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Original Article

Association between knowledge and risk for cardiovascular disease among older adults: A cross-sectional study in China

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ABSTRACT

Objectives: This study aimed to describe cardiovascular risk and cardiovascular disease (CVD) knowledge among older adults, and further explore the association between knowledge and risk.

Methods: In this cross-sectional study, we enrolled 1120 older adults who received physical examination in health centers. The participants were interviewed to obtain their behavioral risk factors related to CVD and clinical characteristics. A risk prediction chart was used to predict participants' cardiovascular risk based on clinical characteristics and behavioral risk factors. Participants' CVD knowledge was collected with a pretested knowledge questionnaire.

Results: Among the 1120 participants, 240 (21.4%) had low cardiovascular risk, 353 (31.5%) had moderate cardiovascular risk, 527 (47%) had high and very high cardiovascular risk. The knowledge level about CVD among 0.8% of the 1120 participants was good while that of 56.9% was poor. Lower CVD knowledge level, older age, lower income, and lower educational level were the independent factors of higher cardiovascular risk level.

Conclusions: This study highlights the need to reduce the cardiovascular risk among older adults. CVD knowledge should be considered when developing health interventions.

What is known?

- Knowledge about stroke/myocardial infarction warning signs and cardiovascular disease(CVD) risk factors is an important prerequisite to initiate proper response to acute CVD events and adopt a healthy lifestyle.
- Several cardiovascular guidelines recommend implementation of risk assessment tools in CVD prevention, because this facilitates early detection of people at high-risk of CVD.

What is new?

- Knowledge about CVD among Chinese older adults is poor, and many of these older adults are at high cardiovascular risk.
- This study highlights the need to reduce the cardiovascular risk among older adults, CVD knowledge should be considered when developing health interventions.

1. Introduction

Cardiovascular diseases (CVDs) such as stroke and myocardial infarction (MI) are the leading diseases among older adults, accounting for 30.3% of all diseases affecting people aged 60 years or above [1]. Aging is an independent risk factor for CVD, and CVD-related deaths increase with aging [2]. China has the highest number of aged people globally, and the population aged 60 or above is still growing. It is estimated that by 2050, 36.5% of Chinese population will be $\geq$ 60 years of age [3], and this is likely to increase the number of people affected by CVD-related mortality.

Knowledge about stroke/MI warning signs and CVD risk factors is an important prerequisite to initiate proper response to acute CVD events and adopt a healthy lifestyle [4,5]. Outcomes of stroke and MI can be effectively improved when treatment is initiated within 4.5 hours and 1 hour, respectively, after onset of symptoms

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[4,5]. The low awareness about signs of stroke/MI and actions for seeking emergency care has been cited as an important factor for hospital presentation delay [5,6]. Several studies have evaluated the state of CVD knowledge among CVD patients, while others have studied knowledge about CVD among the general public [7–9]. However, few studies have focused on CVD knowledge among older adults. It has previously been reported that elderly patients with acute stroke/MI are more likely to experience delays in hospital presentation than younger patients [10,11]. China has the largest elderly population compared to other countries globally. Therefore, it is important to assess CVD knowledge among Chinese older adults to promote the development of targeted educational interventions.

Several cardiovascular guidelines recommend implementation of risk assessment tools in CVD prevention, because this facilitates early detection of people at high-risk of CVD [12,13]. Several cardiovascular risk assessment tools have been developed [14,15]. The World Health Organization and the International Society of Hypertension (WHO/ISH) risk prediction charts are developed based on the findings from epidemiological surveys on the prevalence and magnitude of CVD risk factors in each of the 14 WHO sub-regions, thus have a better regional population coverage [16]. Moreover, in China, the National Programme of Screening and Intervention Subjects with High Risk Cardiovascular Disease recommend the WHO/ISH risk assessment [17]. The chart include sex, age, blood pressure, total blood cholesterol, presence of diabetes and smoking as clinical entry points for overall assessment of cardiovascular risk [16]. Studies investigating public cardiovascular risk based on WHO/ISH risk prediction chart in Malaysia, Cambodia and India reported that majority of people older than 40 years have a low or moderate cardiovascular risk [18,19]. However, information about the prevalence of cardiovascular risk in older adults is limited.

Cardiovascular risk and CVD knowledge are key parts of effective CVD prevention, the association between these two aspects in older adults is not well known. The primary goal of this study was to examine the association between CVD knowledge and cardiovascular risk among older adults. The secondary goals were to assess 10-year cardiovascular risk and the level of CVD knowledge among older adults in China.

2. Methods

2.1. Study setting and sample

This cross-sectional study was conducted in Hunan province in the central south of China which has a GDP per capita of $7,690 (0.9 times that of the national average). Statistics indicate that there are 120.07 million older adults (>60 years) in Hunan, which is equivalent to 18.16% of the overall population in this region, and is slightly higher than the percentage of the older adults in China (17.10%) [20]. This study was conducted from February to August of 2018.

A sample of at least 1025 individuals was estimated to be adequate by a consultant statistician using formula $N=[\mu\alpha^2 \times \pi \times (1\text{-}\pi)]/\delta^2$, where α is the significance level (0.05), δ is the allowable error (0.03), and π is the prevalence rate of risk factors [21]. Among the risk factors included in the prediction chart (hypertension, high cholesterol, diabetes, smoking), hypertension has the highest prevalence rate (57.6%) among Chinese older adults, thus 57.6% was adopted as the prevalence rate in the formula [22]. Finally, a sample size of at least 1040 people was deemed ideal. Considering an estimated non-response rate of 20%, 1250 subjects were enrolled.

Of the 32 physical examination centers in tertiary hospitals in Hunan province, 10 were involved in this study selected through a cluster random sampling. Older adults who visited the physical examination centers were invited to participate in this study. The inclusion criteria were (a) age $\geq$ 60 years; (b) able to communicate verbally; and (c) without history of stroke, coronary heart disease or other atherosclerotic disease. With the support of the relevant departments, 33 registered nurses (RNs) in physical examination centers were trained to be investigators. Individuals who agreed to participate in this study were interviewed individually to fill the CVD knowledge questionnaire. The participants underwent a physical examination which included measurement of height, weight, blood pressure, and collection of blood samples for laboratory investigations (total cholesterol and plasma glucose). This study proposal was approved by the Ethics Review Committee of University of South China (Approval no.: 20160129) and signed informed consent was obtained from all subjects.

2.2. Measurements

2.2.1. Socio-demographic data and health-related characteristics

Participants were interviewed face-to-face by trained registered nurses to collect information on selected socio-demographic characteristics (age, sex, education and income), smoking status (Yes/No), diagnosis and treatment history of hypertension, hyperlipidemia, and diabetes. Smokers included current smokers and those who had quit smoking for less than one year [16].

2.2.2. Calculation of cardiovascular risk using WHO/ISH risk prediction charts

Participants' cardiovascular risks were assessed using the WHO/ISH cardiovascular risk prediction chart for the Western Pacific B sub-region, based on sex (male/female), age (40–49, 50–59, 60–69, $\geq$70), systolic blood pressure (<120 mmHg, 120–140 mmHg, 140–160 mmHg, 160–180 mmHg, >180 mmHg, 1 mmHg = 0.133 kPa), total blood cholesterol (<4 mmol/L, 4–5 mmol/L, 5–6 mmol/L, 6–7 mmol/L, 7–8 mmol/L, >8 mmol/L), presence or absence of diabetes mellitus and smoking status (yes/no). Low risk was defined as <10% risk of CVD within 10 years, moderate risk was 10% to <20%, high risk was 20% to <30%, while very high risk was $\geq$30%.

To determine the prevalence of individual risk factors among the participants, body mass index (BMI) was calculated as weight (kg)/height^2 (m^2). The categories of BMI were defined as: normal weight <25 kg/m^2, overweight 25–30 kg/m^2, and obese $\geq$30 kg/m^2. Hypertension was defined as having systolic blood pressure $\geq$140 mmHg and/or diastolic blood pressure $\geq$80 mmHg, or measurements below these thresholds but using anti-hypertension medication [23]. Two blood pressure readings were taken at 5-min intervals and averaged to obtain the final blood pressure [16]. Participants were classified into high cholesterol group based on low-density lipoprotein-cholesterol $\geq$130 mg/dL and/or total cholesterol $\geq$6.2 mmol/L (240 mg/dL), or measurements below this threshold but receiving cholesterol-lowering medication [24]. Diabetes was defined as fasting plasma glucose $\geq$7.0 mmol/L (126 mg/dL) and/or postprandial plasma glucose $\geq$11.1 mmol/L (200 mg/dL), or measurements below this threshold but receiving insulin or oral hypoglycemic drugs [25].

2.2.3. Knowledge of stroke/MI warning signs and CVD risk factors

A customized structured questionnaire was designed to assess CVD knowledge [26]. The items for the questionnaire were determined from literature and based on warning signs of stoke/MI and CVD risk factors published by the American Stroke Association, the International Stroke Association, the American Heart Association, and the WHO. Prior to conducting this study, the questionnaire was pretested for content, design, reliability, and comprehension on

200 older adults by a research group at University of authors, and necessary modifications were made to simplify the questionnaire for easy understanding and answering. The correlation coefficient of the questionnaire was 0.953, and the Cronbach's α coefficient was 0.826.

The questionnaire consisted of 26 items including 5 stroke and 5 MI warning sign items, 15 CVD risk factor items, and 1 item on calling emergency services (i.e., calling an emergency services should be the first action after a potential stroke/MI). All warning signs of stoke/MI and risk factors of CVD are outlined in the American Stroke Association, American Heart Association, National Stroke Association and National Heart Association. The options for each item were "True" and "False". Each question had a score of 1 for a "True" answer or 0 for a "False" answer, and the scores ranged from 0 to 26. The scores were categorized to high (20–26), moderate (8–19), and low (0–7) [26].

Prior to conducting this study, the questionnaire was pretested for reliability on 200 older adults. The correlation coefficient of the questionnaire was 0.953, and the Cronbach's α coefficient was 0.826.

2.3. Data analysis

All analyses were performed using SPSS 23.0 (IBM Company, Armonk, NY, USA). The frequency and percentage were used to describe the response to each item of the questionnaire. Univariate logistic regression was used to determine the relationship between social-demographic characteristics and CVD knowledge with the cardiovascular risk. The variables with a P-value ≤ 0.25 in the univariate analysis were entered into the multivariate logistic regression analysis to investigate the independent variables of the cardiovascular risk [27]. For each cardiovascular risk model, response options for the dependent variable were categorized as 'low/moderate knowledge' and 'high/very high knowledge'. A P-value <0.05 (two-tailed) was considered statistically significant.

3. Results

3.1. Demographic characteristics of the participants

A total of 1250 subjects were recruited, of which 130 were eliminated because they did not answer 50% of the questions in the questionnaire. Finally, 1120 participants were included for further analysis, translating to a response rate of 89.6%. The participants' mean age was 71.68 (SD = 6.93) years. Of the 1120 participants, 500 (44.6%) were female, 148 (13.2%) had attained a high level of education (college or above), and 579 (51.7%) had a low monthly income (<2000 CNY). (Table 1).

Table 1
Sociodemographic characteristics of participants (N = 1120).

Characteristic		*n* (%)
Gender	Male	620 (55.4)
	Female	500 (44.6)
Age (year)	60–69	452 (40.4)
	70–79	476 (42.5)
	≥80	192 (17.1)
	Mean ± *SD*	71.68 ± 6.93
Residence	City	501 (44.7)
	Rural	619 (55.3)
Educational Level	Uneducated or elementary school	557 (49.7)
	High school	415 (37.1)
	College or above	148 (13.2)
Income (CNY, monthly)	<2000 ($300)	579 (51.7)
	≥2000 ($300)	541 (48.3)

3.2. Cardiovascular risk factors and 10-year cardiovascular risk

Table 2 shows the prevalence of cardiovascular risk factors and CVD risk among the subjects. Of the total 1120 subjects, 37.5% had hypertension, of which 43.6% received treatment for hypertension; 36.2% had high cholesterol, 7.7% of whom received treatment for high cholesterol; while 18.9% had diabetes, of whom 26.4% received treatment for diabetes. Based on calculated BMI, 32.2% of the participants were overweight (25 to <30 kg/m^2), while 2.1% of them were obese (≥30 kg/m^2). Analysis of the calculated cardiovascular risk revealed that 298 participants (26.6%) had a very high cardiovascular risk (≥30%), 229 participants (20.4%) had a high cardiovascular risk (20% to <30%), 353 participants (31.5%) had a moderate cardiovascular risk (10% to <20%), and 240 participants (21.4%) had a low cardiovascular risk (<10%).

3.3. Knowledge of stroke/MI warning signs and CVD risk factors

Table 3 presents participants' knowledge on stroke/MI warning signs and CVD risk factors. The mean score of stroke/MI warning signs and risk factors was 8.08 out of 26 (SD = 2.99). Only 0.8% of 1120 participants had a high level of CVD knowledge (scoring 20–26), while 56.9% participants had low knowledge (scoring 0–7) on CVD.

The mean score of stroke/MI warning signs was 3.10 out of 10-point scale (SD = 1.65). None of the stroke warning signs was identified by more than 50% of participants. Less than 20% of participants identified "sudden confusion or trouble in speaking" and "sudden vision trouble" as stroke warning signs. Regarding the risk factors for CVD, the mean score was 4.98 out of 15-point scale (SD = 1.79). The most commonly identified risk factor was "hypertension" (61.4%), followed by "excessive alcohol consumption" (47.3%) and "hyperlipidemia" (46.7%). On the other hand, atrial fibrillation, stress and metabolic syndrome were identified by less than 20% of participants. Moreover, only 26.1% of the participants chose calling emergency service as their first action after a potential stroke/MI.

3.4. Association between knowledge and risk for CVD

The results of univariate analysis for the association between knowledge and risk of CVD are shown in Table 4. Variables

Table 2
Prevalence of cardiovascular risk factors and 10-year cardiovascular risk among participants (N = 1120).

Variables	*n* (%)
CVD and CVD risk factors and treatment	
Hypertension	420 (37.5)
High cholesterol	406 (36.2)
Diabetes	212 (18.9)
Taking antihypertensive medication if has hypertension	183/420 (43.6)
Taking lipid lowering medication if has high cholesterol	31/406 (7.7)
Taking hypoglycemic medication if has diabetes	56/212 (26.4)
Body mass index, BMI (kg/m$^{2)}$	
Normal (<25)	736 (65.7)
Overweight (25 to <30)	360 (32.2)
Obese (≥30)	24 (2.1)
Smoking	
Yes	351 (31.3)
Never	769 (68.7)
10-year cardiovascular risk	
Low (<10%)	240 (21.4)
Moderate (10 to <20%)	353 (31.5)
High (20%–30%)	229 (20.4)
Very high (>30%)	298 (26.6)

Note:CVD, cardiovascular disease.

Table 3
Participants' knowledge of stroke/MI warning signs and CVD risk factors among them ($N = 1120$).

Category	*n* (%)
Stroke warning signs	
Sudden numbness or weakness	501(44.7)
Sudden dizziness or trouble walking	348(31.1)
Severe unexplained headache	231(20.6)
Sudden vision trouble	218(19.5)
Sudden confusion or trouble speaking	212(18.9)
MI warning signs	
Pain or discomfort in jaw, neck or back	662(59.1)
Chest pain or discomfort	448(40.0)
Pain or discomfort in arm or shoulder	312(27.9)
Faint, light headache or weak	290(25.9)
Shortness in breath	250(22.3)
Call emergency service to a potential stroke/MI	292(26.1)
CVD risk factors	
Hypertension	688(61.4)
Excessive alcohol consumption	503(47.3)
Hyperlipidemia	523(46.7)
Overweight	507(45.3)
Smoking	453(40.4)
Suffering previous stroke/TIA	444(39.6)
Family history of cardiovascular disease	437(39.0)
Ischemic heart disease	436(38.9)
Lack of regular exercise	368(32.9)
Unhealthy diet	317(28.3)
Carotid stenosis	255(22.8)
Diabetes	234(20.9)
Atrial fibrillation	203(18.1)
Metabolic syndrome	113(10.1)
Stress	101(9.0)
Score of stroke/MI warning signs (10 points, *Mean* ± *SD*)	3.10 ± 1.65
Score of CVD risk factors (15 points, *Mean* ± *SD*)	4.98 ± 1.79
Score of stroke/MI warning signs and CVD risk factors (26 points, *Mean* ± *SD*)	8.08 ± 2.99
Total knowledge level (26 points)	
Low (0–7)	637(56.9)
Moderate (8–19)	474(42.3)
High (20–26)	9(0.8)

Note:MI, myocardial infarction; CVD, cardiovascular disease.

Table 4
Univariate analysis of factors associated with cardiovascular risk among participants ($N = 1120$).

Variables		Low/Moderate risk [*n*(%)}	High/Very high risk [*n*(%)]	*OR* (95%CI)	*P*
Gender	Male	323 (52.1)	297 (47.9)	1.017 (0.824– 1.257)	0.872
	Female	270 (54.0)	230 (46.0)	1	
Residence	Rural	316 (51.0)	303 (48.9)	1.058 (0.857–3.401)	0.597
	City	277 (55.3)	224 (47.7)	1	
Age (year)	60–69	257 (56.8)	195(43.2)	0.484(0.356– 0.658)	<0.001
	70–79	246(51.6)	230 (48.3)	0.678(0.500–0.917)	0.012
	≥80	90 (46.9)	102 (53.1)	1	
Income (CNY, monthly)	<2000 ($300)	276 (47.7)	303 (52.3)	1.669(1.350–2.063)	<0.001
	≥2000 ($300)	317 (58.6)	224 (41.4)	1	<0.001
Educational level	Uneducated or elementary school	248 (44.5)	309 (55.5)	3.099(2.217–4.328)	<0.001
	High school	245 (59.1)	170 (40.7)	1.948(1.383–2.746)	<0.001
	College or above	100 (67.5)	48 (32.4)	1	
Knowledge level	Low (0–7)	304 (47.8)	332 (52.2)	8.061(2.162–30.024)	0.002
	Moderate (8–19)	280 (59.1)	194 (40.9)	4.314(1.156–16.086)	0.030
	High (20–26)	9 (100.0)	0 (0.0)	1	

significantly associated with cardiovascular risk included age, income, educational level, and level of knowledge on CVD ($P < 0.05$). These variables were included in the multivariate logistic regression model to determine the independent risk factors for cardiovascular risk.

As shown in Table 5, age, income, educational level, and knowledge level of CVD were found to be independent risk factors for cardiovascular risk. Younger participants had lower cardiovascular risk (60–69: *OR*, 0.555; 95% CI, 0.406–0.760; 70–79: *OR*, 0.703; 95% CI, 0.516–0.958). The cardiovascular risk was significantly higher among those who received a monthly income of <2000 CNY compared to those who received a monthly income of >2000 CNY (*OR*, 1.429; 95% CI, 1.146–1.783), and those who were uneducated or had elementary school level of education compared to other educational level groups (*OR*, 2.784; 95% CI: 1.972–3.935). Generally, cardiovascular risk tended to decrease with higher level of knowledge on CVD (low level: *OR*, 9.796; 95% CI, 2.604–36.855; moderate level: *OR*, 5.562; 95% CI, 1.478–20.926), and the cardiovascular risk was significantly higher among those who had low level of knowledge on CVD compared to those who had high knowledge level (low level: *OR*, 9.796; 95% CI, 2.604–36.855).

Table 5
Multivariate analysis of factors associated with cardiovascular risk among participants ($N = 1120$).

Variable		*OR*	95% CI	*P*
Age (year)	60–69	0.555	0.406–0.760	<0.001
	70–79	0.703	0.516–0.958	0.025
	≥80	1		
Income (CNY, monthly)	<2000 ($300)	1.429	1.146–1.783	0.002
	≥2000 ($300)	1		
Educational level	Uneducated or elementary school	2.784	1.972–3.935	<0.001
	High school	1.818	1.285–2.573	0.001
	College or above	1		
Knowledge level	Low (0–7)	9.796	2.604–36.855	0.001
	Moderate (8–19)	5.562	1.478–20.926	0.011
	High (20–26)	1		

4. Discussion

4.1. Association between cardiovascular disease knowledge and risk among older adults should be considered

The present study comprehensively demonstrates the current status of cardiovascular risk and CVD knowledge among older adults. Results show that older adults with lower level of CVD knowledge have higher cardiovascular risk. These findings are important for designing future CVD intervention models such as programs that increase awareness of CVD among older adults.

Among the 1120 participants, 385 (45.4%) had high cardiovascular risk and very high cardiovascular risk (≥20%), indicating elevated cardiovascular risk in elderly population. This figure is far higher than that of other three developing countries in Asian, where the proportion of WHO/ISH “high CVD risk” (≥20%) in people above 40 years old is 20.8%, 10.4%, 23.1% in Malaysia, Cambodia and India, respectively [18,19]. It is not surprising for this difference because the participants in the current study were older (≥60 years old), and there are significantly positive relation between advanced age and cellular, structural, and functional changes in the heart and blood vessels. Moreover, older adults have been exposed to risk factors of CVD for a longer period than younger ones [28,29].

Some drugs may reduce the risk of CVD in patients with hypertension or high cholesterol by 25%–33% [16]. However, fewer participants in this study with hypertension, dyslipidemia and diabetes were treated for these diseases, which could also explain their relative high cardiovascular risk. Notably, treatment rate for hypertension in the present study is slightly lower than that of elderly in South Africa (43.6% vs 49.7%) [30], the treatment rate for high cholesterol is significantly lower than that of elderly patients in the United States (7.7% vs 42.6%) while the treatment rate of diabetes is almost half of elderly individuals in the United States (26.4% vs 50.9%) [31,32]. These huge gaps suggest the necessity of promoting health education on medication use among the elderly with risk factors in China. In addition, essential public health services and better health accessibility could also be useful in improving the treatment and control of these diseases [33,34].

Our analyses reveal that 56.9% of the participants had low CVD knowledge level. Notably, hypertension, hyperlipidemia, excessive alcohol consumption and smoking were well identified as CVD risk factors by the participants. In contrast, atrial fibrillation (18.1%), metabolic syndrome (10.1%) and stress (9.0%) was less-recognized by many participants as risk factors of CVD. One possible explanation for this phenomenon is that many older adults with hypertension or hyperlipidemia were informed that these diseases were risk factors of CVD by their physicians. We also note that hypertension and hyperlipidemia are frequently reported in the media compared with atrial fibrillation and metabolic syndrome. It was surprising that, unlike older adults in Korea [35], few participants (26.1%) were knowledgeable about the action of calling emergency service in case of vascular emergency, which could lead to adverse CVD events outcomes [36]. These findings underscore the urgent need to provide the elderly population with more knowledge on CVD, especially the unidentified risk factors, warning symptoms and the correct treatment for CVD events.

The multivariate analysis results show that participants with low knowledge on stroke/MI warning signs and CVD risk factors had higher cardiovascular risk, which is concordant with findings from a previous study focusing on women [37]. This can be explained by knowledge, attitude, practice (KAP) model, which states that behavior is determined by people’s knowledge and attitudes towards behavior. Previous studies suggest that knowledge about CVD determines how people adopt healthy living practices and comply with treatment, and further influencing the level of cardiovascular risk. Moreover, the level of knowledge about CVD in a given population is vital for their development of perceptions about the risk of CVD and formulation of healthy behaviors to reduce cardiovascular risk [38,39].

Results show that older adults with low education level or income have higher cardiovascular risk. This is in agreement with previous studies in which people of lower socioeconomic status were found to be at higher cardiovascular risk [40,41]. This is so because people with higher socioeconomic status have more access to health care and medical knowledge making them more likely to adopt healthier behaviors [42].

4.3. Implication for clinical practice

China has the largest elderly population compared with other countries in the world. Thus, reducing the CVD burden among Chinese elderly people is crucial to decreasing the global burden of CVD. This study reveals that cardiovascular knowledge is also an important factor influencing cardiovascular risk. This is an important factor since current prevention approaches for CVD are primarily based on overall cardiovascular risk of individuals, rather than the extent to which a single risk factor changes. Older adults with low knowledge are the most vulnerable group to CVD, hence increasing their knowledge about CVD may help to reduce their vulnerability to CVD. To increase awareness about CVD among older adults, we recommend the following: Firstly, community health service centers should establish CVD knowledge and behavior education feedback systems for the elderly. Although some CVD screening programs have been developed for high-risk populations in China, there is still no continuous health education for high-risk groups. The transformation of knowledge into healthy behavior is a long-term dynamic process. Moreover, older people absorb knowledge more slowly than younger people. Therefore, timely monitoring and feedback is needed to facilitate implementation of the next intervention plan. Secondly, individuals should be informed about their cardiovascular risk profile. Adequate awareness of cardiovascular risk is required to better understand the goals of preventive interventions and to comply with CVD prevention strategies. Thirdly, as many of the risk factors of CVD identified are conditions that occur over time and are limited to those older than 60 years, older adults need education and information earlier in lifespan and continue to reinforce. Furthermore, individuals' educational interventions should be stratified based on their different cardiovascular risks to make education more targeted and cost-effective.

4.3. Limitations

Although this study reveals that cardiovascular knowledge is associated with cardiovascular risk, we did not explore factors that mediate knowledge and risk, such as risk perception and behavior attitude, thus, the reason why knowledge affects the cardiovascular risk remains unclear. The validity of the questionnaires used in this study needs further verification. Future studies should explore the specific reasons that affect knowledge and risk, and develop interventions that increase knowledge about CVD for high-risk populations. Another limitation of this study is that nearly half of the elderly in this study were not educated which may have affected their understanding of some questions in the questionnaire. Indeed, even for those who completed the questionnaire with the assistance of the investigators, some of their answers reflected some lack of understanding rather than a true knowledge gap.

5. Conclusion

This study shows that knowledge about CVD among older adults in Hunan is poor, and many of these older adults are at high cardiovascular risk. Older adults with low knowledge level of CVD are more susceptible to cardiovascular risk. Targeted cardiovascular education is urgently required to improve CVD knowledge and thus reduce its risk among older adults.

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Declaration of competing interest

The authors declare that they have no competing interests.

CRediT authorship contribution statement

Qi Liu: Writing - original draft, Data curation. **Yan-Jin Huang:** Writing - original draft, Investigation. **Ling Zhao:** Writing - review & editing. **Wen Wang:** Investigation. **Shan Liu:** Investigation. **Guo-Ping He:** Writing - review & editing. **Li Liao:** Conceptualization, Supervision. **Ying Zeng:** Conceptualization, Methodology, Writing - review & editing.

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Appendix A. Supplementary data

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