Awareness, treatment, control, and determinants of dyslipidemia among adults in China: results from the China National Stroke Screening and Prevention Project (CNSSPP)

Sampson Opoku (samblessvissions@gmail.com)
Huazhong University of Science and Technology
Yong Gan
Huazhong University of Science and Technology
Emmanuel Addo-Yobo
State University of New York Upstate Medical University
Wei Yue
Tianjin Huanhu Hospital
Zhihong Wang
shenzhen university
Zuxun Lu
Huazhong University of Science and Technology

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Abstract

Background:

Effective management of dyslipidemia could play a vital role in the control of cardiovascular diseases. This study aimed to determine the awareness, treatment, control, and determinants of dyslipidemia in middle-aged and older Chinese adults in China.

METHODS

Using data from the 2015 CNSSPP, a nationally representative sample of 135,403 Chinese adults aged over 40 years were included in the cross-sectional analysis. Dyslipidemia was defined according to the 2016 Chinese guidelines for the management of dyslipidemia in adults. Models were constructed to adjust for sociodemographic, clinical and behavioral characteristics with bivariate and multivariable logistic regressions.

RESULTS

Overall, 51.1% of the subjects were women. Sixty-four percent (36,958/57760) were aware of their condition, of whom 18.9% (6993/36958) received treatment, and of whom 7.3 % (504 /6993) had controlled lipids. Women versus men had higher proportions of awareness, treatment, and control (69.2% vs. 58.3%, 63.8% vs.64.1% and 7.7% vs.7.0%; $p<$ 0.001), respectively. Dyslipidemia treatment was higher in men from rural than urban areas (15.4% vs. 10.6%; $p<0.001$). Most subjects (94.3%), had dyslipidemia in their family. The proportion of awareness was higher among urban compared to rural residents across all the socioeconomic regions: low-income (68.8% vs. 60.4%), middle-income (69.4% vs.63.9%), and high-income (66% vs.58.6%), respectively (all $p<$ 0.001). In the multivariable analysis, significant associations were found between awareness and women, urban residents, having a family history, and central obesity. Being a woman, having a personal history of stroke or CHD, being a drinker, having health insurance, and persons who lived in high-income regions had higher odds of receiving treatment. Adults in the 50 - 59 years age group, having health insurance, central and general obesity, living in a stroke belt or northern zone, urban area, and women showed statistically significant relationships with control.

CONCLUSIONS

Dyslipidemia awareness was moderately high, but treatment and control were low. Improvements in education programs and therapeutic management may be necessary to promote and optimize the management of dyslipidemia.

Introduction

Cardiovascular diseases (CVDs) are the leading cause of morbidity and mortality globally.[1] Dyslipidemia is an established risk factor for CVDs' morbidity and mortality. [2] Annually, 4.4 million deaths occur worldwide as a result of raised cholesterols.[3–5] Dyslipidemia awareness, treatment and control have been studied in general populations and the treatments of lipid disorders have proven to be effective in both primary and secondary prevention of cardiovascular events.[6] Nevertheless, dyslipidemia screening and treatment rates have been low in low- and middle-income countries.[5]

With the rapid economic and health transitions coupled with lifestyle changes, dyslipidemia prevalence in China have increased recent years. The China National Diabetes and Metabolic Disorders Study reports that the levels of TC,

LDL-C, and TG have substantially increased in recent decades, however, awareness and treatment levels still remained low. [7] Song et al., in 2011 reported the awareness, treatment and control rates among dyslipidemic adults' aged ≥ 45 years in China as 20.27%, 14.41% and 4.94%, respectively.[8] In 2014 a systematic review of observational studies on dyslipidemia in China with 387,825 subjects showed 42% prevalence rate, 24.4% awareness rate, 8.8% treatment rate, and 4.3% control rate. [9] In view of the above stated studies, and with reference to the "rule of halves" framework, it can be observed that the rate of dyslipidemia awareness, treatment and control in China have been quite low. The 'rule of halves' is a proxy framework used to estimate indicators of unmet needs for chronic diseases and it stipulates that: (1) about 50% of all diseases should be diagnosed, (2) of whom about 50% should receive treatment and (3) of whom about 50% achieve should treatment targets. [10] Medication adherence and lifestyle changes are known to decrease the cost related to cardiovascular healthcare, and the person's awareness of disease and early onset of treatment are essential for effective management.[11] Studies on dyslipidemia awareness, treatment and control and their determinants at national level in China are limited. Therefore, we aimed to estimate the awareness, treatment and control of dyslipidemia and their determinants among Chinese middle-aged and older adults using a nationally representative sample.

Methods

STUDY POPULATION

This cross-sectional study retrieved data from the 2015 CNSSPP. It was a national program instituted by the Chinese government in 2011 to support stroke prevention and control. Details have been described previously. [12,13] Briefly, it involved Chinese adults aged ≥ 40 years. It used a multistage probability-sampling strategy with random samples drawn from local areas, counties, rural and urban communities. [13] Respondents were recruited from 200 project areas according to local population sizes and counties. Further, an urban and a rural community were chosen from each project area as primary sampling unit based on their geographical locations in the 30 municipalities and provinces across China.

DATA COLLECTION

Personnel were trained to take anthropometric measurements, record blood pressure (BP) and manage matters relating to the questionnaire. The questionnaire collected details of sociodemographic, medical and lifestyle information. Data examined included: age (in four categories, 40–49, 50–59, 60 – 69, and ≥ 70 years old); [14] an urban area was defined using the 12-component urbanization index; [15] level of education (primary school and below, junior/ middle school, senior/middle school, and college/higher);[16] sex (male, female); ethnicity (Han, other ethnicities;[17] marital status (married, widowed/divorced/unmarried). In addition were: health insurance coverage, classified into 'yes' and 'no' (yes refers to respondents on any health insurance program at the time of the interview).[16] Socio-economic regions (high, middle, low-income) based on the per-capita disposable household's income thresholds in 2014.[17] Current smoking (if a participant reported smoking at least one cigarette per day). Current drinking (if a participant reported drinking alcoholic beverages ≥ 1 per week for more than half a year).[17] Physical activity (if a participant reported an activity of ≥ 3 times per week for at least 30 minutes each episode, or engaged in heavy physical work). [16] History of stroke or CHD (a participant self-report of physician's diagnosis of CHD or stroke and/or currently receiving medications). [17] Family history of dyslipidemia was on the basis of whether the respondent's family (parents and siblings) had been diagnosed by a physician for dyslipidemia.[18]. These data were obtained from self-reports of participants. Two geographical groupings were used to zone participants: a) the

north and south zones (according to the Huai River–Qin Mountains Line), and b) the stroke and non-stroke belt zones. The stroke belt was defined based stroke incidence in China i.e. any region containing provinces that met the criteria for a region of high stroke incidence.[17]

Body weight, to the nearest 0.1 kg, and height was measured, to the nearest 0.1 cm. The body mass index (BMI) was calculated as the weight in kilograms divided by the height in meters squared (kg/m2) based on China's Ministry of Health criteria. [19] BMI categories (underweight if BMI < 18.5 kg/m^2, normal weight 18.5–24.0 kg/m^2, overweight 24.0 to < 28 kg/m^2, and obesity ≥ 28 kg/m^2). Central obesity, was measured and defined as ≥ 0.90 and ≥ 0.85 for men and women, respectively.[17]

Blood pressure was measured three times and the average of the three readings was used to define hypertension as systolic BP ≥ 140 mmHg or diastolic BP ≥ 90 mmHg, or self-report of physician diagnosis and currently receiving antihypertensive medications.[20] Fasting glucose was used to define diabetes if ≥ 126 mg/dL (7.0 mmol/L) or self-report of physician diagnosis and currently receiving ant-diabetic medication.

A standardized protocol was used to collect blood samples from participants at all research centers. All laboratories received instructions on the protocols to be followed including labelling of kits for blood collection for each adult. Participants' venous blood samples were collected after 8-hour overnight fasting at tests centers with a lipid and a glucose tube, stored in cold boxes and transported to certified examination centers.

DEFINITIONS OF LIPID VARIABLES

Blood samples were investigated for TC, HDL-C, TG, and LDL-C according to standardized protocols. Lipid disorders were classified based on the latest Chinese guidelines for the prevention and treatment of dyslipidemia in adults. [21] Dyslipidemia was defined as having either or combination of total cholesterol (TC) ≥ 240 mg/dL (6.22 mmol/L) or LDLC ≥ 160 mg/dL (4.14 mmol/L) or HDL-C < 40 mg/dL (1.04 mmol/L), or triglyceride (TG) ≥ 200 mg/dL (2.26 mmol/L) or non-HDL-C ≥ 190 mg/dl (4.9 mmol/L) or a current use of lipid modifying medications.[21] Awareness of dyslipidemia was defined as a self-reported physician diagnosis of dyslipidemia or self-reported use of lipid-lowering medication within the population defined as having dyslipidemia. In addition, treatment of dyslipidemia was defined as using prescribed lipid-lowering medications to treat dyslipidemia among participants with dyslipidemia, and control of dyslipidemia was defined as having dyslipidemia and being treated with medications if the individual has TC < 240 mg/dL, LDL-C < 160 mg/dL, HDL-C ≥ 40 mg/dL and triglycerides < 200 mg/dL. [7,9,19]

DATA ANALYSIS

The International Business Machine Statistical Package for Social Sciences (IBM SPSS) version 19.0 (SPSS Inc, Chicago, Ill) software was used for all analyses. Continuous variables were presented as mean ± SD (normal distribution) and as median(IQR) (skewed distribution). Categorical variables were reported as numbers (percentages), and by proportions and 95% confidence intervals (CIs). The standardized awareness, treatment and control rates were calculated according to the age and sex-specific structure of the 2010 Chinese national population census. We explored the associations between determinants (categorical) and the outcome variables of interest (awareness, treatment, and control), using univariate and multivariable logistic models. Data were presented as unadjusted (OR) and adjusted odds ratios (aOR) and 95% confidence intervals (CI). All statistical tests were two-tailed and pvalues ≤ 0.05 considered statistically significant. Processing of graphs and tables was done using MS excel 2013.

Results

STUDY PARTICIPANTS

About 180,000 participants were further randomly selected from all provinces purposely to assess them for stroke risk factors such as dyslipidemia.[13] Of these, 135,403 weighted participants were finally used for the analysis after excluding people with missing and incomplete data related to BMI and lipid variables. Table 1 summarizes the distribution of participant's characteristics. Overall, 51.1% were women. The mean age (SD) was 56.56 ± 9.98 years. More than a third of respondents were aged 50–59 years (42.3%). Approximately, sixty-two percent (62.1%) of the subjects had primary or no education, and over 50% lived in rural areas (53.6%). Most respondents (94.3%), had a family history of dyslipidemia. Slightly over 40% of them were overweight, about 33% were current smokers, 19% drank alcohol, and 62% were physically active. About 62.4% of participants had central obesity.

Table 1
Overall, dyslipidemic and non-dyslipidemic and characteristics among adults, China 2014

Variables	Total	Dyslipidemic	Non-dyslipidemic	P values
Total	135,403 (100%)	57760 (42.7%)	77642 (57.3%)	
Age,	56.56 ± 9.98	56.48 ± 9.73	56.62 ± 10.16	0.12
Median (IQR)				
40–49	35617 (26.3)	14821 (25.7)	20796 (26.8)	< 0.001
50–59	57300 (42.3)	25037 (43.3)	32263 (41.6)	
60–69	26154 (19.3)	11437 (19.8)	14717 (19.0)	
70 and above	16331 (12.1)	6465 (11.2)	9866 (12.7)	
Sex				
Men	66259 (48.9)	27816 (48.2)	38443 (49.5)	< 0.001
Women	69144 (51.1)	29945 (51.8)	39199 (50.5)	
Residence				
Rural	72556 (53.6)	31292 (54.2)	41264 (53.1)	< 0.001
Urban	62847 (46.4)	26469 (45.8)	36378 (46.9)	
Nationality				
Han	130934 (96.7)	55557 (96.2)	75377 (97.1)	< 0.001
Others	4465 (3.3)	22.3 (3.8)	2262 (2.9)	
Marital Status				
Married	80154 (59.2)	32362 (56.0)	47792 (61.6)	< 0.001
Divorced/Widowed/Others	55248 (40.8)	25398 (44.0)	29850 (38.4)	
Level of Education				
Primary and Below	84118 (62.1)	37459 (64.9)	46659 (60.1)	< 0.001
Junior/Middle School	32233 (23.8)	12264 (21.2)	19969 (25.7)	
Senior High School	13104 (9.7)	5598 (9.7)	7506 (9.7)	
College and above	5948 (4.4)	2440 (4.2)	3508 (4.5)	
Health Insurance				
Yes	104254 (77.0)	49092 (85.0)	55162 (71.0)	< 0.001
No	31149 (23.0)	8669 (15.0)	22480 (29.0)	
Socio- economic region				
Low- income	32084 (23.7)	15029 (26.0)	17055 (22.0)	< 0.001

Variables	Total	Dyslipidemic	Non-dyslipidemic	P values
Middle- income	40212 (29.7)	18395 (31.8)	21817 (28.1)	
High-income	63108 (46.6)	24337 (42.1)	38771 (49.9)	
Geographical Regions				
1North	75174 (55.5)	29172 (50.5)	46002 (59.2)	< 0.001
South	60229 (44.5)	28589 (49.5)	31640 (40.8)	
Stroke Belt Zone				
Yes	23262 (17.2)	9449 (16.4)	13813 (17.8)	< 0.001
No	112142 (82.8)	48312 (83.6)	63830 (82.2)	
Weight	65.00 (58.00–71.50)	65.00 (58.00–72.00)	55.00 (49.00–63.00)	< 0.001
Height	162.07 ± 8.40	161.85 ± 8.56	162.24 ± 8.27	< 0.001
BMIa				
Median (IQR)	25.2 (23.02–27.47)	25.7 (23.46–27.89)	25.05 (22.66–27.09)	
Underweight (< 18.5 kg/m2	1835 (1.4)	568 (1.0)	1267 (1.6)	< 0.001
Normal (18.5 -<24.0)	46598 (34.4)	16968 (29.4)	29630 (38.2)	
Overweight (24.0 -< 28)	59314 (43.8)	26232 (45.4)	33082 (42.6)	
Obesity (≥ 28.0)	27655 (20.4	13992 (24.2)	13663 (17.6)	
Waist Circumference†				
Median (IQR)	86.00(80.00–93.00)	88.0 (80.00–95.00)	85.00 (79.00–92.00)	
Normal < 90/85 cm (M/W)	56214 (42.0)	21034 (36.7)	35180 (45.9)	< 0.001
Central obese ≥ 90/85 cm (M/W)	77700 (58.0)	36230 (63.3)	41470 (54.1)	< 0.001
Family History of Dyslipidemia	127624 (94.3)	53695 (93.0)	3714 (4.8)	< 0.001
History of CHD	123279 (91.0)	51455 (89.1)	71824 (92.5)	< 0.001
History of Stroke	107268 (79.2)	44726 (77.4)	62542 (80.6)	< 0.001
Fasting Blood Glucose(FBG)mmol/l	5.94 ± 1.91	5.95 ± 1.95	5.94 ± 1.88	< 0.001
Systolic Blood Pressure (SBP)	94.22 ± 63.66	98.34 ± 63.29	91.16 ± 63.77	< 0.001
Diastolic Blood Pressure (DBP)	57.80 ± 39.00	59.84 ± 38.36	56.28 ± 39.39	< 0.001
Diabetes Mellitus	41036 (30.3)	19059 (33.0)	21977 (28.3)	< 0.001
Hypertension	84462 (62.4)	37634 (65.2)	46828 (60.3)	< 0.001

Variables	Total	Dyslipidemic	Non-dyslipidemic	P values
Hypertension and diabetes	28577 (21.1)	13606 (23.6)	14971 (19.3)	< 0.001
Drinking (Current)	25747 (19.0)	11249 (19.5)	14498 (18.7)	< 0.001
Smoking (Current)	43992 (32.5)	19078 (33.0)	24914 (32.1)	< 0.001
Physical activity	83913 (62.0)	35349 (61.2)	48564 (62.5)	< 0.001
Lipid variables: Median (IQR)				
TC mmol/l	4.90 (4.23–5.62)	5.26 (4.35–6.25)	4.73 (4.18–5.29	< 0.001
HDL-C mmol/l	1.31 (1.10–1.60)	1.09 (0.93–1.43)	1.42 (1.23–1.70)	< 0.001
LDL-C mmol/l	2.85 (2.21–3.41)	3.03 (2.22–3.88)	2.75 (2.21–3.20)	< 0.001
Triglycerides mmol/l	1.50 (1.06–2.16)	2.30 (1.51–3.10)	5.47 (4.98–6.20)	< 0.001
Non-HDL-C [Ø] mmol/l	3.53 (2.84–4.23)	4.10 (3.28–4.86)	3.24 (2.63–3.78)	< 0.001
Dyslipidemia was defined as total cholesterol (TC) > 6.22 mmol/L **or** low-density lipoprotein (LDL-C) > 4.14 mmol/L				
or high-density lipoprotein (HDL-C) < 1.04 mmol/L **or** triglycerides (TG) > 2.26 mmol/L **or** non-high density				
lipoprotein > 4.9 mmol/L **or** self-reported treatment. Data shown as mean ± SD, or median (IQR) or n(%)				
**p-value* for comparison of dyslipidemic vs. non dyslipidemic respondents.				

AWARENESS, TREATMENT AND CONTROL OF DYSLIPIDEMIA

A previous study by Opoku et al. with a sample of 136,945 Chinese adults' aged ≥ 40 years showed that the prevalence of dyslipidemia was 43%. In this study, as shown in Table 2, a total of 36,958 (64.0%) persons were aware of the condition, of whom 6993 (18.9%) received treatment, and of whom 505 (7.3%) had controlled lipids. Considering the age groups, the highest proportion of awareness (64.3%) was seen among the ≥ 70 year olds, adults aged 60–69 years had the highest proportion for treatment (19.2%), whilst lipids control was highest (9.8%) among 40–49 years old individuals. Women versus men, respectively, had higher proportions of awareness, treatment, and control (69.2% vs. 58.3%, 23.6% vs. 12.9%, and 8.3% vs. 4.7%).

Table 2
Awareness, treatment and control of dyslipidemia and their determinants among Adults, China 2014

Variable		Awareness	Treatment	Control
Total		36958 (64%)	**6993** (18.9%)	**504** (7.2%)
Age group (years)	40–49	64.2 (63.4–64.9)	19.1 (12.3–27.6)	9.8 (5.1–16.8)
	50–59	63.7 (63.1–64.3)	18.8 (12.1–27.3)	6.8 (3.1–13. 0)
	60–69	64.2 (63.3–65.1)	19.2 (12.4–27.7)	5.2 (2.1–10.9)
	70 and above	64.3 (63.1–65.4)	18.3 (11.7–26.7)	6.6 (2.9–12.7)
		P = 0.718	P = 0.632	P < 0.001
Sex	Men	58.3 (57.8–58.9)	12.9 (7.4–20.5)	4.7 (1.8–10.2)
	Women	69.2 (68.7–69.7)	23.6 (16.1–32.6)	8.3 (4.1–14.9)
		P < 0.001	P < 0.001	P < 0.001
Residence	Rural	61.0 (60.5–61.6)	18.6 (11.9–27.1)	8.2 (4.0–14.8)
	Urban	67.5 (66.9–68.1)	19.3 (12.5–27.8)	6.2 (2.7–12.2)
		P < 0.001	P = 0.081	P < 0.001
Ethnicity	Han	67.5 (66.9–68.1)	19.0 (12.3–27.5)	7.3 (3.4–13.6)
	Others	61. 0 (60.5–61.6)	16.8 (10.5–25.0)	4.3 (1.5–9.6)
		P < 0.001	P = 0.040	P = 0.077
Marital Status	Married	63.8 (63.3–64.3)	19.5 (12.7–28.1)	7.0 (3.2–13.3)
	Divorced/Widowed/Others	64.2 (63.6–68.2)	18.2 (11.6–26.6)	7.5 (3.5–13.9)
		P = 0.367	P < 0.001	P = 0. 0.371
Level of Education	Primary and Below	62.6 (62.1–63.1)	18.4 (11.8–26.8)	7.3 (3.4–13.6)
	Junior/Middle School	65.6 (64.8–66.4)	20.1 (13.2–28.7)	7.2 (3.3–13.5)
	Senior High School	67.0 (65.8–69.8)	19.3 (12.5–27.8)	6.7 (3.0–12.9)
	College and above	69.5 (67.7–71.3)	19.6 (12.7–28.2)	7.2 (3.3–13.5)
		P < 0.001	P = 0.001	P = 0.961
Health Insurance	Yes	63.4 (62.9–63.8)	19.1 (12.3–27.6)	6.2 (2.7–12.2)
	No	67.5 (66.5–68.5)	17.8 (11.3–26.2)	12.8 (7.3–20.4)
		P < 0.001	P = 0.020	P < 0.001
Socio- economic region	Low- income	63.3 (62.5–64.0)	17.3 (10.9–25.6)	5.3 (2.1–11.0)
	Middle- income	66.1 (65.4–66.8)	17.4 (11.0–25.7)	6.8 (3.1–13.0)

Variable		Awareness	Treatment	Control
	High-income	62.8 (62.2–63.4)	21.1 (14.0–29.8)	8.5 (4.2–15.2)
Geographical Regions	North	63.1 (53.4–72.1)	19.5 (12.7–28.1)	8.7 (4.3–15.4)
	South	64.8 (55.1–73.6)	18.4 (11.8–26.8)	5.6 (2.3–11.4)
		P < 0.001	P = 0.009	P < 0.001
Stroke Belt	Yes	64.0 (54.3–72.9)	18.0 (11.4–26.4)	5.0 (1.9–10.6)
	No	64.8 (55.1–73.6)	19.1 (12.3–27.6)	7.6 (3.6–14.0)
		P < 0.001	P = 0.069	P = 0.003
BMI	Underweight (< 18.5 kg/m2	64.6 (63.9–65.3)	18.3 (11.7–26.7)	8.5 (4.2–15.2)
	Normal (18.5 -<24.0)	62.1 (58.1–66.1)	14.4 (8.6–22.3)	7.8 (3.7–14.3)
	Overweight (24.0 -< 28)	63.6 (63.0–64.2)	19.2 (12.4–27.7)	6.9 (3.1–13.1)
	Obesity (≥ 28.0)	64.0 (63.2–64.8)	19.4 (12.6–28.0)	6.4 (2.8–12.5)
		P = 0.179	P = 0.032	P = 0.075
Waist Circumference	Normal < 90/85 cm	62.3 (52.6–71.3)	17.7 (11.2–26.0)	7.3 (3.4–13.6)
	Central obese ≥ 90/85 cm	64.9 (55.6–73.7)	19.7 (12.8–28.3)	7.1 (3.3–13.4)
Family History	Yes	66.2 (56.6–74.9)	18.9 (12.2–27.4)	7.3 (3.4–13.6)
of Dyslipidemia	No	34.6 (25.8–44.3)	19. 7 (12.8–28.3)	4.3 (1.5–9.6)
		P < 0.001	P = 0.438	P = 0.061
History of Stroke	Yes	66.2 (56.6–74.9)	20.0 (13.1–28.6)	7.5 (3.5–13.9)
	No	56.4 (46.6–65.8)	14.6 (8.7–22.5)	5.6 (2.3–11.4)
		P < 0.001	P < 0.001	P = 0.028
History of CHD	Yes	65.8 (56.2–74.5)	19.3 (12.5–27.8)	7.2 (3.3–13.5)
	No	49.5 (39.8–59.2)	15.0 (9.0–23.0)	7.7 (3.7–14.1)
		P < 0.001	P < 0.001	P = 0674
Diabetes Mellitus	**Yes**	64.4 (54.7–73.3)	18.0 (11.4–26.4)	7.6 (3.6–14.0)
	No	63.8 (54.1–72.7)	19.4 (12.6–28.0)	7.0 (3.2–13.3)
		P = 0.177	P < 0.001	P = 0.378
Hypertension	**Yes**	64.1 (54.4–73. 0)	64.1 (54.4–73.0)	7.0 (3.2–13.3)
	No	63.8 (54.1–72.7)	63.8 (54.1–72.7)	7.7 (3.7–14.1)
		P = 0.452	P = 0.452	P = 0.281

Variable		Awareness	Treatment	Control
Drinking (Current)	**Yes**	68.6 (59.1–77.1)	68.6 (59.1–77.1)	6.3 (2.7–12.3)
	No	62.9 (53.2–71.9)	62.9 (53.2–71.9)	7.6 (3.6–14.0)
		P < 0.001	P < 0.001	P = 0.058
Smoking (Current)	**Yes**	68.6 (59.1–77.1)	68.6 (59.1–77.1)	7.6 (3.6–14.0)
	No	61.7 (51.9–70.8)	61.7 (51.9–70.8)	6.9 (3.1–13.1)
		P < 0.001	P < 0.001	P = 0.279
Physical activity	**Yes**	64.1 (54.4–73.0)	64.1 (54.4–73.0)	7.6 (3.6–14.0)
	No	63.8 (54.1–72.7)	63.8 (54.1–72.7)	6.6 (2.9–12.7)
		P = 0.370	P = 0.370	P = 0.100

Figure 1 shows that the proportion of dyslipidemia awareness among women in rural and urban settings was similar (69% vs. 69.5%), but dissimilar in urban (65.3%) than in rural men (52.4%), ($p < 0.001$). Treatment was higher in men living in rural compared to urban areas (15.4% vs. 10.6%). Unlike men, urban women compared with their rural counterparts had greater treatment (26.9% vs. 20.8%). The proportion of control was seen more in women than in men of both residences.

As shown in Fig. 2 the proportions of awareness were more among urban compared with rural residents across all the three socioeconomic regions: low-income (68.8% vs. 60.4%), middle-income (69.4% vs. 63.9%), and high-income (66% vs. 58.6%), respectively ($p < 0.001$). Rural versus urban adults showed higher treatment results in two socioeconomic regions namely: low - income (18.3% vs. 15.8%), and high- income (20.8% vs. 19.3%). The proportion of dyslipidemia control in rural areas was higher in all socioeconomic regions: low –income (6.3% vs. 3.4%), middle-income (9.4% vs. 3.3%), and high-income (8.7% vs. 8.3%), (all p < 0.001).

Women recorded significantly higher dyslipidemia proportions for awareness, treatment and control in all socio-economic regions ($p < 0.001$) Fig. 3.

DETERMINANTS OF AWARENESS, TREATMENT, AND CONTROL OF DYSLIPIDEMIA.

Table 3 shows the CORs and adjusted ORs of the determinants for dyslipidemia awareness. In the bivariate analysis, we found positive association between dyslipidemia awareness and the following determinants: education levels, current smoking, living in a middle-income region, and current drinking. However, having a health insurance and living in a northern zone were related to lower odds for awareness. In the adjusted model, being overweight (AOR: 0.92, 95% CI: 0.89–0.97) and living in a stroke belt zone (AOR: 0.80, 95% CI: 0.76–0.84) showed lower likelihoods of dyslipidemia awareness.

Table 3
Univariate and multivariate analyses of factors affecting awareness of dyslipidemia among adults. * Adjusted for all variables cited in the table

Variable			Awareness		Treatment		Control	
			COR (95%CI)	*aOR (95%CI)	COR (95%CI)	*aOR (95%CI)	COR (95%CI)	*aOR (95%CI)
		50–59	0.98 (0.94–1.02)		0.99 (0.94–1.05)		0.67 (0.54–0.82)	0.69 (0.55–0.85)
Age	(Ref: 40–49)	60–69	1.00 (0.95–1.05)		1.02 (0.96–1.09)		0.51 (0.38–0.67)	0.53 (0.40–0.70)
		70 and above	1.00 (0.94–1.07)		0.98 (0.91–1.06)		0.64 (0.47–0.89)	0.68 (0.49–0.95)
Sex	(Ref: men)		1.61 (1.55–1.66)	1.53 (1.46–1.59)	1.89 (1.81–1.97)	1.78 (1.69–1.88)	1.83 (1.46–2.29)	1.64 (1.30–2.07)
Residence	(Ref: rural)		1.33 (1.28–1.37)	1.40 (1.35–1.45)	1.00 (0.96–1.05)		0.74 (0.62–0.89)	0.68 (0.56–0.83)
Nationality	(Ref: others)		1.07 (0.95–1.13)		1.07 (0.96–1.20)		1.74 (0.92–3.28)	
Marital Status	(Ref: Divorced/Widowed/Others)		0.98 (0.95–1.02)		1.06 (1.02–1.11)	1.00 (0.96–1.08)	0.92 (0.77–1.10)	
		Junior/Middle School	1.14 (1.09–1.19)	1.05 (1.00–1.10)	1.10 (1.04–1.16)	1.02 (0.96–1.08)	0.98 (0.79–1.22)	
Level of Education	(Ref: Primary and Below)	Senior High School	1.21 (1.14–1.29)	1.03 (0.96–1.09)	1.07 (1.00–1.15)	1.00 (0.92–1.08)	0.92 (0.67–1.25)	
		College and above	1.36 (1.25–1.49)	1.05 (0.95–1.16)	1.15 (1.03–1.27)	1.02 (0.91–1.13)	0.99 (0.64–1.52)	
Health Insurance	(Ref: no)		0.83 (0.79–0.88)	1.09 (1.03–1.14)	1.07 (1.01–1.13)	1.12 (1.05–1.19)	0.46 (0.37–0.56)	0.50 (0.41–0.62)
Socio-economic region	(Ref: Low-income)	Middle-income	1.13 (1.08–1.19)	1.04 (0.99–1.09)	0.98 (0.92–1.03)	0.94 (0.89–1.00)	1.31 (0.99–1.72)	1.01 (0.76–1.36)
		High-income	0.98 (0.94–1.02)	0.88 (0.84–0.93)	1.22 (1.15–1.28)	1.24 (1.17–1.31)	1. 66 (1.29–2.12)	1.25 (0.95–1.67)
Geographical Regions	(Ref: South)		0.93 (0.90–0.96)	1.03 (0.98–1.07)	1.02 (0.98–1.06)		1.59 (1.32–1.92)	1.74 (1.40–2.16)

Variable			Awareness		Treatment		Control	
Stroke Belt	(Ref: Non-stroke Belt		0.80 (0.77–0.84)	0.80 (0.76–0.84)	0.91 (0.86–0.97)	0.86 (0.81–0.91)	0.64 (0.47–0.86)	0.54 (0.39–0.74)
		Underweight (< 18.5 kg/m2	0.90 (0.76–1.07)	0.97 (0.8--1.16)	0.84 (0.67–1.06)	0.87 (0.89–1.00)	0.94 (0.34–2.62)	1.13 (0.40–3.22)
BMI	(Ref: Normal (18.5 ≤ 24.0)	Overweight (24.0 -< 28)	0.96 (0.92–0.99)	0.92 (0.89–0.97)	1.07 (1.02–1.13)	1.04 (0.98–1.09)	0.80 (0.65–0.99)	0.78 (0.63–0.97)
		Obesity (≥ 28.0)	0.98 (0.93–1.02)	0.95 (0.90–1.00)	1.09 (1.03–1.15)	1.06 (0.99–1.13)	0.74 (0.58–0.95)	0.73 (0.57–0.94)
Waist Circumference	(Ref: Normal < 90/85 cm)		1.12 (1.08–1.16)	1.04 (1.00–1.09)	1.15 (1.10–1.20)	0.99 (0.94–1.04)	0.96 (0.80–1. 17)	
History of CHD	(Ref: no)		1.96 (1.86–2.06)	1.41 (1.33–1.49)	1.24 (1.15–1.33)	1.13 (1.05–1.21)	0.92 (0.65–1.30)	
Family History of Dyslipidemia	(Ref: no)		3.71 (3.47–3.97)	3.21 (2.99–3.45)	0.94 (0.87–1.02)		1.67 (0.94–2.98)	
History of Stroke	(Ref: no)		1.51 (1.46–1.58)	1.20 (1.15–1.25)	1.33 (1.26–1.40)	1.23 (1.17–1.30)	1.37 (1.03–1.80)	1.23 (0.93–1.62)
Diabetes Mellitus	(Ref: no)		1.03 (0.99–1.06)		0.93 (0.89–0.97)	0.94 (0.90–0.99)	1.09 (0.90–1.32)	
Hypertension	(Ref: no)		1.01 (0.98–1.05)		1.00 (0.95–1.04)		0.90 (0.75–1.09)	
Drinking (Current)	(Ref: no)		1.29 (1.24–1.35)	0.99 (0.94–1.04)	1.53 (1.46–1.61)	1.16 (1.09–1.23)	0.81 (0.66–1.01)	
Smoking (Current)	(Ref: no)		1.36 (1.31–1.41)	1.03 (0.98–1.08)	1.42 (1.36–1.48)	0.98 (0.93–1.04)	1.11 (0.92–1.33)	
Physical activity	(Ref: no)		1.02 (0.98–1.05)		1.02 (0.98–1.07)		1.17 (0.97–1.42)	
COR, Crude odds ratio; aOR, adjusted odds ratio								

Women had higher odds of dyslipidemia awareness compared with men (AOR: 1.53, 95% CI: 1.46–1.59). The likelihood of awareness was higher among urban compared with rural residents (AOR: 1.40, 95% CI: 1.35–1.45). The bivariate and multivariate analyses showed that awareness was more than three times higher in adults with a family history of dyslipidemia in their immediate family compared to those without a positive family history (AOR: 3.21, 95% CI: 2.99–3.45). Subjects with a history of CHD or stroke had positive associations with awareness [AOR (95% CI),

1.41 (1.33–1.49)], and [AOR (95% CI), 1.20 (1.15–1.25)], respectively. Participants with central obesity were more likely to be aware of dyslipidemia in both the crude and adjusted models.

Compared to men, women were more likely to receive treatment [AOR (95% CI)], 1.78 (1.69–1.88). The odds of treatment in individuals having a health insurance was higher than those without even after adjustment [AOR = 1.12; CI (1.05–1.19)]. Subjects with a positive personal history of CHD or stroke had higher adjusted odds of being treated [(AOR (95% CI), 1.13 (1.05–1.21)], or [(AOR (95% CI), 1.23(1.17–1.30)]. Adults living in a high-income socioeconomic region were more likely to be treated for dyslipidemia. Current alcohol drinkers had higher likelihood for treatment [(AOR (95% CI), 1.16 (1.09–1.23). The probability of receiving treatment significantly decreased among adults with diabetes and those living in a stroke belt zone.

The probability of controlling dyslipidemia was higher among women [AOR (95% CI), 1.64 (1.30–2.07)], and individuals living in northern China [AOR (95% CI), 1.74 (1.40–2.16)]. Table 3.

Overall, persons within the age category of 50–59 years were least likely to get their condition controlled. [OR (95% CI), 0.69 (0.55–0.85)]. The likelihood of controlling dyslipidemia was 32% lower in urban than rural participants (AOR = 0.68, 95% CI: 0.56–0.83). The probability of controlling dyslipidemia decreased with more than normal body weight (overweight and obesity), which were statistically significant. Persons with a health insurance and those living in a stroke belt zone were less likely to have controlled dyslipidemia. The bivariate analysis showed significant association between control and history of stroke [COR (95% CI), 1.37(1.03–1.80)], and high-income region [COR (95% CI), 1.66(1.29–2.12)], however, in the adjusted analysis, the above mentioned variables lost their significance. Table 3.

Discussion

This is a nationwide population-based report on the awareness, treatment, control and relevant determinants of dyslipidemia among middle and older aged Chinese adults. Main findings include: Sixty-four percent of subjects with dyslipidemia were aware of their condition, of whom 18.9% received pharmacological treatment, and of whom 7.3% had controlled lipids. Treatment and control proportions in both residences were higher in women than men. The following determinants showed higher likelihood for awareness: women, urban residence, junior or middle school, health insurance, family history of dyslipidemia, history of stroke, central obesity and history of CHD. Women, health insurance, history of CHD, current drinking and personal history of stroke showed positive association with treatment. Dyslipidemia control saw significant relationships with age groups, women, urban residence, northern zone, health insurance, stroke belt, overweight, and general obesity.

If our results are juxtaposed with the 'rule of halves' framework, [10] obviously, the proportion of treatment (18.9%) and control (7.3%) observed is well below the 50% benchmark. Although, our result suggests that awareness has improved, more actions are needed to scale-up and improve treatment of lipid disorders in China. The present results on awareness, treatment and control were higher compared with previous studies in China[9,22] Further, we recorded higher awareness and treatment, but lower control values for dyslipidemia compared with other studies. [7,8] The low level of control observed in the current study could partly be explained by the low treatment value observed despite evidences available on the therapeutic use of statins,[22,23] or due to poor adherence to medications.[24] The low level of control seen may also reveal some level of ineffectiveness in the current treatment approaches. Therefore, strategies to improve patient's adherence to medication regimens, the increased use of treatment protocols that ensure adequate treatment and access to more affordable medications should be targeted. Notably, drugs therapy alone does not control dyslipidemia completely. Measures such as lifestyle modifications and good nutrition are effective

in controlling high blood lipids. [25–27] There is also the need to place more emphasis on prevention. Efforts are needed to scale-up both targeted and opportunistic screening programs, health promotions, and provision of more effective cholesterol-modifying medications for use. Early identification of populations who are not only at risk, but who could benefit most from preventive measures is crucial. Hence, the use of both pharmacological and non- pharmacological approaches are preferred for effective dyslipidemia management. The low treatment and control identified present a great opportunity for China to improve its dyslipidemia management strategy.

In the present study, subjects aged 40–49 years had higher odds for dyslipidemia control than older participants. This results was in accord to data from a Korean study where younger adults were more likely to have controlled LDL-C than the elderly.[28] However, many reverse results have been reported between older ages and dyslipidemia control. [7,22,29] Again, differing from our findings, a positive association between aging and the control of chronic diseases such as hypertension has been reported. [30] Our results may support the finding that dyslipidemias such as raised TC control rates may differ depending on the participants and country, and rates may range from 18–100%.[31]

Consistent with prior reports, [22,29] we showed that women were more likely than men to have dyslipidemia awareness, treatment and control. Similarly, two studies on the management of raised LDL-C indicated that women recorded higher likelihood of awareness, treatment and control. [6,32] Behavioral differences between the sexes could partly explain this results, as women are reported to seek healthcare services more often than men. [6] An earlier study [18] reported no relationship between dyslipidemia treatment and place of residence, but our study demonstrated positive association between dyslipidemia awareness or treatment with urban residence. Similarly, studies in Malaysia and Thailand, [33,34] showed high awareness and treatment levels between raised LDL-C and urban centers. Further, findings from studies in low and middle-income countries have reported lower values of dyslipidemia awareness and treatment in rural settings. [19,35] The high awareness and treatment levels found in urban areas may be attributed to wealthier and better educated populations usually found in cities. [36] Again, it may buttress the evidence of difficult access to health care common in rural areas. [11] Hence, health promotion programs should target areas such as rural settings with limited healthcare resources. The lower level of control seen among urban populations merits some explanation, albeit difficult, as poor adherence to treatment regimens may play a role. Junior/middle school education level was independently related to dyslipidemia awareness, but not treatment and control. This result contradicts previous reports.[7,18] The mechanisms underlying the link between length of education and awareness of dyslipidemia is not clear. Nevertheless, a previous report suggested that education is the finest socioeconomic status index and can predict CVD's awareness.[37] Future studies are warranted to examine this results.

Health insurance coverage was associated with dyslipidemia awareness and treatment, but not control. In line with our finding, a US study found respondents without health insurance with lower levels of awareness and treatment for elevated LDL-C. [38] Insured individuals were more likely to receive treatment in another study. [38] Once dyslipidemia is seen, effective management follows, and health insurance fundamentally addresses socioeconomic barriers to effective healthcare.[38] The negative relationship that existed between having health insurance and dyslipidemia control in the current study was inconsistent with earlier reports,[6,38,39] since health insurance is related to improved CV risk factor control and outcomes.[39]

Residing in a high compared with low-income region was associated with less dyslipidemia awareness, but high treatment level. This may suggest that high-income region is an independent driver for treatment. High- income communities have been reported to demonstrate high association with treatment of chronic conditions.[40] It may be

that, the availability or easier access to health facilities in high-income regions facilitates the usage of health services.

From this study, staying in northern China was an independent determinant for dyslipidemia control. A study determined that stroke prevalence was significantly higher in the northern parts of China,[41] and living in the north was associated with high dyslipidemia prevalence.[8,42] We speculate that, the high prevalence of stroke and dyslipidemia found in the north could positively affect inhabitants' behaviors towards treatment and yield favorable results. We showed that lower likelihoods of dyslipidemia awareness, treatment, and control were related to living in the stroke belt region of China. This results was dissimilar to that of the REGARDS study [43] where lower control rate was found outside the stroke belt region. This finding may indicate that effective and efficient management of lipid disorders may not be related to the stroke belt zone. Studies are required to further investigate why awareness and treatment of dyslipidemia were less likely in the stroke belt zone. We observed a negative association between dyslipidemia awareness and obesity. This was consistent with an earlier study.[44] Speculatively, the low awareness level seen could be due to the natural history of the disease, or one's poor attitude towards healthcare. Overweight and general obesity were significant negative predictor for dyslipidemia control, these were similar to earlier researches.[7,18] An explanation could be that dyslipidemia control is difficult in individuals with more than normal body weight. Central obesity was a significant positive predictor of dyslipidemia awareness. This finding might reflect efforts instituted by healthcare systems to improve screening for blood lipid disorders among high-risk individuals.[45]

Subjects with a personal history of CHD or stroke were more likely to know or receive treatment for dyslipidemia. Similarly, a previous study observed that personal history of ASCVDs were associated with higher use of statins.[46] In addition, other reports [35–37] had observed that people who experienced cardiovascular events often become more focused on their health, especially on CVD risk factors such as dyslipidemia. Therefore, these individuals are more likely to comply with lipid-modifying medications and/ or lifestyle interventions.

Patients with family history of dyslipidemia in their immediate family had the strongest independent association of awareness in this study. This is in line with the result of He et al. where persons with a family history of dyslipidemia had higher likelihood of awareness.[7] It has also been found that the chances of diagnosis and treatment of dyslipidemia is generally higher in high-risk individuals including those with CVDs. Predictably, family members would be more mindfulness and watchfulness of dyslipidemia and doctors would pay more attention to these patients.[7]

Subjects with diabetes were less likely to get treatment for dyslipidemia. A reverse results was seen by Li et al. [41] where dyslipidemia treatment among persons with diabetes was up to about 55.9%. We speculate that there persons did not receive adequate treatment due to wrong attitude towards the disease or poor adherence to treatment.[47,48]. The low likelihood of treatment could also be as a result poor knowledge about diabetic dyslipidemia among patients. Therefore, it is imperative for health workers to intensity health education and pay more attention to detect lipid disorders in suspected co-morbid patients. This study found that current drinking was associated with dyslipidemia treatment. This was dissimilar to findings in the Jilin province of China, [7] where current drinking was associated with low level of treatment. We speculate that these individuals were already in the health service system, so they were more likely to be treated with medication.

Strengths And Limitations

Key strengths of the study include its population based design, representation of a wide range of urban and rural communities across China. Thus, this nationwide coverage allows for calculation of nationally representative estimates. Further, these analyses consisted of several determinants of dyslipidemia awareness, treatment, and control, which may provide a broader view of the relative role of different determinants in prevention efforts.

This survey was cross-sectional, thus, exploring casualty was limited. Another limitation observed was that participants' previous experience on medication use for other conditions could affect treatment adherence. Also, we did not investigate the effect of cognitive factors such as self-efficacy and illness perception of people who received treatment and had controlled dyslipidemia. Information bias might occur from self-reported characteristics.

Conclusion

In summary, dyslipidemia awareness was high (64.0%), with low treatment (18.9) and control (7.3) proportions. Higher proportions of awareness, treatment and control were seen in women than men. Treatment was higher in rural than urban men (15.4% vs. 10.6%), but women in urban areas showed higher proportion for treatment versus their rural counterparts (26.9% vs. 20.8%). Dyslipidemia control was more in women than men in both rural and urban areas.

Women, urban residence, family history of dyslipidemia and central obesity were positive associated factors of awareness. Personal history of stroke or CHD, having health insurance, alcohol drinkers and women were more likely to be treated for dyslipidemia. Diabetics and living in a stroke belt region had significant negative association with treatment. Regarding dyslipidemia control, health insurance, general and central obesity recorded negative relationship with control. Therefore, improved health education and treatment are needed for better dyslipidemia management.

Abbreviations

CNSSPP: China National Stroke Screening and Prevention Project CVD:Cardiovascular disease DALYs:disability-adjusted life-years TC:Raised total cholesterol TG:Raised triglycerides LDL-C:Raised low-density lipoprotein HDL-C:Low high-density lipoprotein ASCVD:Atherosclerotic cardiovascular disease

Declarations

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Availability of data

The dataset of the study is available from the corresponding author on reasonable request.

Authors' contributions

SO developed the research question and designed, and conducted analysis of the manuscript, SO, YG, EAY and DT critically reviewed the manuscript and ZXL approved the final design and provided supervision. All authors have approved the final manuscript.

Ethics approval

This study was approved by the Ethics Committee of the Xuanwu Hospital Institutional Review Board, Capital Medical University (Beijing, China), and performed according to the declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests:

None

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Figures

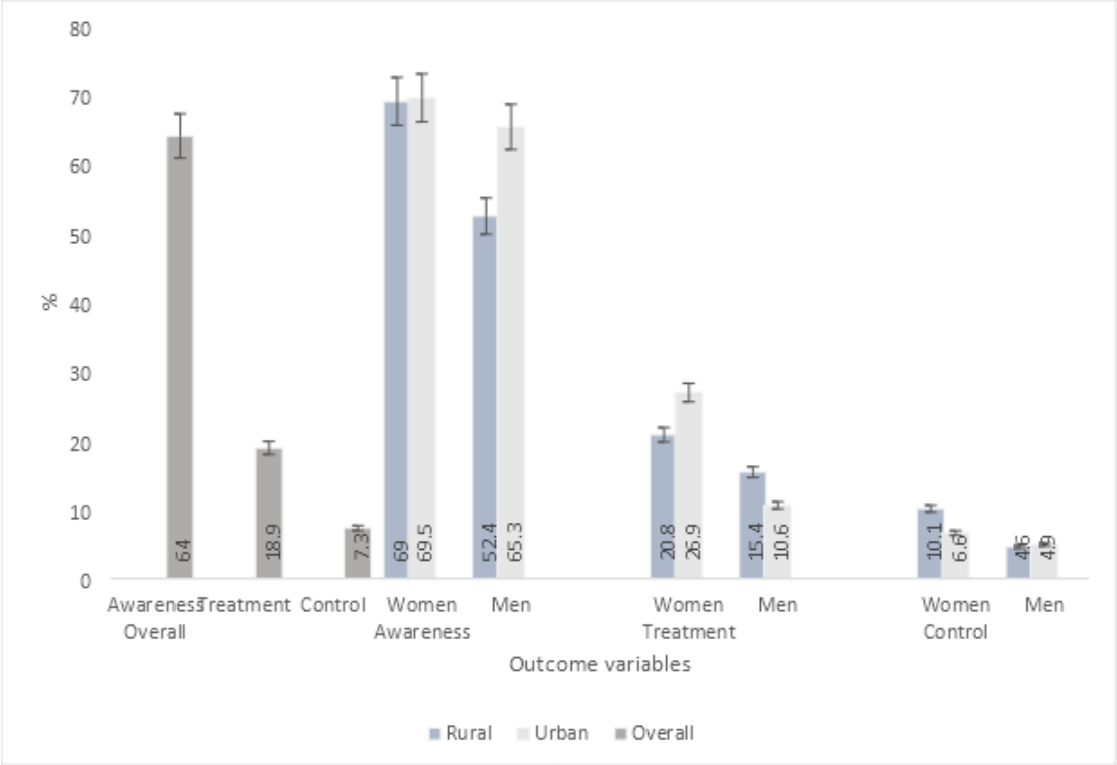

Figure 1

The overall, sex and rural/urban proportions of dyslipidemia awareness, treatment and control among the study population.

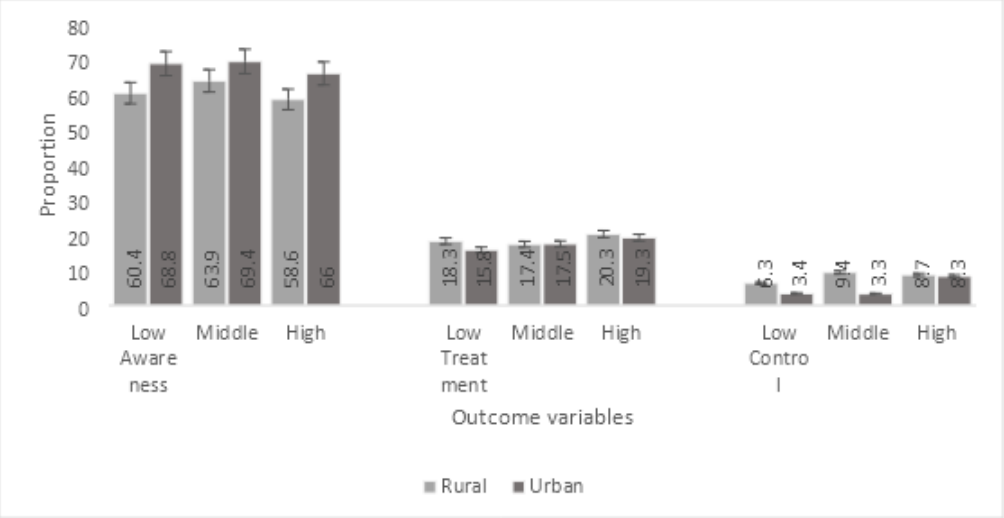

Figure 2

Proportions of dyslipidemia awareness, treatment and control among rural and urban populations compared with the socioeconomic regions (low, middle, high) of China

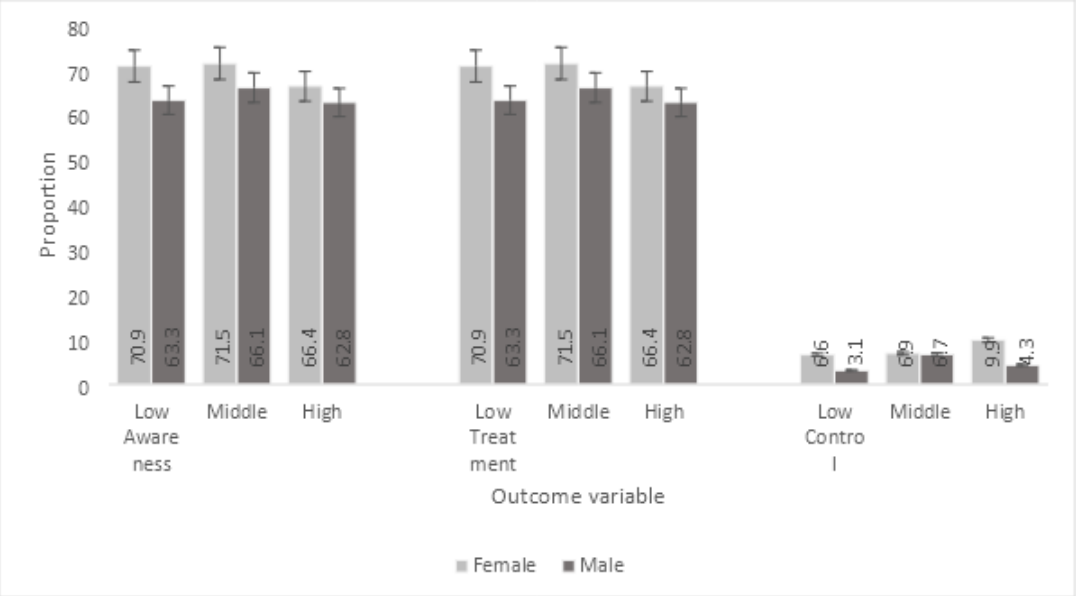

Figure 3

Proportions of dyslipidemia awareness, treatment and control among men and women compared with socio-economic regions (low, middle, high) of China.

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