-HDL (mmol/L)	3.60±0.97	3.69±0.98	3.65±0.98
Fasting glucose (mmol/L)	5.95±1.71	5.73±1.48	5.83±1.60

Notes: Others (occupation)=unemployed, homemakers, and retired individuals.

10-year ASCVD risk≥10% based on the China-PAR (Prediction for ASCVD Risk in China) model for individuals aged ≥20 years without prior CVD.[10]

10-year ischemic CVD risk ≥10% based on the risk prediction chart for the Chinese population.[11]

Statistical analysis

Statistical analysis was performed using the IBM SPSS Statistics 26 (IBM SPSS, USA) program, with descriptive statistical methods (means and standard deviations) for measurement data, t-tests or ANOVA for group comparisons, Tamhane's T2 test for multiple comparisons, general linear models for trend tests. Enumeration data were presented as frequencies and percentages. Group comparisons were conducted using the Chi-square (χ^2) test, and pairwise comparisons were performed using the Bonferroni correction. Trend analysis was conducted using the trend χ^2 test. Multivariable logistic regression analysis was employed for influencing factors analysis. The significance level was set at P<0.05.

Results

General characteristics of participants

Of 45,901 participants included, 21,366 (46.5%) were male and 24,535 (53.5%) were female; 22,369 (48.7%) were urban residents. High-cardiovascular-risk participants accounted for 22.9%(n=10,523) (Table 1).

CVH scores and distribution

The mean total CVH score of the study participants was 66.9 ± 12.8. The scores of women, married individuals, urban residents, and non-CVD high-risk participants were significantly higher than those of men, unmarried individuals, rural residents, and CVD high-risk participants ($P < 0.05$). With increasing age, the total CVH score decreased significantly ($P < 0.05$). With higher educational level, the total CVH score increased significantly ($P < 0.05$). Comparison of total CVH scores among participants with different current occupations showed significant differences ($P < 0.05$); the scores of public service employees, administrative employees, and others were all higher than those of labour workers, while the scores of administrative employees and others were lower than those of public service employees ($P < 0.05$) (Table 2).

The mean scores for diet, physical activity, smoking, sleep, BMI, blood lipids, blood glucose, blood pressure, and the total CVH score among participants were 37.7 ± 31.0, 79.8 ± 38.8, 71.6 ± 40.3, 84.7 ± 24.0, 58.8 ± 31.4, 67.4 ± 29.5, 79.9 ± 25.4, and 45.8 ± 33.9, respectively.

Women scored higher than men in diet, physical activity, smoking, BMI, blood glucose, and blood pressure, but lower in sleep and blood lipids ($P < 0.05$). Married individuals had higher scores in diet, sleep, blood glucose, and blood pressure, but lower scores in physical activity, smoking, and BMI compared with unmarried individuals ($P < 0.05$). Urban residents scored higher in diet, smoking, blood lipids, and blood pressure, but lower in physical activity, sleep, and blood glucose compared with rural residents ($P < 0.05$). Participants at high risk for CVD had lower scores across all eight indicators than those at non–high risk ($P < 0.05$). With increasing age, scores for diet, sleep, BMI, blood lipids,

Table 2
Cardiovascular health indicators scores of participants.

Variable	Diet (mean ± SD)	Physical activity (mean ± SD)	Smoking (mean ± SD)	Sleep (mean ± SD)	BMI (mean ± SD)	Blood lipids (mean ± SD)	Blood glucose (mean ± SD)	Blood pressure (mean ± SD)	Total score (mean ± SD)
Gender									
Male	36.8±30.6	75.4±41.4	47.0±46.6	85.8±23.1	56.2±30.8	68.7±29.2	77.6±26.3	41.1±32.1 ([1])	62.4±12.5 ([1])
Female	38.5±31.2	83.6±36.0	93.0±12.8	83.8±24.7	61.1±31.8	66.3±29.6	81.9±24.4	49.8±35.0	70.9±11.7
Age group (years)									
35–44	47.8±30.4	75.0±41.1	69.8±41.5	89.0±19.6	62.2±32.3	72.6±28.7	87.1±21.9	63.1±33.0	71.9±13.8
45–54	38.5±30.8	80.7±38.1	69.9±40.8	86.4±22.5	58.1±31.5	67.1±29.4	83.0±24.1	50.4±34.1	68.0±13.0
55–64	36.1±30.7	82.0±37.3	71.7±40.0	83.3±24.9	58.1±30.9	64.9±29.5	77.9±25.7	42.0±32.4	65.8±12.1
65–79	32.7±30.4	78.1±40.2	75.0±39.0	81.6±26.4	58.9±31.5	68.3±29.5	73.8±26.9	33.7±30.5	64.0±11.7
Trend test t-value	-31.593	5.665	8.814	-21.670	-6.232	-10.463	-36.659	-59.919	-41.986
P-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Educational level									
Primary school or below	28.6±29.0	80.7±38.3	77.6±36.0	82.8±25.7	57.0±31.4	66.5±29.7	79.4±25.8	41.3±33.4	65.5±12.0
Junior/senior high school	42.8±30.7	79.7±38.8	66.3±42.9	85.8±22.9	59.7±31.3	67.8±29.3	79.9±25.3	47.7±33.9	67.4±13.2
College or above	52.8±29.4	75.7±40.8	74.1±39.8	87.7±20.7	63.5±31.8	69.5±28.9	82.6±23.5	56.3±33.5	71.4±12.8
Trend test t-value	44.903	-7.160	-4.921	11.397	11.546	5.783	7.198	24.683	25.549
P-value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Marital status									
Married	34.0±31.9 ([1])	83.8±35.3 ([1])	73.3±41.1 ([1])	80.0±27.2 ([1])	60.1±31.9 ([1])	66.4±29.2	76.7±26.5 ([1])	41.9±34.1 ([1])	65.7±12.7 ([1])
Unmarried	38.0±30.9	79.5±39.0	71.5±40.2	85.0±23.7	58.8±31.4	67.5±29.5	80.1±25.3	46.0±33.9	67.0±12.8
Current occupation									
Labour workers	34.9±30.3	77.2±40.5	64.7±43.4	85.0±23.8	57.4±31.3	68.7±29.3	81.0±25.1	44.6±33.5	65.5±12.7
Public service employees	45.2±30.4[a]	79.0±38.8[a]	69.7±40.9[a]	86.0±22.6	69.8±31.6[a]	69.0±28.8	81.0±24.4	54.0±34.9[a]	69.2±13.8[a]
Administrative employees	46.4±30.6[a]	74.0±42.0[ab]	63.6±44.4[b]	88.1±21.0[ab]	69.6±31.5[a]	67.8±29.4	81.8±24.5	50.9±33.4[ab]	67.8±13.7[ab]
Others*	36.6±31.2[abc]	84.0±35.7[abc]	80.9±33.4[abc]	83.2±25.1[abc]	69.2±31.5[a]	65.6±29.7[abc]	78.0±26.0[abc]	43.7±33.9[bc]	67.7±12.2[ab]
Residence									
Urban	41.9±31.1 ([1])	79.0±39.4 ([1])	72.7±39.4 ([1])	84.3±24.0 ([1])	58.7±31.4 ([1])	68.7±28.7 ([1])	78.4±25.9 ([1])	48.2±34.0 ([1])	67.7±12.7 ([1])
Rural	33.8±30.3	80.5±38.2	70.5±41.1	85.0±23.9	58.9±31.5	66.2±30.1	81.3±24.8	43.5±33.7	66.2±12.8
High risk of CVD									
Yes	33.4±30.7 ([1])	78.7±39.6 ([1])	66.7±42.7 ([1])	81.8±26.0 ([1])	50.5±30.1 ([1])	57.0±33.8 ([1])	68.0±28.6 ([1])	23.6±27.4 ([1])	58.9±12.0 ([1])
No	39.0±30.9	80.1±38.5	73.1±39.4	85.5±23.3	61.3±31.4	70.5±27.3	83.4±23.2	52.4±32.9	69.3±12.0
Total	37.7±31.0	79.8±38.8	71.6±40.3	84.7±24.0	58.8±31.4	67.4±29.5	79.9±25.4	45.8±33.9	66.9±12.8

Notes: a indicates P < 0.05(compared with labour workers), b indicates P < 0.05(compared with public service employees), c indicates P < 0.05(compared with administrative employees).

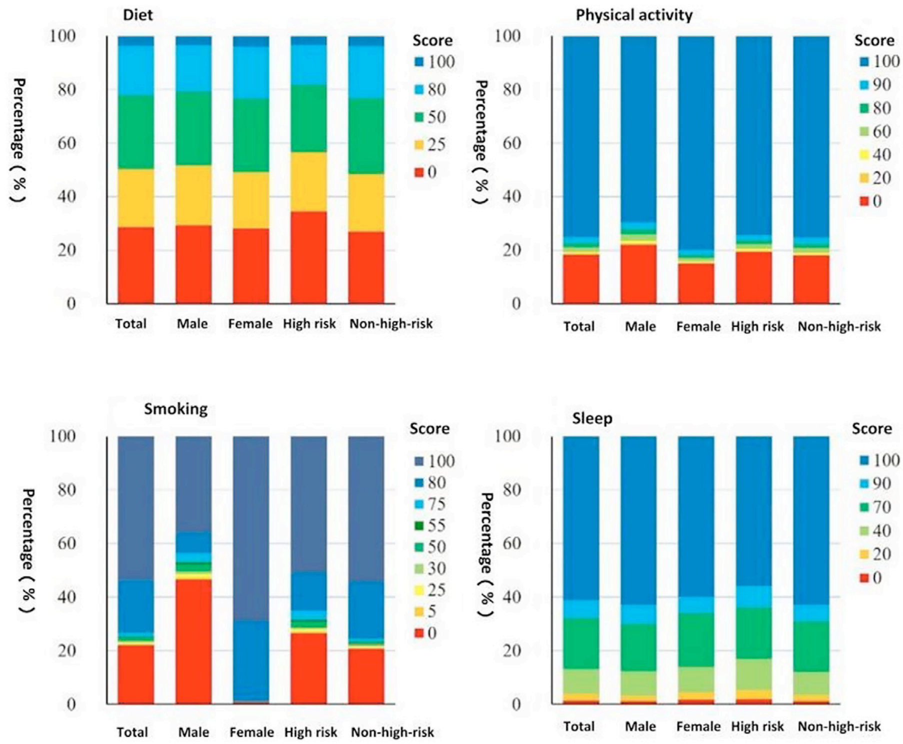

Fig. 1. Distribution of health behavior scores of participants.

blood glucose, and blood pressure declined, while scores for physical activity and smoking increased (P < 0.05). With higher educational level, scores for diet, sleep, BMI, blood lipids, blood glucose, and blood pressure increased, whereas scores for physical activity and smoking decreased (P < 0.05). Comparison by current occupation also showed significant differences across all indicators (P < 0.05). Service employees scored higher than labour workers in diet, physical activity, smoking, BMI, and blood pressure. Administrative employees scored higher than labour workers in diet, BMI, and blood pressure, but lower in physical activity than both labour workers and service employees, and lower in smoking and blood pressure than service employees, while having higher sleep scores than both labour workers and service employees. Participants categorized as other occupations had higher diet scores than labour workers but lower than service employees and administrative employees; higher physical activity and smoking scores than labour workers, service employees, and administrative employees; and lower sleep, blood lipids, blood glucose, and blood pressure scores than the other three groups. Their BMI scores were also higher than those of labour workers (P < 0.05) (Table 2).

Among the four health behavior indicators, all except diet had a majority of participants achieving full scores (100). Physical activity had the highest proportion of full scores, with 34,494/45,901 participants (over 75%) achieving 100 points, while only 1,741/45,901 participants (3.8%) achieved a full score in diet. In smoking, 9,963/21,366 men (46.6%) scored zero, while 7,373/24,535 women (over 30%) scored 80 points. For sleep, 28,142/45,901 participants (61.3%) achieved a full score, and 4,949/24,535 women (20.2%) scored 70 points. Non-high-cardiovascular-risk participants had a higher proportion of full scores across all behavior indicators (Fig. 1).

Regarding health indicator, only blood glucose had more than 50% of participants scoring full points, with 26,581/45,901 (57.9%). Blood pressure had the lowest rate of full scores(18.9%), with 8,668/45,901 (18.9%). Women had a higher proportion of full scores for BMI, 7,834/24,535 (31.9%). Among high-risk participants, 4,477/10,523 (42.5%) had blood lipid scores of 40 or below. For blood pressure, 18,279/45,901 participants (39.8%) scored 0, 5, or 25 points, this percentage rose to 7,111/10,523 (67.6%) among high-risk participants (Fig. 2).

CVH categories and distribution

Based on total CVH scores, 7,524 participants (16.4%) were classified as having high CVH (≥80 points), 34,071 (74.2%) as having moderate CVH (50–79 points), and 4,306 (9.4%) as having low CVH (<50 points). Significant differences in the distribution of CVH were observed by sex, marital status, current occupation, residence, and CVD risk status (P < 0.05). A decreasing trend in the proportion of high CVH was observed with increasing age, while an increasing trend was found with higher educational level (P < 0.05) (Table 3).

Influencing factors of CVH

Multinomial logistic regression analysis using the low CVH group (<50 points) as the reference category showed that, compared to males, females had higher odds of being in the moderate CVH group (OR = 3.671; 95% CI: 3.380–3.987) and the high CVH group (OR = 13.620; 95% CI: 12.312–15.068); participants aged 45–64 years had significantly lower odds of high CVH compared to those aged 35–44 years: OR = 0.620 (95% CI: 0.539–0.713) for moderate CVH, OR = 0.469 (95% CI: 0.405–0.543) for high CVH, for the 65–79 age group, differences were not statistically significant; Educational level was positively associated with CVH level. Participants with college education or above were 5.355 times more likely to be in the high CVH group than those with primary school education or less (95% CI: 4.373–6.558); rural residents had a lower likelihood of having high CVH compared to urban residents (OR = 0.784; 95% CI: 0.720–0.855).

In addition, compared to high-risk participants, non-high-risk participants were 5.040 times more likely to be in the moderate CVH group (95% CI: 4.660–5.450), 18.274 times more likely to be in the high CVH group (95% CI: 16.016–20.871) (Table 4).

Multivariable logistic regression analysis was performed with CVH status as the dependent variable and sex, age, educational level, marital

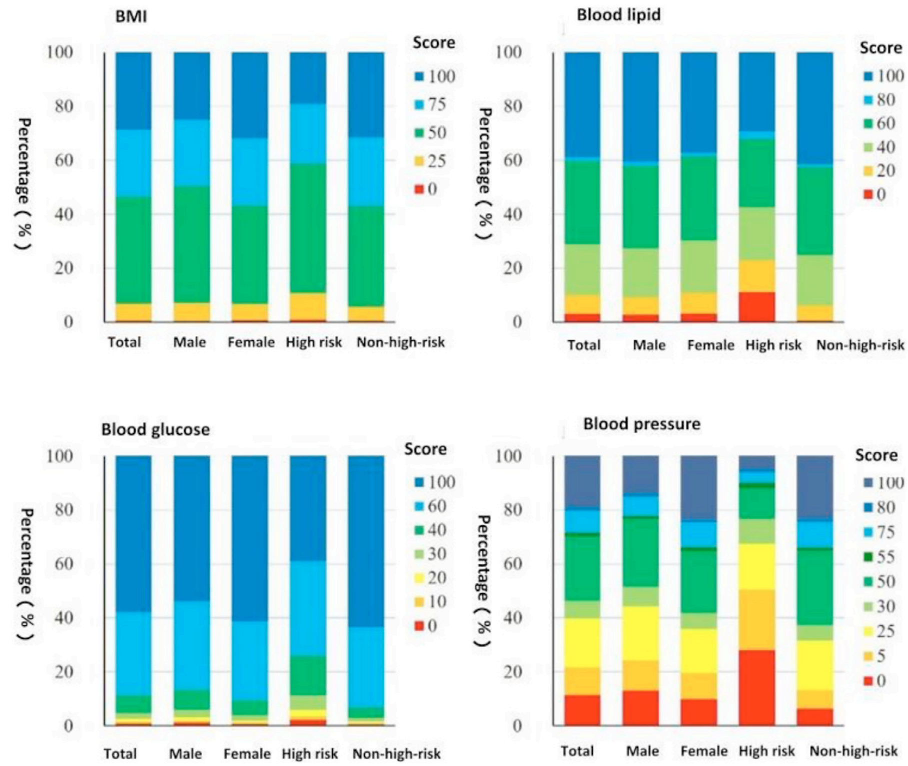

Fig. 2. Distribution of health factor scores of participants.

status, current occupation, residence, and CVD risk status as independent variables. Using low CVH as the reference group, the likelihood of having moderate CVH was higher among women, those aged 55–64 and 65–79 years, those with junior/senior high school or college and above education, those in other occupations, and non–high-risk participants for CVD, while it was lower among public service employees, administrative employees, and rural residents ($P < 0.05$). The likelihood of having high CVH was higher among women, those with junior/senior high school or college and above education, those in other occupations, and non–high-risk participants for CVD, while it was lower among those aged 45–54 or 55–64 years and rural residents ($P < 0.05$).

Discussion

This study evaluated CVH of community-dwelling residents aged 35–79 years in Nanjing City based on Life's Essential 8. The average CVH score in this population was 66.9 out of 100, indicating a moderate level of cardiovascular health, which is comparable to the United States (64.7)[12], the United Kingdom (67.8)[13], and slightly lower than the national average in China (73.6).[14] However, the proportion of individuals with high CVH scores in Nanjing City was notably lower than the aforementioned populations. Several factors may account for this discrepancy, for example, the U.S. study included participants aged 2–79 years, and the Chinese survey included adults aged 20–59 years, both of which involved a higher proportion of younger individuals. In addition, the comparison studies were conducted in earlier years, while this study reflects more recent data. With rapid socioeconomic development and urbanization in recent years, unhealthy lifestyle behaviors such as poor diet, physical inactivity, and chronic stress have become more prevalent, potentially leading to a decline in overall cardiovascular health.

Both health behaviors and medical condition jointly contribute to CVH status.

Participants in Nanjing City exhibited higher average scores for health behavior factors compared to health factors. Among the eight indicators, physical activity, sleep, and blood glucose had the highest average scores. Over three-quarters of the participants reported at least 150 minutes of moderate-to-vigorous physical activity per week, meeting the guideline recommended in the " Physical Activity Guidelines for Chinese (2021) ".[15] Notably, administrative employees had the lowest physical activity scores among all occupational groups. In addition, a declining trend in physical activity scores was observed with increasing educational level, suggesting physical activity interventions target highly educated participants and white-collar workers. Female participants scored lower in sleep than males, may due to combined impact of biological differences and psychosocial stressors, making women more susceptible to sleep disturbances.

More than 20% women participants reported average sleep durations between 6 to 7 hours per night. A study from the United States demonstrated that moderate sleep deprivation can lead to endothelial inflammation and dysfunction in healthy women, thereby elevating cardiovascular risk,[16] suggesting attention on sleep health in the CVD control of women.

This study found that among the eight indicators, dietary scores were the lowest among Nanjing residents, with only 3.8% achieving a perfect score. This is consistent with previous studies[12–14] and suggests suboptimal dietary structure of Nanjing residents. Rapid economy development in China led to significant dietary patterns change, including increased consumption of meat and fats and a decline in the intake of grains.[17] In addition, the dietary structure in Jiangsu Province involve excessive intake of fats and sugars[18,19], largely due to the high consumption of pastries, snacks, and sugary beverages. In this study, labour workers and rural residents had lower dietary scores, which may be attributed to limited awareness of nutritional health, constrained purchasing power, and poor accessibility to healthy foods. Therefore, it is crucial to address the dietary patterns of Nanjing residents—particularly these two groups—by implementing targeted nutritional interventions that enhance dietary knowledge and improve overall diet quality.

Another notable finding of this study was the relatively low scores for blood pressure, the prevalence of hypertension was 39.8% (18,729/45,901) in Nanjing City, and as high as 67.6% (7,111/10,523) among high- cardiovascular-risk residents—significantly exceeding the national average reported in previous studies.[20] Smoking also emerged

Table 3
Distribution of cardiovascular health among participants [n (%)].

Variable	Low CVH [n (%)]	Moderate CVH[n (%)]	High CVH [n (%)]
Gender			
Male	3 330 (15.6)	16 319 (76.4)	1 717 (8.0)
Female	976 (4.0)	17 752 (72.3)	5 807 (23.7)
χ^2 value	1808.704	96.484	2035.180
P value	<0.001	<0.001	<0.001
Age group (years)			
35-44	401 (6.2)	3 980 (62.1)	2 030 (31.7)
45-54	1 271 (8.8)	10 367 (71.8)	2 796 (19.4)
55-64	1 474 (9.8)	11 700 (77.9)	1 840 (12.3)
65-79	1 160 (11.6)	8 024 (79.9)	858 (8.5)
Trend test χ^2value	132.705	787.378	1685.914
P-value	<0.001	<0.001	<0.001
Educational level			
Primary school or below	1 902 (10.0)	14 894 (78.1)	2 268 (11.9)
Junior/senior high school	2 221 (9.6)	16 701 (72.1)	4 243 (18.3)
College or above	183 (5.0)	2 476 (67.4)	1 013 (27.6)
Trend test χ^2value	50.642	293.253	667.553
P-value	<0.001	<0.001	<0.001
Marital status			
Married	4 016 (9.3)	31 914 (74.1)	7 135 (16.6)
Unmarried	290 (10.2)	2 157 (76.1)	389 (13.7)
χ^2 value	2.432	5.194	15.579
P value	0.119	0.023	<0.001
Current occupation			
Labour workers	2 054 (11.2)	13 822 (75.2)	2 493 (13.6)
Public service employees	350 (8.6) [a]	2 740 (67.4) [a]	973 (24.0) [a]
Administrative employees	494 (10.1)	3 432 (69.9) [a]	983 (20.0) [ab]
Others*	1 408 (7.6) [ac]	14 077 (75.8) [bc]	3 075 (16.6) [abc]
χ^2 value	145.904	181.066	323.538
P value	<0.001	<0.001	<0.001
Residence			
Urban	1 800 (8.0)	16 571 (74.1)	3 998 (17.9)
Rural	2 506 (10.6)	17 500 (74.4)	3 526 (15.0)
χ^2 value	91.061	0.478	69.634
P value	<0.001	0.490	<0.001
High risk of CVD			
Yes	2 302 (21.9)	7 816 (74.3)	405 (3.8)
No	2 004 (5.7)	26 255 (74.2)	7 119 (20.1)
χ^2 value	2505.463	0.014	1566.148
P value	<0.001	0.907	<0.001
Total	4 306 (9.4)	3 4071 (74.2)	7 524 (16.4)

Notes: a indicates P < 0.001(compared with labour workers), b indicates P < 0.001(compared with public service employees), c indicates P < 0.001(compared with administrative employees), d indicate trend χ^2 value.

as a persistent public health issue, 46.6% of male participants scored zero on the smoking, slightly lower than the national average smoking rate among Chinese men.[21] Over 30% of female participants reported exposure to secondhand smoke, suggesting a pressing need to enhance tobacco cessation awareness and public education on the dangers of secondhand smoke. Interestingly, this study found lower blood lipid scores in female participants than males, which contrasts with earlier reports.[22] One plausible explanation is the postmenopausal decline in estrogen levels and higher lipoproteins level, causing higher prevalence of lipid abnormalities in older female.

A large prospective cohort study in the United Kingdom[23] demonstrated 60% lower risk of cardiovascular disease incidence and a 73% lower risk of cardiovascular mortality in individuals with higher CVH scores. Similar findings were also reported in Chinese populations[24], reinforcing the critical role of maintaining high CVH levels in preventing CVD and reducing premature mortality.

In this study, female participants exhibited better CVH status than males, which is consistent with previous research.[25,26] This gender disparity may be attributed to biological, psychological, behavioral, and socioeconomic differences between men and women.[27,28]

Furthermore, the negative association between CVH scores and age, positive association between CVH scores and educational level were observed in the study, mirror findings from earlier studies.[29,30] Rural residents were 21% less likely to attain high CVH scores compared to their urban counterparts, possibly due to disparities in socioeconomic status, health awareness, quality of life, and access to healthcare services. Moreover, high-cardiovascular-risk participants consistently had lower scores on CVH and all indicators.

In recent years, China has actively promoted the "Early Screening and Comprehensive Intervention Program for High-Risk Populations of Cardiovascular Diseases," establishing a systematic approach for identifying and managing high-risk individuals, thereby laying a solid foundation for the primary prevention of cardiovascular disease. Building on the results of this study, future efforts should prioritize individualized lifestyle interventions to improve both the precision and effectiveness of intervention.

This study has several limitations:

(1) Lifestyle-related data were collected by questionnaire, diet, physical activity, smoking, and sleep indicators were scored base on self-reporting, may causing response bias; (2)Smoking behavior was defined as traditional cigarettes and electronic nicotine delivery systems (e.g., e-cigarettes), while this study only assessed traditional cigarette use. As a result, comparisons with other studies using broader definitions should be made with caution. Be aware, self-report is not always indicating the response bias or recall bias. Self-report is based on participant's perception and cognition. It could be real options to the situation of fact.

Table 4
Multivariate logistic regression analysis of factors associated with cardiovascular health.

Variable	Low CVH *OR (95%CI)*	Moderate CVH *OR (95%CI)*	High CVH *OR (95%CI)*
Gender			
Male	1.00	1.00	1.00
Female	1.00	3.67(3.38~3.98) (1)	13.61(12.31~15.06) (1)
Age group (years)			
35–44	1.00	1.00	1.00
45–54	1.00	0.10(0.88~1.13)	0.62(0.54~0.72) (1)
55–64	1.00	1.21(1.06~1.37) (1)	0.47(0.41~0.55) (1)
65–79	1.00	2.17(1.87~2.52) (1)	1.01(0.85~1.21)
Education level			
Primary school or below	1.00	1.00	1.00
Junior/senior high school	1.00	1.29(1.19~1.39) (1)	2.29(2.08~2.53) (1)
College or above	1.00	2.32(1.94~2.78) (1)	5.37(4.39~6.58) (1)
Marital status			
Married	1.00	1.00	1.00
Unmarried	1.00	0.93(0.81~1.06)	0.90(0.75~1.07)
Current occupation			
Labour workers	1.00	1.00	1.00
Public service employees	1.00	0.87(0.76~0.99) (1)	1.02(0.88~1.19)
Administrative employees	1.00	0.88(0.78~0.99) (1)	0.94(0.81~1.06)
Others*	1.00	1.14(1.05~1.24) (1)	1.23(1.12~1.37) (1)
Residence			
Urban	1.00	1.00	1.00
Rural	1.00	0.80(0.75~0.86) (1)	0.79(0.72~0.86) (1)
High risk of CVD			
Yes	1.00	1.00	1.00
No	1.00	5.04(4.66~5.45) (1)	18.29(16.03~20.87) (1)

(2) This cross-sectional study focused on relatively stable demographic factors as predictors, causal relationships between predictors and CVH cannot be determined, as well as behavioral and social determinants of CVH, requiring analysis on more variables.
(3) This study employed a descriptive analytical approach, treating each observed variable as an independent factor without considering potential interactions or structural pathways. Future research should adopt more advanced statistical methods to explore the relationships among these variables.

In summary, CVH of community residents in Nanjing City is at a moderate level, with only a small proportion of individuals achieving high CVH scores. Men, older adults, individuals with lower educational level and high cardiovascular risk, rural residents represent priority populations for CVH improvement. Targeted interventions should focus on promoting health lifestyles, health education, improving sleep quality, optimizing dietary patterns, encouraging smoking cessation, and strengthening blood pressure management, to improve CVH and prevent the progression of CVD in the general population.

Declarations

Not applicable.

Authors' contributions

Conceptualization, X.Y. and H.X.; Methodology, X.Y.; Data curation, W.X. and Z.C.; Formal analysis, W.X. and Z.C.;

Funding acquisition, H.X.; Project administration, H.X.; Resources, not applicable; Supervision, H.X.; Validation, H.X.; Writing—original draft, X.Y.; Writing—review and editing, H.X. All authors have read and agreed to the published version of the manuscript.

Ethical approval and consent to participate

The study received approval from Ethics Committee of the Nanjing Center for Disease Control and Prevention (Approval No. PJ2020-B001-01).

Consent for publication

Not applicable.

Availability of data and materials

Not applicable.

Competing interests

All authors declare that there are no competing interests.

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