Preventive Medicine Reports 33 (2023) 102219

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: www.elsevier.com/locate/pmedr

Differences in primary and secondary stroke prevention strategies for Chinese men and women

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ARTICLE INFO

Keywords:
Stroke prevention
Medication use
Risk factor control
Sex-specific differences
China Kadoorie Biobank

ABSTRACT

This study aimed to explore whether stroke prevention strategies differ for men and women. Data used were from China Kadoorie Biobank. According to the China-PAR Project model, a predicted 10-year stroke risk of ≥7% is defined as a high stroke risk. The effects of risk factor control and medication use as primary and secondary stroke prevention strategies were assessed, respectively. Logistic regression models were used to assess the sex-specific differences in the primary and secondary stroke prevention practices. Of the 512,715 participants (59.0% women), 218,972 (57.4% women) had a high risk of stroke and 8884 (44.7% women) had an established stroke. Of high-risk participants, women were considerably less likely than men to receive antiplatelets (odds ratio [OR], 0.80; [95% confidence interval, CI, 0.72–0.89]), antihypertensives (0.46[0.44–0.48]), and antidiabetics (0.65 [0.60–0.70]). Meanwhile, stroke women were significantly less likely to receive antiplatelets (0.75[0.65–0.85]) but more likely to receive antidiabetics (1.56 [1.34–1.82]) than their male counterparts. Besides, differences were found in risk factor control between women and men. Sex-specific differences in stroke prevention strategies are prevalent in China. Effective prevention requires the implementation of better overall nationwide strategies and special emphasis on women.

1. Introduction

Stroke is the leading cause of death and disability in China. According to the 2016 Global Burden of Diseases, Injuries, and Risk Factors Study, the age-standardized incidence of stroke in China was 354/100,000 person-years in 2016, which is the highest in the world(Johnson et al., 2019). Owing to this high incidence rate and the country's large population size, China accounted for more than 40% of all stroke cases and more than 30% of all stroke-related deaths and disability-adjusted life years worldwide(Johnson et al., 2019), making stroke a major public health issue in China.

Sex-specific differences in stroke epidemiology have been widely reported. For instance, some studies have reported that although stroke is more common among men, but its effects are more severe in women (Appelros et al., 2009; Gargano and Reeves, 2007; Reeves et al., 2008). Similar epidemiological patterns has been reported in China (Wang et al., 2017; Wang et al., 2019; Yu et al., 2015). This might attribute to the longer lifespan, and worse physical and psychological functions and poorer quality of life after stroke (Martínez-Sánchez et al., 2011; Petrea et al., 2009; Poynter et al., 2009).

Although significant advances have been achieved in the treatment of stroke, preventing the very first and any recurrent instances of stroke

Abbreviations: CKB, China Kadoorie Biobank; OR, odds ratio; CI, confidence intervals; TIA, transient ischemic attack; China-PAR, China-Prediction for Atherosclerotic Cardiovascular Disease Risk; BMI, body mass index; BP, blood pressure.

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https://doi.org/10.1016/j.pmedr.2023.102219
Received 17 December 2022; Received in revised form 17 March 2023; Accepted 23 April 2023
Available online 26 April 2023

remains the best strategy for reducing the burden of stroke (Jauch et al., 2013). Primary prevention strategies that aim to prevent stroke by targeting the modifiable risk factors such as diet, smoking, physical activity, history of cardiovascular diseases is particularly important because approximately 77% of all strokes are first events (Virani et al., 2020). Moreover, secondary prevention strategies that aim to prevent recurrent strokes are also important as they help to substantially reduce the burden of stroke because recurrent strokes are more disabling, fatal, and expensive to treat than the first strokes (Luengo-Fernandez et al., 2012; Rothwell et al., 2004).

The more pronounced stroke burden on women indicate that it is crucial to determine the appropriate stroke primary and secondary prevention strategies for them. However, sex-specific stroke prevention strategies have not yet been implemented in China (Chinese Society Of Neurology, 2019). Thus, China lacks adequate data on the potential differences in the stroke prevention strategies between men and women. Although studies have described the secondary prevention strategies used by Chinese patient who has stroke (Chen et al., 2014; Wei et al., 2010), they did not investigate the sex-specific differences in the use of those strategies. Given the disparities in the burden of stroke between the sexes, prevention strategies should be assessed separately for men and women. Herein, we aimed to describe the sex-specific differences in risk factor control and medication use for primary and secondary stroke prevention, to guide the development of sex-specific stroke prevention strategies in China.

2. Methods

2.1. Study population and data collection

The study population was selected from the CKB baseline survey. Detailed information about the CKB study design and procedures is available in previous reports (Chen et al., 2011; Chen et al., 2005). Briefly, the baseline survey took place between 2004 and 2008 from 10 (5 urban and 5 rural) geographically areas across China and enrolled 512 715 adults aged 30–79 years. During the baseline survey, data on each participant's sociodemographic characteristics, lifestyle practices, and medical history were collected by trained health workers using an interviewer-administered, laptop-based questionnaires.

Moreover, anthropometric measurements were undertaken using calibrated instruments with standard protocols. Blood pressure was measured twice using a UA-779 digital sphygmomanometer (A&D Instruments; Abingdon, UK) after at least five minutes in seated position, and a third measurement was taken if the values of systolic blood pressure (BP) differed by greater than 10 mm Hg. A 10-ml non-fasting blood sample was collected and time since the last eat were recorded from each participant and onsite plasma glucose was tested using the SureStep Plus meter (LifeScan, Milpitas, CA, USA).

To ensure quality control, a repeat survey of approximately 3% of the participants randomly selected from a particular community was conducted within a few weeks of the initial baseline survey.

The selection of the study population is depicted in Fig. 1.

2.2. Definitions

An established stroke if participants answered "yes" to the option of "stroke/transient ischemic attack (TIA)" in response to the question "Has a doctor ever told you that you had the following disease?" followed by a list of diseases, including stroke/TIA. The 10-year risk of stroke was estimated based on the China-Prediction for Atherosclerotic Cardiovascular Disease Risk (China-PAR) stroke risk model which used Cox proportional hazards model to estimate the 10-year risk of stroke in the Chinese population based on a range of major cardiovascular risk factors, with a high risk of stroke being defined as a predicted 10-year risk greater than or equal to the 90th centile (Xing et al., 2019). The China-PAR has been verified a good validity and suited to the Chinese population (Cheng et al., 2019; Tang et al., 2020).

Hypertension history was defined as the administration of antihypertensives, or a self-report of a previous diagnosis of hypertension. Diabetes mellitus history was defined as the administration of antidiabetics, or a self-report of a previous diagnosis of diabetes mellitus.

The smoking status was assigned as "never smoker," "former smoker" or "current smoker". The alcohol consumption status was assigned as "never drinker", "former drinker", "current weekly drinker," or "current daily drinker." The participants' diets were defined based on their self-reported consumption of certain foodstuffs, including vegetables, fruit, and red meat. Physical activity was defined as the total metabolic equivalent of task of each type of physical activity, in accordance with the 2011 Compendium of Physical Activities (Du et al., 2013).

The uses of medications including calcium channel antagonists, β-Blockers, ACE-I, diuretics, aspirin, statins, chlorpropamide or metformin and insulin were collected from participants, and then they were assigned to four types: anti-platelet, BP-lowering, anti-hyperglycemia and lipid-lowering.

The participants were considered to have their risk factors under control if their BP was <120/80 mm Hg, their body mass index (BMI) was between 18.5 and 24.0 kg/m^2, they were not a current smoker (including "never smoker" or "former smoker" who quit), they were not a current drinker (and neither a daily nor a weekly regular drinker), they

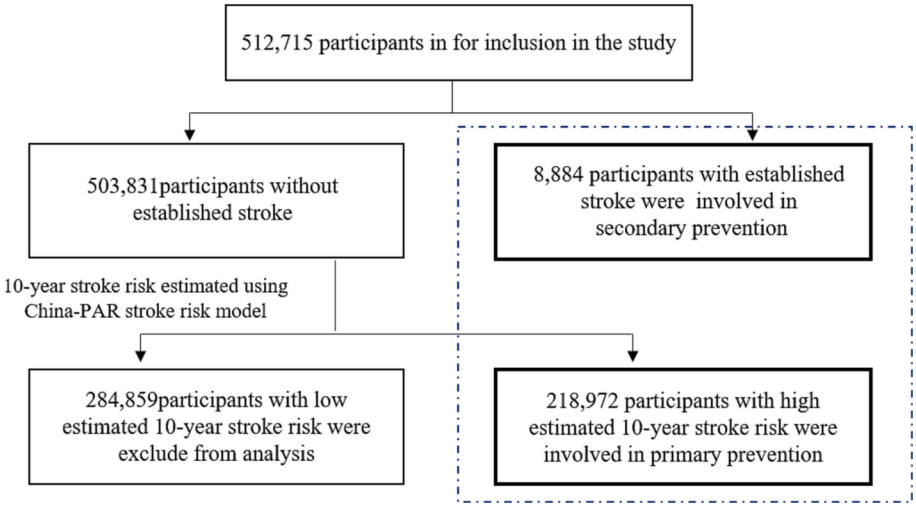

Fig. 1. Flowchart of the selection of the study population.

achieved their physical activity targets (the upper quartile of the metabolic equivalent of task), and they ate a balanced diet (consuming vegetables and fruits daily and red meat 1–6 days a week)(Lv et al., 2017).

2.3. Statistical analysis

The risk factor control and medication use components in the primary and secondary stroke prevention strategies were described for both men and women with a high risk of stroke and established stroke, respectively. Categorical variables were compared using the χ^2 test and reported as n (%). Continuous variables were compared using the *t*-test and were reported as the mean ± standard deviation. Logistic regression analysis was used to evaluate the associations between sex and medication use and between sex and risk factor control, while adjusting for sociodemographic information (i.e., age, geographical location, region, education level, occupation, household income, and health insurance), medical history (diabetes mellitus, hypertension, and dyslipidemia), and stroke duration (only applicable to cases of secondary prevention). The results are reported as adjusted odds ratios (ORs) with 95% confidence intervals (CIs) for women, with the values for men taken as the reference. A p-value<0.05 is considered to be statistically significant. All analyses were conducted using SAS software (v9.4; SAS Institute, Cary, North Carolina).

3. Results

3.1. Participant characteristics

Of the 512,715 participants, 218,972 participants (57.4% women) had a high 10-year risk of stroke, and 8,884 participants (44.7% women) had an established stroke (Table 1).

Among those with high risk of stroke, women were more likely to have higher education, be married, and be from a higher income household yet less likely to have health insurance, were more likely to have a history of hypertension or diabetes mellitus but less likely to have a family history of stroke (Table 1).

Among those with established stroke, women were less likely to have higher education, be married, be from a higher income household or to have health insurance, and more likely to have a history of hypertension or diabetes mellitus and a family history of stroke (Table 1).

3.2. Medication use and risk factor control among high-risk participants

The reported use of any medication for primary stroke prevention among high-risk participants was 7.7%, with the use of antiplatelets, antihypertensives, antidiabetics, and lipid-lowering drugs being 1.2%, 5.7%, 2.0%, and 0.2%, respectively. Fewer women than men used primary prevention drugs (4.8% women vs. 11.6% men; $p < 0.0001$), specifically antiplatelets, antihypertensives, antidiabetics, and lipid-lowering drugs (0.7%, 3.5%, 1.4%, and 0.1%, respectively, in women vs. 1.8%, 8.7%, 2.9%, and 0.4%, respectively, in men) (Table 2). The lower use of any of these drugs for primary stroke prevention among women was consistent across participants of all different sociodemographic characteristics, except in those aged ≥60 years (Fig. 2). Moreover, similar profiles were observed in the use of the four drug classes across participants with different sociodemographic characteristics (Table S1).

In terms of risk factor control for stroke prevention, a higher proportion of women reported that they were able to manage the different risk factors, except for their BMI. Specifically, most of the women were not current smokers (97.5%) or current drinkers (98.3%); the corresponding percentages for men were 34.1% and 67.6%, respectively. Moreover, approximately one third (36.6%) of all women met their physical activity and BP control targets; these rates were 18.5% and 6.8%, respectively, in men. More women than men had a balanced diet (8.1% vs. 4.8%; $p < 0.0001$). However, fewer women than men met their BMI targets (52.6% vs. 56.1%; $p < 0.0001$) (Table 2). These sex-specific

Table 1
Characteristics of participants with high stroke risk and established stroke by sex.

	High stroke risk (N = 218,972)			Established stroke (N = 8,884)		
	Men (N = 93,259) n (%)	Women (N = 125,713) n (%)	P value	Men (N = 4,911) n (%)	Women (N = 3,973) n (%)	P value
Age(year)						
<60	43,130(46.3)	125,616(99.9)	<0.0001	1,828(37.2)	1,659(41.8)	<0.001
≥60	50,129(53.7)	97(0.1)		3,083(62.8)	2,314(58.2)	
Urbanity						
Rural	59,547(63.8)	77,936(62.0)	<0.0001	2,081(42.4)	1,534(38.6)	0.0003
Urban	33,712(36.2)	47,777(38.0)		2,830(57.6)	2,439(61.4)	
Region						
Southern	51,823(55.6)	63,292(50.3)	<0.0001	1,921(39.1)	1,565(39.4)	<0.7921
Northern	41,436(44.4)	62,421(49.6)		2,990(60.9)	2,408(60.6)	
Education						
Primary school or lower	52,790(56.6)	51,773(41.2)	<0.0001	2,160(44.0)	2,411(60.7)	<0.0001
Middle school	22,876(24.5)	44,779(35.6)		1,432(29.2)	890(22.4)	
High school	11,856(12.7)	21,725(17.3)		806(16.4)	486(12.2)	
College or above	5,737(6.2)	7,436(5.9)		513(10.5)	186(4.7)	
Marital status						
Married	84,225(90.3)	120,642(96.0)	<0.0001	4,499(91.6)	3,140(79.0)	<0.0001
Others	9,034(9.7)	5,071(4.0)		412(8.4)	833(21.0)	
Household income(yuan)						
<9999	29,707(31.9)	36,745 (29.2)	<0.0001	1,417(28.9)	1,221(30.7)	0.0539
≥10000	63552(68.1)	88,968 (70.8)		3,494(71.1)	2,752(69.2)	
Health insurance status						
Insured	79,773(85.5)	99,600 (79.2)	<0.0001	4,343(88.4)	3,226(81.2)	<0.0001
Uninsured	13,486(14.5)	26,113 (20.7)		568(11.6)	747(18.8)	
History of disease						
Hypertension	3,829(26.9)	7,343(29.6)	<0.0001	2,769(56.4)	2,443(61.5)	<0.001
Diabetes mellitus	1,402(9.9)	4,217(17.0)	<0.0001	505(10.3)	602(15.2)	<0.001
Family history of stroke	19,014(20.4)	21,452(17.1)	<0.0001	1,284(26.2)	1,094(27.5)	0.141
Duration of stroke (year, mean ± SD)	–	–	–	5.22 ± 0.96	5.12 ± 0.99	<0.001*

SD = standard deviation, *for *t* test.

Table 2
Medication uses and stroke risk factors control in participants with high stroke risk and established stroke by sex.

	High stroke risk				Established stroke			
	Total (N = 218,972) n (%)	Men (N = 93,259) n (%)	Women (N = 125,713) n (%)	P Value	Total (N = 8,884) n (%)	Men (N = 4,911) n (%)	Women (N = 3,973) n (%)	P value
Medication uses								
Any drug	16,876(7.7)	10,840(11.6)	6,036(4.8)	<0.0001	3,793(42.8)	2,110(43.0)	1,683(42.4)	0.567
Anti-platelet drugs	2,536(1.2)	1,667(1.8)	869(0.7)	<0.0001	1,098(12.4)	679(13.8)	419(10.6)	<0.0001
BP-lowering drugs	12,550(5.7)	8,112(8.7)	4,438(3.5)	<0.0001	2,905(32.7)	1,606(32.7)	1,299(32.7)	0.9949
Anti-hyperglycemia drugs	4,355(2.0)	2,663(2.9)	1,692(1.3)	<0.0001	780(8.8)	355(7.2)	425(10.7)	<0.0001
Lipid-lowering drugs	516(0.2)	343(0.4)	173(0.1)	<0.0001	137(1.5)	78(1.6)	59(1.5)	0.6946
Risk factors control								
Not a current smoker	154,299(70.5)	31,754 (34.1)	122,545 (97.5)	<0.0001	6,518(73.4)	2,757 (56.1)	3,761 (94.6)	<0.0001
Not a current drinker	186,594(85.2)	63,063(67.6)	123,531(98.3)	<0.0001	7,915(89.1)	3,997(81.4)	3,918(98.6)	<0.0001
Balanced diet	14,553(6.7)	447(4.8)	10,182(8.1)	<0.0001	837(9.4)	388(7.9)	449(11.3)	<0.0001
Achieving Physical activity target	63,178(28.9)	17,211(18.5)	45,967(36.6)	<0.0001	475(5.4)	293(6.0)	182(4.6)	0.0039
BMI control	118,441(54.1)	52,331(56.1)	66,110(52.6)	<0.0001	5,038(56.7)	2,778(56.6)	2,260(56.9)	0.7643
BP control	52,354(23.9)	6,293(6.8)	46,061(36.6)	<0.0001	971(10.3)	470(9.6)	501(12.6)	<0.0001

BMI = Body Mass Index, BP = blood pressure.

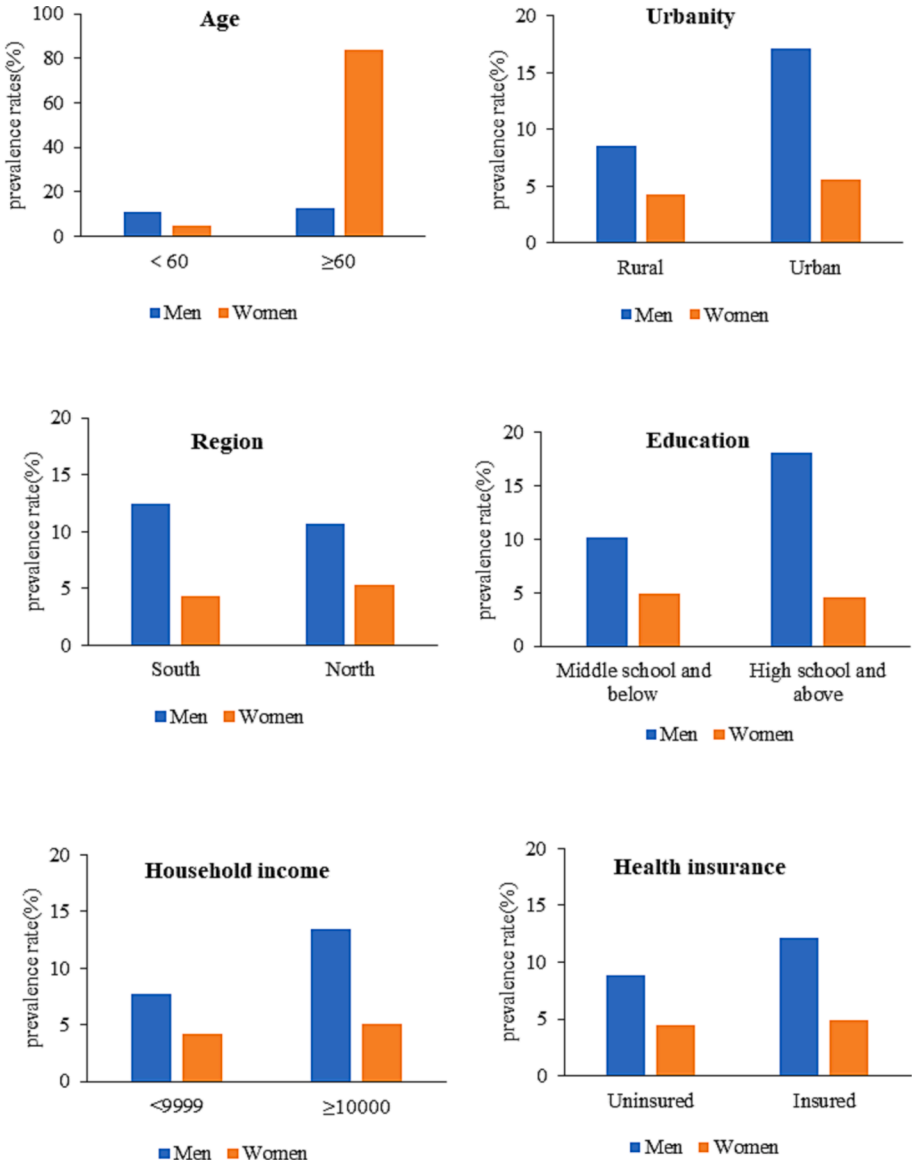

Fig. 2. Use of any stroke primary prevention medication among participants with high stroke risk by sex and individual characteristics.

differences remained consistent across individuals with different sociodemographic characteristics (Table S2).

3.3. Medication use and risk factor control among established stroke participants

Among participants with an established stroke, the reported use of any medication for secondary stroke prevention was 42.8%, with no differences observed between women and men (Table 2). When considering sociodemographic characteristics of participants, women with higher levels of education (i.e., high school or above) were significantly less likely than their male counterparts to use any secondary prevention medication (Fig. 3). The overall use of antiplatelets, antihypertensives, antidiabetics, and lipid-lowering drugs was 12.4%, 32.7%, 8.8%, and 1.5%, respectively. The use of antiplatelets was lower among women than among men (10.6% vs.13.8%; $p < 0.0001$); however, the opposite was observed in terms of the antidiabetics (10.7% vs.7.2%; $p < 0.0001$). There were no significant sex-specific differences in the use of antihypertensives and lipid-lowering drugs (Table 2). Sex-specific differences in use of the four drug classes were observed across participants with different sociodemographic characteristics (Table S3).

In terms of the stroke risk factors, 94.6% and 98.6% of the women were not current smokers and not current drinkers, respectively, and these rates were significantly higher than those for men (56.1% and 81.4%, respectively; $p < 0.0001$). Moreover, more women than men had a balanced diet (11.3% vs. 7.2%; $p < 0.0001$) and met their BP control targets (12.6% vs. 9.6%; $p < 0.0001$). However, fewer women than men achieved their physical activity targets (4.6% vs. 6.0%; $p = 0.0039$). Finally, no significant sex-specific differences were observed with respect to BMI control (56.9% in women vs. 56.6% in men; $p = 0.7643$). Sex-specific differences in the stroke risk factors were observed across participants with different sociodemographic characteristics (Table S4).

3.4. Adjusted sex-specific differences in primary and secondary stroke prevention

The adjusted sex-specific differences in primary and secondary stroke prevention are shown in Fig. 4.

In terms of primary stroke prevention, women were found to have a 7% lower odds of using any primary prevention medication (OR, 0.93; 95% CI, 0.88–0.99; $p = 0.0128$) and 20%, 54%, and 35% lower odds of using antiplatelets (OR, 0.80; 95% CI, 0.72–0.89; p < 0.0001),

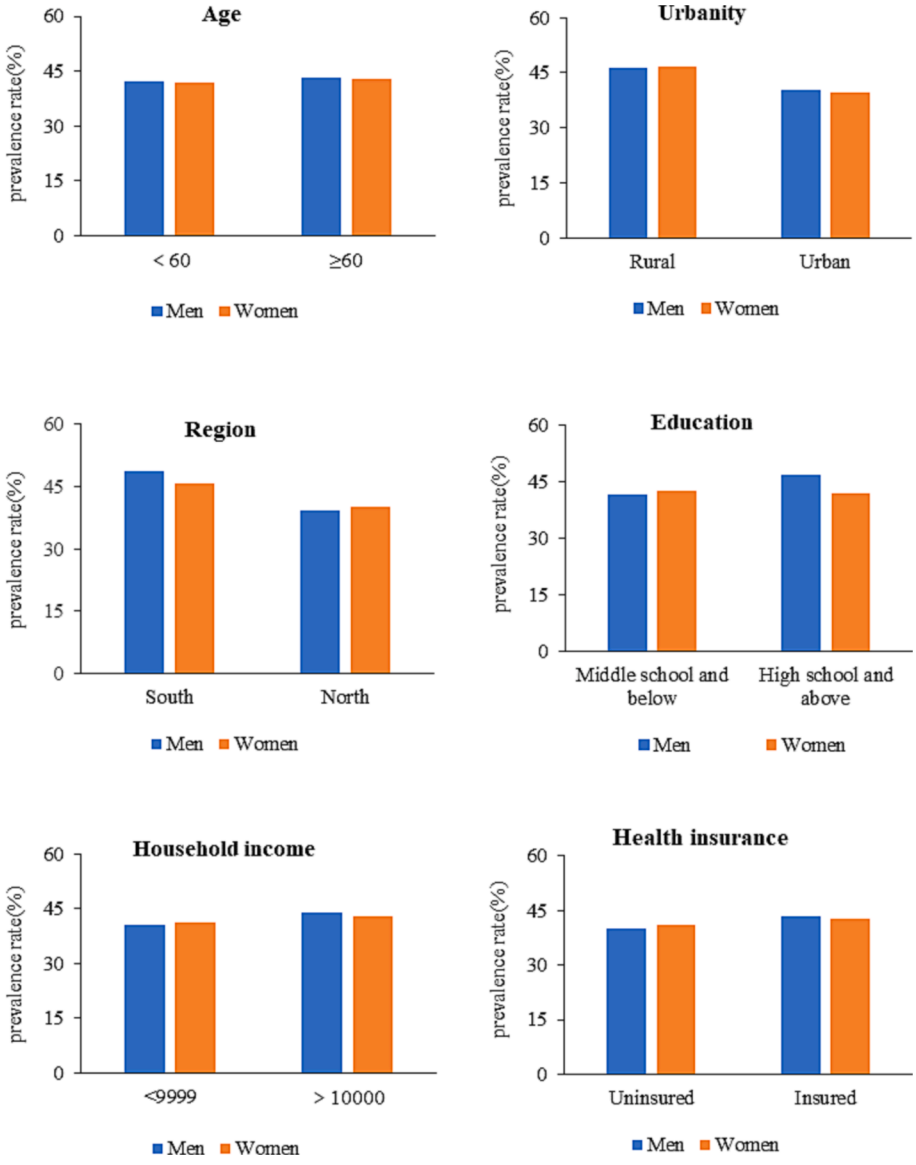

Fig. 3. Use of any secondary prevention medication among participants with established stroke by sex and individual characteristics.

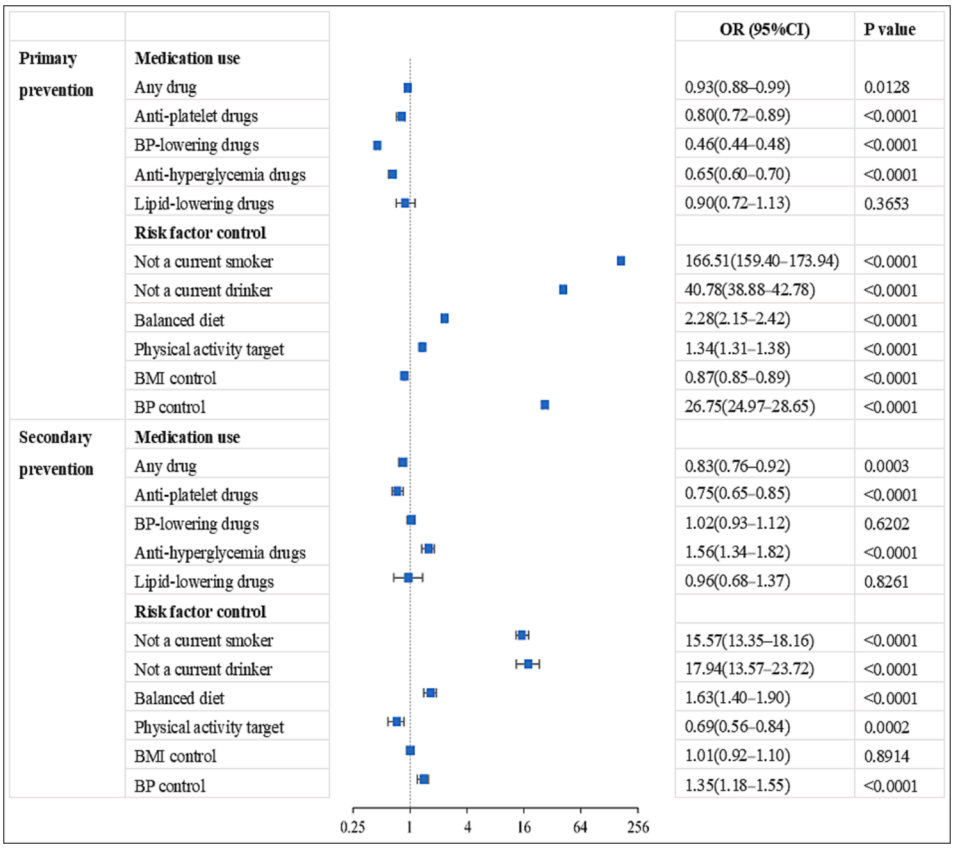

Fig. 4. Adjusted sex differences in stroke primary and secondary prevention. Adjusted for age, region, education level, occupation, household income, health insurance, history of disease (diabetes mellitus, hypertension) and duration of stroke (only for secondary prevention). Hypertension was not included in adjustment for risk factor control of blood pressure. BMI = Body Mass Index, BP = blood pressure.

antihypertensives (OR, 0.46; 95% CI, 0.44–0.49; $p < 0.0001$), and antidiabetics (OR, 0.65; 95% CI, 0.60–0.70; $p < 0.0001$), respectively. The odds of using lipid-lowering drugs did not vary by sex. In terms of the stroke risk factors, women were more likely than men to control their smoking and drinking habits; that is, women were 166 and 41 times more likely than men to be non-current smokers (OR, 166.51; 95% CI, 159.40–173.94; $p < 0.0001$) and non-current drinkers (OR, 40.78; 95% CI, 38.88–42.78; $p < 0.0001$), respectively. In addition, women had 128%, 34%, and 2575% higher odds of eating a balanced diet (OR, 2.28; 95% CI, 2.15–2.42; $p < 0.0001$) and meeting their physical activity targets (OR, 1.34; 95% CI, 1.31–1.38; $p < 0.0001$) and BP control targets (OR, 26.75; 95% CI, 24.97–28.65; $p < 0.0001$), respectively, than men. However, women had 13% lower odds of meeting their BMI targets (OR, 0.87; 95% CI, 0.85–0.89; $p < 0.0001$) than men.

In terms of secondary stroke prevention, women had 17% lower odds of using any secondary prevention medication (OR, 0.83; 95% CI, 0.76–0.92; p = 0.0003). In particular, women had 25% lower odds of using antiplatelets (OR, 0.75; 95% CI, 0.65–0.85; $p < 0.0001$), but 56% higher odds of using antidiabetics (OR, 1.56; 95% CI, 1.34–1.82; $p < 0.0001$) than men. The odds of using antihypertensives and lipid-lowering drugs did not vary by sex. In terms of the stroke risk factors, women than men, had 16- and 17-times higher odds of being non-current smokers (OR, 15.57; 95% CI, 13.35–18.16; $p < 0.0001$) and non-current drinkers (OR, 17.94; 95% CI, 13.57–23.72; $p < 0.0001$), respectively. Furthermore, women had 63% and 35% higher odds of eating a balanced diet (OR, 1.63; 95% CI, 1.40–1.90; $p < 0.0001$) and meeting their BP control targets (OR, 1.35; 95% CI, 1.18–1.55; $p < 0.0001$), respectively, than men. However, women had 29% lower odds of meeting their physical activity targets (OR, 0.69; 95% CI, 0.58–0.84; $p = 0.0002$) than men. Finally, the odds of achieving the BMI target did not vary by sex (OR, 1.01; 95% CI, 0.92–1.10; $p = 0.8914$).

Furthermore, we conducted these age-standardized rates of medication use and risk factor control by sexes. The similar patterns were observed except for any drug, anti-platelet drugs and BP-lowering drugs in participants with high stroke risk (Table S5), generally supporting our key findings.

4. Discussion

To the best of our knowledge, this is the first study to examine the sex-specific differences in primary and secondary stroke prevention strategies in the Chinese population using a large, nationally representative, population-based sample. Our findings indicated that the primary and secondary stroke prevention strategies were suboptimal for both women and men in China. In addition, sex-specific differences were observed in the medication use and risk factor control. Women were at an overall disadvantage in terms of the use of primary and secondary stroke prevention drugs but an advantage in terms of the stroke risk factor control.

Our study makes an important contribution to the field by controlling for confounding factors and demonstrating that the use of primary stroke prevention medications, except for lipid-lowering drugs, was significantly lower among women than among men with a high 10-year stroke risk. Such trends were observed across participants with different sociodemographic characteristics and may be partly attributable to the disadvantages women face with the Chinese health care system. Although women tend to possess a better knowledge of stroke (Itzhaki et al., 2016; Madsen et al., 2015), they usually prioritize their family members' health (Song and Bian, 2014). Moreover, it is possible that some women may not have received appropriate guidance from their physicians.

China has a high stroke recurrence rate, much higher than reported

in any Western countries (Ma et al., 2008), indicating that secondary stroke prevention strategies are insufficiently implemented. The efficacy of using antiplatelets as a secondary prevention strategy against recurrent stroke was demonstrated previously (Wong et al., 2013). In this study, we found that <15% of the participants with an established stroke used antiplatelets; this rate was lower than that noted in other high- and middle-income countries (Yusuf et al., 2011). A study conducted in China showed that the frequency of antiplatelet administration decreased after the occurrence of a stroke (Wei et al., 2010), indicating that both physicians and patients may have misunderstood the relevance of prescribing antiplatelets. Moreover, physicians' lack of familiarity with the appropriate treatment recommendations may also contribute to patients' failure to adhere to their medications after being discharged from the hospital (Bi et al., 2009). We also noted the insufficient prescription of antidiabetics and lipid-lowering drugs for secondary stroke prevention. Poor adherence to secondary stroke prevention guidelines exacerbated by a combination of cultural, financial, social, and psychological factors poses a significant challenge in China (Su et al., 2014; Wu et al., 2005). Therefore, systematic approaches should be established to improve the implementation of secondary stroke prevention methods in China.

We found that women with an established stroke reported a substantially lower use of antiplatelets for secondary stroke prevention; this was consistent with the findings of previous studies (Di Carlo et al., 2003; Simpson et al., 2005). Although a growing body of evidence shows that antiplatelets, such as aspirin, have comparable efficacies in men and women (Baigent et al., 2009), inequalities in the prescription of these drugs are common. The under-prescription of aspirin for secondary stroke prevention may be explained by the same reasons applicable to patients with cardiovascular diseases, including misperceptions related to disease prevalence and severity and the insufficient health care service utilization (Cho et al., 2008; Koopman et al., 2013; Zhao et al., 2020). In addition, in this study, women who had an established stroke had a higher prevalence of hypertension and diabetes mellitus. The under-prescription of antiplatelets among women may be associated with their side effects (e.g., gastrointestinal bleeding). This represents a specific challenge to China given the tense doctor-patient relationships that making doctors' prescription more prudent to avoid patients' dissatisfaction or disputes. Moreover, besides antiplatelets, anticoagulants are commonly used for stroke prevention and treatment. Because the CKB did not investigate the use of anticoagulants, it is uncertain whether the under-prescription of antiplatelets among women was due to their use of anticoagulants.

In terms of risk factor control, we found that women were less likely than men to meet their recommended weight targets. However, women were more likely than men to have their smoking, drinking, diet, and BP under control. Our findings corroborate those from previous studies (De Smedt et al., 2016; Wang et al., 2019) and provide implications for having sex-specific health policy and resource arrangements for stroke prevention. For instance, more attention needs to be paid to the lifestyle risk factors and BP control among men and to weight management among women. One notable finding of our study was that women with a high risk of stroke had better control over their diet and physical activity but were less likely to meet their BMI targets than their male counterparts; this may be attributable to the high prevalence of smoking among men, as some studies have shown that current smokers often have a lower BMI than ex-smokers and never smokers (Kvaavik, 2004; Sneve and Jorde, 2008). These findings suggest that more efforts are needed to develop weight management programs for never-smokers and ex-smokers.

Lifestyle and behavioral risk factors for stroke are more common among men than among women. However, these factors may also disproportionately increase the risk of stroke among women. Several large cohort studies have suggested that risk factors such as smoking (Peters et al., 2013), diabetes (Peters et al., 2014), and obesity (Wilson et al., 2002) increase the risk of stroke to a greater extent in women than in men. Accordingly, a stronger emphasis on primary stroke prevention efforts targeting women may yield significant benefits. Additional studies are needed to determine the factors that hinder women from engaging in primary stroke prevention, thereby enabling health care providers and policymakers to address the suboptimal stroke prevention practices for women.

Although the present study did not explore the effects of health care delivery on stroke prevention, issues within the Chinese health care system were recognized as a crucial impediment to the effective implementation of stroke prevention strategies in the country (Liu et al., 2011). China lacks effective primary health care networks such as those present in Western countries, making it challenging to frequently monitor and control the risk factors for stroke (Li et al., 2016). Meanwhile, the hospital-based health care delivery system in China, which focuses on acute and serious diseases but lacks disease prevention services, significantly impacts the incidence and control of stroke. Additionally, the integration of emergency units, hospitals, community health care centers, and rehabilitation centers is weak, resulting in poor long-term medication adherence and rehabilitation services (Li et al., 2019). Moreover, the health insurance coverage rate exceeds 80% in China but is insufficient in most cases. Services such as primary prevention care or long-term care for patients with chronic illness are not covered, thereby posing a challenge to stroke prevention in China.

Our findings highlight the best practices for bridging the gaps due to the sex-specific differences in stroke prevention strategies. Intervention policies should promote research to determine the reasons underlying these sex-specific differences; the issuance of sex-specific practice guidelines for stroke prevention; amendments of physicians' underestimation of the stroke risk among women; improvements in patient awareness, adherence, and self-efficacy; and the resolution of structural defects and a reimbursement system for general health care in China.

Our study strengths lie in its large, nationally representative sample size, which made it possible to assess stroke and the related risk factors, and the inclusion of confounding factors, which allowed us to understand the sex-specific differences in primary and secondary stroke prevention strategies and to identify the vulnerable groups. Our findings provide insightful information and evidence for use in future studies on the management and treatment of stroke and for establishing stroke prevention guidelines in China. However, our study also has some limitations. First, the study included only Chinese participants, thereby limiting the generalizability of our findings. Second, this was a cross-sectional descriptive study, which limited the establishment of causality. Third, the identification of stroke and medication use were based on self-reported data, which might have caused a recall bias. However, the Prospective Urban Rural Epidemiology-China study suggested that the confirmation rate between self-reported stroke and hospital records was 89% (Yusuf et al., 2011), and our findings were comparable to those of the Prospective Urban Rural Epidemiology-China study. In addition, evidence from many other studies conducted in different populations has demonstrated that self-reported cases of stroke have high specificity and credibility (Okura et al., 2004; Yamagishi et al., 2009). Fourth, the subtype and severity of stroke were not specified in the CKB baseline survey, which could have affected the use of secondary prevention strategies.

5. Conclusion

Despite current efforts to combat stroke, both primary and secondary stroke prevention strategies are being implemented in a suboptimal manner in China, and significant discrepancies in the implementation of these strategies exist between the sexes. Women with a high risk of stroke are less likely to take primary prevention medications than men. These findings indicate the need for an in-depth assessment of the current preventive care services and for substantial improvements in multifaced interventions, with the aim to develop and deliver services specifically tailored to the needs of women.

Ethical statement

The CKB study has obtained its ethical approval from Central Ethical Committee of the Chinese Centre for Disease Control and Prevention, the University of Oxford UK and Institutional Research Boards in the 10 study regions, meanwhile, all the participants had provided written informed consent before survey. The present study was reviewed by the Scientific Ethics Committee of the Chinese Academy of Sciences and followed the Declaration of Helsinki.

Role of funding sources

This research was funded by the National Natural Science Foundation of China (82173648, 72004104), Hwa Mei Research Fund of Hwa Mei Hospital, University of Chinese Academy of Sciences (2019HMKY32), Ningbo Clinical Research Center for Digestive System Tumors (2019A21003), Ningbo Science and Technology Innovation 2025 Specific Project (2020Z096), the Innovative Talent Support Plan of the Medical and Health Technology Project in Zhejiang Province (2021422878), Zhejiang Provincial Public Service and Application Research Foundation (LGF20H250001, GC22H264267), the Medical and Health Science and Technology Program of Zhejiang Province (2023XY154), the Internal Fund of Ningbo Institute of Life and Health Industry, University of Chinese Academy of Sciences (2020YJY0212), and Natural Science Foundation of Tianjin (20JCZDJC00540). The funders had no role in the design, data collection, analysis, interpretation of the data, and writing of this work.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

Acknowledgments

The authors thank the participants in the study and the members of the survey teams in each of the 10 regional centers, as well as to the project development and management teams based at Beijing, Oxford, and the 10 regional centers.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2023.102219.

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