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Research Paper

The impact of perception bias for cardiovascular disease risk on physical activity and dietary habits

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ABSTRACT

Objective: Cardiovascular disease (CVD) remains a significant public health challenge in China. Accurate perception of individual CVD risk is crucial for timely intervention and preventive strategies. This study aimed to determine the alignment between CVD risk perception levels and objectively calculated CVD risk levels, then investigate the disparity in physical activity and healthy diet habits among distinct CVD risk perception categories.

Methods: From March to August 2022, a cross-sectional survey was conducted in Zhejiang Province using convenience sampling. Participants aged between 20 and 80 years, without prior diagnosis of CVD were included. CVD risk perception was evaluated with the Chinese version of the Attitude and Beliefs about Cardiovascular Disease Risk Perception Questionnaire, while objective CVD risk was assessed through the Prediction for Atherosclerotic Cardiovascular Disease Risk (China-PAR) model. Participants' demographic information, self-reported physical activity, and healthy diet score were also collected.

Results: A total of 739 participants were included in the final analysis. Less than a third of participants (29.2%) accurately perceived their CVD risk, while 64.5% over-perceived it and 6.2% under-perceived it. Notably, half of the individuals (50.0%) with high CVD risk under-perceived their actual risk. Compared to the accurate perception group, individuals aged 60–80 years old ($OR = 6.569$), currently drinking ($OR = 3.059$), and with hypertension ($OR = 2.352$) were more likely to under-perceive their CVD risk. Meanwhile, participants aged 40-<60 years old ($OR = 2.462$) and employed ($OR = 2.352$) were more likely to over-perceive their risk. The proportion of individuals engaging in physical activity was lowest in the under-perception group, although the difference among the three groups was not statistically significant ($\chi^2 = 2.556$, $P = 0.278$). In addition, the proportion of individuals practicing healthy diet habits was also lowest in the under-perception group, and a significant statistical difference was observed among the three groups ($\chi^2 = 10.310$, $P = 0.006$).

Conclusion: Only a small proportion of participants accurately perceived their CVD risk, especially among those with high actual CVD risk. Individuals in the under-perceived CVD risk group exhibited the lowest rates of physical activity engagement and healthy diet adherence. Healthcare professionals should prioritize implementing personalized CVD risk communication strategies tailored to specific subgroups to enhance the accuracy of risk perception.

What is known?

- There is a stark contrast between the widespread presence of cardiovascular disease (CVD) risk factors and the insufficient management of these factors.

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- Foreign studies have shown differences between how people perceive their risk and the risk level for CVD, whereas research in China remains limited.
- Limit research focuses on the difference between healthy lifestyles and CVD risk perception categories in the Chinese population.

What is new?

- A minority of the Chinese CVD risk population accurately perceived their CVD risk; notably, half of the individuals identified as having high CVD risk under-perceived their actual risk.
- Individuals with advanced age, currently drinking, and hypertension were more likely to under-perceive their CVD risk, while participants aged 40–<60 years old and employed were more likely to over-perceive their risk.
- There is a disparity in physical activity and diet habits across three risk perception categories. In addition, the proportion of individuals engaging in healthy physical activity and healthy diet habits was lowest in the CVD risk under-perception group.

1. Introduction

Cardiovascular disease (CVD) is the leading cause of premature mortality worldwide, accounting for approximately 20.5 million CVD-related deaths in 2021 [1], and more than three-quarters of CVD deaths occurred in low- and middle-income countries [2]. CVD remains a significant public health challenge in China [3], where rapid urbanization and lifestyle changes have increased prevalence [4]. It is urgent to prioritize managing metabolic risk factors and mitigating CVD risk. CVD risk indicates the probability of encountering a cardiovascular event within a defined period (e.g., 10 years, 30 years, or a lifetime) [5], which is determined by integrating various predictive factors through mathematical models [6]. Healthcare professionals utilize this data to inform preventive measures and interventions to diminish CVD risk, including lifestyle adjustments and medication [7].

CVD risk perception, denoting one's belief in susceptibility to developing CVD [8], can significantly influence the adoption and maintenance of health behaviors [9]. Accurate perception of individual CVD risk is crucial for timely intervention and preventive strategies [10]. However, study has highlighted the discrepancies between individuals' self-perceived risk and objectively calculated CVD risk scores, potentially leading to suboptimal health behaviors and increased disease burden [11]. In 2019, an American Heart Association report revealed that only 44% of individuals accurately perceived their risk of developing CVD, down from 65% in 2009, with significant disparities based on age, race, and socioeconomic status [12]. Thakkar et al. [10] also found that patients attending primary healthcare centers in Australia and general practitioners held a perception bias by underestimating the risk of future cardiovascular events. Furthermore, perceived risk encompasses one's beliefs regarding personal susceptibility to specific health hazards and the potential consequences, influenced by cultural assumptions, beliefs, values, and perceptions about wellness, illness, and death [13]. The attitude toward risk varies across different cultural backgrounds [14]. Given the unique sociocultural context and healthcare challenges in China, understanding the perception bias in CVD risk is critical for developing effective interventions and reducing the burden of CVD in this population.

Over the past four decades, various measurements have been employed to assess CVD risk perception, including single-item tools and multidimensional scales [15]. None of these researches have defined a cut-off value or a classification system for categorizing distinct levels of CVD risk perception, which poses challenges in establishing suitable criteria for comparison with objectively calculated CVD risk. Therefore, we translated and cross-culturally adapted the Attitudes and Beliefs about Cardiovascular Disease (ABCD) Risk Perception Questionnaire [16], which has been validated across multiple countries [17–19]. Through latent profile analysis, we identified three distinct categories of risk perception (perceived high risk, perceived medium risk, and perceived low risk) [20], offering valuable reference standards for evaluating risk perception biases in CVD risk.

As elucidated in the Health Belief Model, risk perception is a reliable predictor of individuals' propensity to embrace preventive or detection behaviors [21]. Adequate lifestyle changes, such as increasing daily physical activity and adopting a healthy diet, play an important role in primary and secondary prevention of CVD [22,23]. Previous studies have shown diverse correlations between CVD risk perception and physical activity: some reported a positive correlation [24,25] (r = 0.012–0.281), whereas others found a negative correlation [10,26] (r = −0.37). Likewise, the association between CVD risk perception and healthy eating may be either positively correlated (r = 0.409) [25] or not related [27]. Understanding these detailed relationships is essential for designing effective interventions tailored to individual CVD risk perceptions to promote primary prevention and encourage healthier behaviors.

With this in mind, the current study aimed to determine the alignment between perceived CVD risk levels and calculated CVD risk levels. This process will allow for identifying distinct categories of CVD risk perception while examining the associated factors. Additionally, we aimed to investigate the disparity in physical activity and healthy diet habits among three CVD risk perception categories.

2. Methods

2.1. Study design and participants

From March to August 2022, a cross-sectional survey using convenience sampling was performed in two communities in Changxing and the department of endocrinology and physical examination at the second affiliated hospital Zhejiang University school of medicine in Hangzhou city [20]. Inclusion criteria: 1) registered as Zhejiang citizens in the Hangzhou District or Changxing area; 2) aged between 20 and 80 years due to the requirements of CVD risk estimation model [6]; 3) without a CVD diagnosis; 4) a complete physical examination report from the last three months; and 5) proficient in reading and speaking Mandarin. Exclusion criteria involved individuals with severe medical conditions, pregnancy, mental deficiencies, or treatment for psychiatric disorders [20]. Based on the recommendation for sample size calculation in cross-sectional research [28] and accounting for a 20% attrition rate, we included fifteen demographic characteristics and seven scale-based dimensions as independent variables in our study, resulting in a minimum required sample size of 275.

2.2. Measurements

2.2.1. General information

Demographic information included age, gender, height (in centimeters), weight (in kilograms), waist circumference (in centimeters), marital status, education level, employment status, CVD family history, and self-reported health status [20,25]. Body mass index (BMI) was calculated by dividing weight (in kilograms) by the square of height (in meters) [20,25]. Central obesity was indicated

when a waist circumference of 85 cm or more for women and 90 cm or more for men [29]. CVD Family history was identified as having at least one immediate family member (parent or sibling) who has experienced myocardial infarction or stroke [6,20,25]. Self-reported health status was evaluated by asking, "In general, how would you rate your health status?" with responses ranging from 1 (very poor) to 5 (excellent) [30].

2.2.2. 10-Year CVD absolute risk appraisal

The 10-year absolute CVD risk value was computed utilizing the Prediction for Atherosclerotic Cardiovascular Disease Risk equation (China-PAR) based on the gender-specific Cox proportional hazards model [6]. Indicators considered in the estimation included gender, age (year), geographic region (north or south China), urbanization (urban/rural), smoking status (yes/no), waist circumference (cm), systolic blood pressure (treated or untreated; mmHg), total cholesterol (mmol/L), high-density lipoprotein cholesterol (HDL-C; mmol/L), presence of diabetes (yes/no), and CVD family history (yes/no) [6,20,25]. Participants were categorized into three risk classes according to the cut-off values specified in the Chinese guideline: low risk (less than 5%), moderate risk (5%–9.9%), and high-risk level (10% or greater) [31]. The risk value was determined using the online calculator available at https://www.cvdrisk.com.cn/ASCVD/Eval.

2.2.3. CVD risk perception

The ABCD Risk Perception Questionnaire [32], validated for the Chinese population [16], assessed individuals' perceptions of CVD risk. This questionnaire consists of 26 items across 4 dimensions: CVD-related knowledge (8 items), risk perception (8 items), perceived benefits and intention to change physical activity (6 items), and perceived benefits and intention to change dietary habits (4 items) [20,25]. For the knowledge dimension, a score of 1 was assigned for correct answers, while incorrect or "I don't know" responses received a score of 0. Responses to the remaining three dimensions were recorded using a Likert 4-point scale, where one represented "strongly disagree" and four represented "strongly agree," with the addition of a "not applicable" option assigned a value of 0 [20,25]. The Cronbach's α coefficient of 4 dimensions was 0.801, 0.940, 0.900, and 0.830, respectively [16]. In our previous study, we utilized 8 items of risk perception dimension as indicators to delineate three categories of CVD risk perception: perceived low risk ($\leq$11 points), perceived medium risk (12–20 points), and perceived high risk ($\geq$21 points) [20].

2.2.4. Healthy diet score

In line with the updated Chinese Dietary Guideline [33], the healthy diet score was calculated by assessing weekly intake of 6 food categories: fresh fruit ($\geq$ 7 times/week), fresh vegetables ($\geq$ 7 times/week), whole grains ($\geq$ 7 times/week), consumption of fish and other seafood ($\geq$ 1 time/week), consumption of beans and bean products ($\geq$ 4 times/week), and consumption of red meat ($<$ 7 times/week) [20,25,34]. A score of 1 was assigned to responses meeting the specified criterion for each food group, with the total score ranging from 0 to 6. Individuals achieving a total score of $\geq$ 4 were categorized into the healthy group [35].

2.2.5. Self-reported physical activity

The short form of the International Physical Activity Questionnaire (IPAQ) was used to evaluate physical activity [36]. Participants reported their weekly frequency and duration of vigorous and moderate physical activities, walking, and sedentary behavior [20,25]. The responses were processed and aggregated according to the IPAQ Chinese guideline [37]. Test-retest reliability in the Chinese population ranged from 0.71 to 0.93, while concurrent validity compared to accelerometers was 0.60 [38]. Individuals who participated in more than 150 min of moderate-intensity physical activity or 75 min of vigorous-intensity physical activity each week were classified as achieving the recommended physical activity levels [20,25,31], considered healthy in the current study.

2.3. Data collection

Data collection was conducted following a standardized protocol, with questionnaires administered by three researchers (Z. Guo, X. Wang, and Y. Fu). The researchers invited eligible participants to each study site, utilizing a paper-based questionnaire and web-based survey platform hosted by WJX (www.wjx.com) [20,25]. This approach allowed participants to select their preferred format for completing the survey. Paper questionnaires were distributed and collected on-site, while electronic questionnaires were completed by participants using a smartphone to scan a QR code, with researchers reviewing the responses for completeness before submission. Before commencing the survey, participants were presented with a file outlining the research aim, data usage, and privacy protection [20,25]. After signing the consent, they independently complete the questionnaire.

The questionnaire covered general data, CVD absolute risk score, CVD risk perception, healthy diet score, and self-reported physical activity [20,25]. Participants self-assessed most items, which took less than 10 min, except for the CVD absolute risk value. The investigator calculated this appraisal using an online calculator based on indicators obtained from participants' health check reports, with their permission. In cases where participants could not write or access the smartphone, the investigator read each item, and responses were recorded according to the participants' statements. After excluding 43 incomplete or invalid responses, the final analysis included 739 participants [25].

2.4. Statistical analysis

Statistical analyses were performed using IBM SPSS 26.0. Continuous variables were reported as mean and standard deviation (SD), while categorical variables were summarized as frequencies with corresponding percentages [20]. To assess the categories of CVD risk perception, we compared risk perception classes with 10-year objective CVD risk levels, categorizing them into accurate risk perception, risk under-perception, or over-perception [20,39]. Chi-square tests were employed for categorical variables to compare differences between CVD risk perception categories, and one-way analysis of variance (ANOVA) along with Tukey's multiple comparison tests were used to ascertain the mean differences of continuous variables. We employed multinomial logistic regression models, utilizing the full information maximum likelihood method alongside a stepwise approach (Forward: LR), to explore the factors linked with various categories of CVD risk perception. A *P*-value of less than 0.05 was considered statistically significant.

2.5. Ethical considerations

The study protocol received approval from the Ethics Committee of the Second Affiliated Hospital, Zhejiang University School of Medicine (No. 2022-0280) [20,25]. All eligible participants voluntarily completed the survey, fully disclosing that no private information would be gathered. The research procedure adhered to rigorous protocols to uphold confidentiality, privacy, and anonymity according to the guidelines of the Declaration of Helsinki.

3. Results

3.1. Participants' characteristics

A total of 739 participants were included, with the majority being female (61.3%) and 38.7% being male. Most participants were aged 20–40, had attained higher education (53.5%), and reported a higher monthly income (54.7%). In terms of CVD risk factors, approximately 16.0% of participants reported current smoking or drinking habits, 39.4% had central obesity, 22.3% were diagnosed with hypertension, and 40.9% had diabetes (Table 1).

3.2. Correlation between CVD risk perception and objective calculated CVD risk

Table 2 indicates that in the objective CVD risk level, over half of the participants were categorized in the low CVD risk group, 22.9% into the moderate risk group, and 11.9% into the high-risk group. Regarding the perceived CVD risk level, 14.2% considered

Table 2
Cross-tabulation between perceived CVD risk and calculated 10-year CVD risk ($n = 739$).

Perceived CVD risk level	Objective CVD risk level			Total [n (%)]
	Low	Moderate	High	
Low	102	2	1	105 (14.2)
Moderate	231	70	43	344 (46.5)
High	149	97	44	290 (39.3)
Total [n (%)]	482 (65.2)	169 (22.9)	88 (11.9)	739 (100)

Note: CVD = cardiovascular disease. Numbers in absolute, the percentage of total was calculated in column.

Table 1
Characteristics of individuals among risk perception categories ($n = 739$).

Variables	n (%)	Under perception ($n = 46$)	Accurate perception ($n = 216$)	Over perception ($n = 477$)	χ^2/F	P
Age (years)						
20–<40	380 (51.4)	2 (4.3)	106 (49.1)	272 (57.0)	174.054	<0.001
40–<60	237 (32.1)	9 (19.6)	53 (24.5)	175 (36.7)		
60–80	122 (16.5)	35 (76.1)	57 (26.4)	30 (6.3)		
Gender					20.158	<0.001
Male	286 (38.7)	31 (67.4)	90 (41.7)	165 (34.6)		
Female	453 (61.3)	15 (32.6)	126 (58.3)	312 (65.4)		
Educational level					-	<0.001[a]
Junior school or below	119 (16.1)	22 (47.8)	40 (18.5)	57 (11.9)		
Middle/high school/specialty degree	225 (30.4)	24 (52.2)	74 (34.3)	127 (26.6)		
Bachelor's degree or above	395 (53.5)	0 (0)	102 (47.2)	293 (61.5)		
Marital status					9.304	0.010
Single	209 (28.3)	4 (8.7)	63 (29.2)	142 (29.8)		
Married	530 (71.7)	42 (91.3)	153 (70.8)	335 (70.2)		
Ethnic group					-	0.521[a]
Han Chinese	722 (97.7)	46 (100.0)	210 (97.2)	466 (97.7)		
Minority	17 (2.3)	0 (0)	6 (2.8)	11 (2.3)		
Employment status					76.039	<0.001
Employed	473 (64.0)	8 (17.4)	113 (52.3)	352 (73.8)		
Unemployed	266 (36.0)	38 (82.6)	103 (47.7)	125 (26.2)		
Monthly income (RMB)					44.147	<0.001
< 5,000	335 (45.3)	40 (87.0)	111 (51.4)	184 (38.6)		
≥ 5,000	404 (54.7)	6 (13.0)	105 (48.6)	293 (61.4)		
Smoking status					9.496	0.009
Current smoking	121 (16.4)	15 (32.6)	32 (14.8)	74 (15.5)		
Non-smoking/quit smoking	618 (83.6)	31 (67.4)	184 (85.2)	403 (84.5)		
Drinking status					18.497	<0.001
Current drinking	122 (16.5)	18 (39.1)	30 (13.9)	74 (15.5)		
Non-drinking/quit drinking	617 (83.5)	28 (60.9)	186 (86.1)	403 (84.5)		
Hypertension					88.426	<0.001
Yes	165 (22.3)	32 (69.6)	67 (31.0)	66 (13.8)		
No	574 (77.7)	14 (30.4)	149 (69.0)	411 (86.2)		
Diabetes					68.982	<0.001
Yes	302 (40.9)	42 (91.3)	106 (49.1)	154 (32.3)		
No	437 (59.1)	4 (8.7)	110 (50.9)	323 (67.7)		
CVD family history					-	0.041[a]
Yes	68 (9.2)	0 (0)	17 (7.9)	51 (10.7)		
No	671 (90.8)	46 (100.0)	199 (92.1)	426 (89.3)		
BMI (kg/m^2)					-	0.057[a]
< 18.5	66 (8.9)	0 (0)	19 (8.8)	47 (9.9)		
18.5–23.9	409 (55.3)	24 (52.2)	112 (51.9)	273 (57.2)		
≥ 24.0	264 (35.7)	22 (47.8)	85 (39.4)	157 (32.9)		
Central obesity					14.573	0.001
Yes	291 (39.4)	26 (56.4)	100 (46.3)	165 (34.6)		
No	448 (60.6)	20 (43.5)	116 (53.7)	312 (65.4)		
Subjective health status					12.451	0.002
Excellent/good	608 (82.3)	29 (63.0)	181 (83.8)	398 (83.4)		
Fair/poor	131 (17.7)	17 (37.0)	35 (16.3)	79 (16.6)		
CVD related knowledge	5.76 ± 1.92	5.57 ± 1.79	5.73 ± 1.93	5.78 ± 1.93	0.295	0.744
Perceived benefits and intention to change PA	18.43 ± 3.63	18.46 ± 2.71	18.07 ± 4.49	18.60 ± 3.25	1.537	0.216
Perceived benefits and intention to change DH	12.62 ± 2.32	13.15 ± 2.16	12.61 ± 2.84	12.58 ± 2.06	1.285	0.277

Note: Data are n (%) or *Mean* ± *SD*. BMI = body mass index. CVD = cardiovascular disease. PA = physical activity. DH = dietary habits.
[a] Fisher exact test.

themselves at low risk, 46.5% at moderate risk, and 39.3% at high risk. Significant differences in objective CVD risk levels were observed among CVD risk perception groups (χ^2 = 73.727, $P < 0.001$). We compared perceived CVD risk with objective CVD risk levels to define risk perception categories. Among the participants, 29.2% (216/739) accurately perceived their CVD risk, meaning their perceived risk level matched the objective risk level. While 64.5% (477/739) participants overestimated their risk, meaning their perceived risk was higher than the objective risk level, and 6.2% (46/739) underestimated it. In a group of 88 individuals with high objective CVD risk, 44 perceived their risk as low or moderate risk, indicating that half of this high-risk population underestimates their true risk of developing CVD.

3.3. Influencing factors of CVD risk perception categories

As shown in Table 1, no statistically significant differences were found in the ethnic group, BMI categories, CVD-related knowledge, perceived benefits and intention to change physical activity, and perceived benefits and intention to change dietary habits. Nevertheless, significant differences in risk perception categories can be observed across age, gender, educational level, marital status, employment status, monthly income, smoking/drinking status, hypertension, diabetes, CVD family history, central obesity, and subjective health status groups ($P < 0.05$).

Subsequently, these statistically significant independent variables were included in the multivariable-adjusted regression analysis, while only age, educational level, employment status, drinking status, and hypertension were involved in the final equation. Compared to the accurate perception group, individuals aged 60–80 years old (OR = 6.569, 95%CI = 1.227–35.160), currently drinking (OR = 3.059, 95%CI = 1.299–7.205), and with hypertension (OR = 2.352, 95%CI = 1.056–5.236) were more likely to under-perceive their CVD risk. Meanwhile, participants aged 40-<60 years old (OR = 2.462, 95%CI = 1.496–4.053) and employed (OR = 2.352, 95%CI = 1.442–3.837) were more likely to over-perceive their risk (Table 3).

3.4. Impact of risk perception categories on health behaviors

According to the Chinese Physical Activity and Nutrition Guidelines, adhering to the recommended levels of physical activity and dietary habits is considered 'healthy.' This study examined the disparity in PA and DH across three risk perception categories. The proportion of individuals engaging in healthy PA was lowest in the under-perception group (19.57%) compared to the accurate perception group (21.30%), and over-perception group (26.21%). However, the difference among the three groups was not statistically significant (χ^2 = 2.556, P = 0.278). In addition, the proportion of individuals practicing healthy DH was also lowest in the under-perception group (21.74%), compared to the accurate perception group (25.54%), and over-perception group (35.43%), with a significant statistical difference observed among the three groups (χ^2 = 10.310, P = 0.006).

4. Discussion

The present study found that less than a minority of participants (29.2%) accurately perceived their CVD risk, while 64.5% over-perceived it, and a smaller fraction (6.2%) under-perceived it compared to their CVD risk. These findings emphasize the widespread prevalence of CVD risk perception bias and the urgent need for risk perception education and effective risk communication initiatives. Notably, half of the individuals (50.0%) identified as having a high CVD risk under-perceived their actual risk, suggesting that strengthened intervention strategies should be employed to target this high CVD-risk population. Our study revealed that most participants maintained unhealthy lifestyles, with notable implications for community nursing interventions. Specifically, when examining the prevalence of healthy physical activity and dietary habits, our findings indicated a concerning trend: individuals in the risk under-perception group exhibited the lowest adherence to healthy physical activity and nutritional habits. This suggests a critical area where targeted interventions may be necessary to address misperceptions and promote healthier behaviors among this demographic. Understanding these patterns can inform tailored strategies to improve CVD outcomes within risk populations.

Previous studies have reported various levels of CVD risk perception, which can be influenced by the assessment tools employed. Acheson et al. [40] found that over 70% of individuals with a family history of coronary heart disease or stroke perceived themselves to be at average or below-average risk. Their assessment utilized a single item with a five-point Likert scale to evaluate perceived personal risk. Similarly, a study in Switzerland used a single item to assess smokers' perception of CVD risk, categorizing options as none or low risk, intermediate risk, and high risk, and the results revealed that only 42% of participants accurately perceived their CVD risk, while 39.0% over-perceived and 19% under-perceived it compared to their actual risk [41]. In addition, Hwang et al. [42] employed a four-item questionnaire to evaluate perceived CVD risk among 238 Korean blue-collar workers (average actual CVD risk was 11.8%), with a higher total score indicating higher perceived risk, and the results revealed a widespread trend of CVD risk under-perception among participants. These disparate findings underscore the importance of establishing standardized classifications for CVD risk perception to facilitate comparability across different studies. In our previous study [20], utilizing latent

Table 3
Determinants of CVD risk perception bias.

Characteristic	CVD risk under-perception	CVD risk over-perception
	OR (95%*CI*)	*OR* (95%*CI*)
Age (Ref = 20–<40)		
40–<60	0.925 (0.163, 5.254)	2.462 (1.496, 4.053)
60–80	6.569 (1.227, 35.160)	0.589 (0.302, 1.149)
Educational (Ref = level Junior school or below)		
Middle/high school/specialty degree	1.819 (0.722, 4.583)	0.693 (0.369, 1.303)
Bachelor's degree or above	0.001 (0.001, 0.002)	0.819 (0.366, 1.832)
Employment status (Ref = Unemployed)		
Employed	0.818 (0.183, 3.665)	2.352 (1.442, 3.837)
Current drinking	3.059 (1.299, 7.205)	1.308 (0.769, 2.224)
Hypertension	2.352 (1.056, 5.236)	0.478 (0.301, 0.757)

profile analysis, we delineated risk perception levels into three categories (perceived high risk, perceived medium risk, and perceived low risk). This methodological approach provided a robust framework for conducting comparative analyses against objectively calculated levels of CVD risk. Furthermore, our study indicated that a minority of participants were able to perceive their CVD risk accurately; this revelation underscores the complexity inherent in accurately perceiving and comprehending one's susceptibility to CVD, suggesting potential avenues for further exploration and intervention in enhancing public health awareness and education regarding cardiovascular risk factors.

Previous research has established associations between various demographic and health-related factors and CVD risk misperception, such as gender [41,43], age [41,44], BMI [44], educational level [44], CVD family history [45], hypertension [45], hyperlipidemia [41], diabetes mellitus [41], etc. Notably, the factors indicating over-perception or under-perception of CVD risk varied across studies, and these findings align with certain outcomes observed in the present study. Compared to the accurate perception group, individuals who were currently drinking ($OR = 3.059$) and those diagnosed with hypertension ($OR = 2.352$) exhibited a higher likelihood of under-perceiving their CVD risk. Despite extensive efforts [46,47] in education and guidance regarding CVD risk factors such as smoking, alcohol consumption, hypertension, and diabetes, persistent misperceptions endure concerning individuals' future susceptibility to CVD. Specifically, underestimating this risk can hinder the adoption of preventive behaviors, posing a significant obstacle to effective CVD prevention strategies. It underscores the urgent need for more targeted and effective risk communication strategies to enhance public understanding and awareness of potential cardiovascular hazards. To our surprise, contrasting perceptions of CVD risk among various age groups were observed. Table 3 illustrates that participants aged 60–80 ($OR = 6.569$, 95% $CI = 1.227–35.160$) were more prone to under-perceive their cardiovascular disease (CVD) risk than those aged 20–40. Conversely, participants aged 40 to under 60 ($OR = 2.462$, 95% $CI = 1.496–4.053$) were also more inclined to over-perceive their CVD risk. These findings indicate that distinguished risk communication strategies should be delivered according to different age groups.

Consistent with previous research findings [10,48], our study highlights variations in healthy lifestyle adherence across distinct CVD risk perception categories. Individuals in the under-perceived CVD risk group showed the lowest rates of physical activity engagement and adherence to a healthy diet compared to the other two groups. The results can be explained through the Health Belief Model [21], in which individuals' health-related behaviors are influenced by their perceptions of susceptibility to a health threat, the severity of the danger, the benefits of preventive actions, and the barriers to taking those actions. In the context of CVD, individuals who perceive themselves to be at lower risk may also perceive fewer barriers to engaging in unhealthy behaviors and may underestimate the severity of the consequences. As a result, they may be less likely to engage in preventive behaviors such as regular exercise and maintaining a healthy diet.

Conversely, individuals who accurately perceive themselves to be at higher risk of CVD are more likely to recognize the severity of the threat and perceive greater benefits to adopting and adhering to healthy behaviors. This offers valuable insights for targeted interventions aimed at improving cardiovascular health. Research has also concentrated on developing and validating various risk communication strategies, such as framed messages [49], tailored messages [50], risk communication tools [51], and shared decision-making risk communication [52], which provide valuable insights for clinical practice.

The present study has several limitations. Firstly, a web-based online survey may have introduced sample bias due to the high proportion of young individuals and those with higher education levels but low 10-year CVD risk in the enrolled sample. This approach excluded older participants who may not have access to smartphones or computers, potentially skewing the results. Future research will be conducted to validate the study findings across a more diverse population. In addition, convenience sampling was utilized in this study, and stratified sampling based on objective CVD risk levels was not implemented. Consequently, there were considerable disparities in the proportions of individuals with objective CVD risk levels, with the majority falling into the low-risk category. Although these align with the distribution pattern observed in CVD risk groups, they may lead to overestimating the study's conclusions. Future research endeavors could independently focus on subgroups with varying risk levels to provide more nuanced insights. Finally, given the cross-sectional nature of this study, it is imperative to acknowledge that causal relationships between variables and outcomes cannot be established. Consequently, interpretations of lifestyle differences across various risk perception categories should be cautiously approached. Future longitudinal cohort studies could provide valuable insights into the true impact of risk perception categories on lifestyle behaviors.

5. Conclusion

In the current study, only a small proportion of participants accurately perceived their CVD risk, especially among those with high actual CVD risk, where risk under-perception was prevalent. Age, educational level, and hypertension were identified as factors associated with CVD risk misperception. Individuals classified within the underperceived CVD risk group exhibited the lowest rates of physical activity engagement and adherence to a healthy diet. Healthcare professionals should prioritize implementing personalized CVD risk communication strategies tailored to specific subgroups to enhance the accuracy of risk perception as early as possible.

CRediT authorship contribution statement

Zhiting Guo: Conceptualization, Methodology, Data Curation, Formal analysis, Investigation, Writing-original draft, Writing review & editing. **Yujia Fu:** Methodology, Investigation, Data Curation. **Xuyang Wang:** Methodology, Investigation, Data Curation. **Aline Aparecida Monroe:** Writing review & editing. **Yuping Zhang:** Conceptualization, Methodology, Data Curation, Resources, Supervision, Project administration, Writing review & editing. **Jingfen Jin:** Conceptualization, Methodology, Data Curation, Resources, Supervision, Project administration, Funding acquisition, Writing review & editing. **Meifen Chen:** Conceptualization, Methodology, Data Curation, Resources, Project administration, Funding acquisition, Writing review & editing.

Data availability statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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Declaration of competing interest

The authors declare no conflict of interest regarding this article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijnss.2024.10.011.

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