Cardiometabolic health of Chinese older adults with diabetes living in Beijing, China.

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Abstract:

ABSTRACT Objectives: Using the PRECEDE-PROCEED model, this study examined the presence of metabolic syndrome and modifiable cardiovascular disease (CVD) risk factors associated with metabolic syndrome among Chinese adults with diabetes living in Beijing, China.

Design and Sample: The cross-sectional study collected data through face-to-face interviews. The study included 73 Chinese older adults with diabetes. Their mean age was 68 years (±7.66), with a range from 52 to 90 years.

Measurements: Data were collected on demographic characteristics, blood pressure (BP), body mass index (BMI), waist circumference, lipid profile and fasting glucose, physical activity, diet, and health status.

Results: The great majority (85%) had metabolic syndrome; 65% had hypertension; 52% had high levels of low-density lipoproteins, and 80.6% had a high level of fasting glucose. Half of the participants (51.4%) were overweight, 16.7% were obese, and 86.3% had central obesity. Age, gender, BMI, income, insurance, smoking history, physical activity, and diet explained 23% of the variance in the metabolic syndrome component, systolic blood pressure.

Conclusions: The association of predisposing and enabling factors and health behavior with the metabolic syndrome needs to be further explored. Persons with diabetes should have regular health screenings to check for blood pressure, BMI, cholesterol, glucose, and triglycerides in order to decrease the risks associated with metabolic syndrome and CVD.

Keywords: cardiometabolic health | Chinese older adults | diabetes | metabolic syndrome | nursing | public health nursing | China

Article:

Cardiovascular disease (CVD) and type 2 diabetes have reached epidemic proportions globally, with staggering effects on world health and economies. In 2005, 17.5 million deaths were due to coronary heart disease (CHD) and stroke, and it is projected that by 2015, as many as 20 million people will die from CVD, and this will be the leading cause of death in all countries (Poole-Wilson, 2005; World Health Organization [WHO], 2007). It is estimated that 180 million people worldwide have diabetes, and this number is expected to double by 2030 (WHO, 2006). The prevalence of type 2 diabetes is on the rise in countries with emerging economies; the largest increases in type 2 diabetes by 2025 will be in low- and middle-income countries (International Diabetes Federation, 2006).

In developed countries, more than 80% of health care dollars will be spent on the consequences of CVD and type 2 diabetes. WHO (2007) estimates that during the years 2006–2015, China alone will expend $558 billion to battle CVD and type 2 diabetes. For those in developing or underdeveloped and struggling economies, there will not be enough funds to supply the medications needed to control these diseases (International Diabetes Federation, 2006).

A major increase in diabetes is expected among older adults (Wild, Roglic, Green, Sicree, & King, 2004), and China is projected to experience a particularly huge increase in the elderly population. Outpacing other countries, China already has the second largest number of individuals suffering from type 2 diabetes in the world, and this number is expected to increase from 20.8 million in 2000 to 42.3 million in 2030 (Wild et al., 2004). The prevalence of type 2 diabetes in China is 1.5 times higher in urban areas than in rural areas. Wong and Wang (2006) estimated that 68.6% of people with diabetes were undiagnosed in mainland China.

In 2003, 50% of the older adult Chinese population had CVD and a dramatic increase in CVD morbidity and mortality is predicted in the next 20 years in China (Wu et al., 2001). Unlike most countries, where death from CVD is due to heart attacks rather than stroke, in China the opposite is true: the incidence of stroke is four times that in Western countries. CVD also tends to strike persons 10 years younger than in the West (Parry, 2004; World Heart Federation, 2007). With the population of China expected to exceed 1.3 billion individuals by 2023, the burden of CVD and type 2 diabetes may be insurmountable (International Diabetes Federation, 2006; WHO, 2007).

Although epidemiologic studies have reported the prevalence of metabolic syndrome and obesity and the associated cardiovascular risks in general Chinese populations, few studies have examined the factors related to metabolic syndrome and its components in older adults with type 2 diabetes residing in large cities, such as Beijing, where people's lifestyles have changed in the past two decades. Identification of the risk factors for metabolic syndrome and its components may be the key to decreasing CVD morbidity in Chinese older adults with type 2 diabetes.

Background

Metabolic syndrome risk factors and cardiovascular disease. The risk of CVD is attributable primarily to preventable risk factors. Indeed, key risk factors contribute to over 90% of CVD deaths, regardless of ethnicity, gender, or location. Environmental risk factors include increased urbanization and industrialization, leading more people to migrate to cities, where the food supply is greater and contains more fat and dietary sodium, where there is more mass transportation, and where work and lifestyles do not include exercise (Gu et al., 2005; Poole-Wilson, 2005; Wild et al., 2004). Lifestyle risk factors include a high-fat diet, lack of exercise, smoking, and excessive alcohol consumption, which can lead to underlying treatable chronic conditions such as elevated glucose, hypertension, and elevated cholesterol (Gu et al., 2005; He et al., 2007; Poole-Wilson, 2005; Wong & Wang, 2006).

The Westernization of China has been linked to the risks of developing metabolic syndrome and its components, such as central obesity, hypertension, and low high-density lipoprotein (HDL) cholesterol (Lee et al., 2001). The prevalence of metabolic syndrome among older adults in the city of Beijing has been reported to be as high as 46.3% (34.8% in men and 54.1% in women) (He et al., 2006). A nationwide study found that more than 30% of Chinese adults were overweight and 13.7 % of the population experienced metabolic syndrome (Gu et al., 2005). The prevalence of central and overall obesity in Chinese living in major cities is 33.97% and 9.78%, respectively (Hu et al., 2007).

Body mass index, metabolic syndrome, and cardiovascular disease. Overweight and obesity have increased in China in the past two decades and have become a major health concern (He et al., 2007; Zhou et al., 2002). Body mass index has been consistently associated with cardiovascular risk. Individuals who are obese are at a higher risk of hypertension, hypercholesterolemia, hyperglycemia, hyperinsulinemia, and type 2 diabetes (Hu et al., 2000). Studies among Chinese older adults have found that body mass index (BMI) was strongly associated with lower levels of high-density lipoprotein cholesterol, higher levels of cholesterol, triglycerides, and fasting glucose, as well as metabolic syndrome, risk of CHD, stroke, and peripheral arterial disease (He et al., 2007; Hu et al., 2000). Despite the low relevance of obesity in Chinese populations compared with Western countries, a clear relationship has been established between BMI and cardiovascular risk factors and comorbidities in the Chinese population (Lee et al., 2002).

Metabolic syndrome and cardiovascular disease. The Framingham Heart Study (Framingham Heart Study, 2008) identified the following risk factors for CHD: cigarette smoking, elevated blood pressure, serum total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C), low serum HDL cholesterol (HDL-C), diabetes, and advancing age (Wilson et al., 1998). The Framingham risk score used for cardiovascular risk assessment is based on the Framingham Heart study, supported by the National Heart, Lung & Blood Institute (Grundy, Pasternak, Greenland, Smith, & Fuster, 1999). The characteristics measured include blood pressure, TC, HDL cholesterol, smoking status, age, and gender. Based on these risk characteristics, individuals receive a predictive risk of having a cardiovascular event within the next 10 years.

Metabolic syndrome has been defined as the presence of abnormalities in any three of five measures: waist circumference, triglycerides, cholesterol, blood pressure, and fasting glucose level (The National Cholesterol Education Program's Adult Treatment Panel III report, 2002). Several studies have shown that individuals with metabolic syndrome have a higher prevalence of CVD than those without metabolic syndrome (Kahn, Buse, Ferrannini, & Stern, 2005; Lorenzo, Williams, Hunt, & Haffner, 2007; Malik et al., 2004; Solymoss et al., 2003; Yavuz et al., 2008). Older adults with metabolic syndrome are at a higher risk of stroke (Milionis et al., 2005) and vascular events (Saely et al., 2005) and the number of metabolic syndrome components is associated with the severity of coronary artery disease (CAD) (Malik et al., 2004; Yavuz et al., 2008) and overall mortality (Malik et al., 2004).

Wong et al. (2003) noted that 40% of individuals diagnosed with metabolic syndrome are at a medium risk of CHD in 10 years, and men are at a higher risk than women. Older Chinese adults with metabolic syndrome have been found to be 1.43 times more likely than other adults to develop CHD, 1.45 times more likely to suffer a stroke, and 1.50 times more likely to have CVD (He et al., 2006). Hu et al. (2006) found that Chinese patients with metabolic syndrome had an increased incidence of major cardiac and cerebral events at long-term follow-up. Moreover, metabolic syndrome has been shown to predict cardiovascular mortality (Hunt, Resendez, Williams, Haffner, & Stern, 2004; Malik et al., 2004).

Studies have indicated that optimal control of LDL-C, HDL-C, and blood pressure can prevent 80% of CHD (Wong et al., 2003). The current study therefore examined the presence of metabolic syndrome, its components, and the modifiable risk factors associated with metabolic syndrome among Older Chinese adults with diabetes living in Beijing, China.

Conceptual framework. The PRECEDE-PROCEED Planning Model guided the study (Green & Kreuter, 2005). This model emphasizes the need to identify factors influencing health outcomes and provides a comprehensive structure for health needs assessment, program design, implementation, and evaluation of health promotion programs. The PRECEDE phases include social assessment (quality of life) (Phase 1); epidemiological assessment (health, genetics, behavior, and environment) (Phase 2); educational and ecological assessment (predisposing, reinforcing, and enabling) (Phase 3); and administrative and policy assessment and intervention alignment (educational strategies and policy regulation organization) (Phase 4). Components of the model used in the current study were predisposing, enabling, behavior, and health (Fig. 1). Predisposing factors were operationalized as demographic variables (age, gender, and BMI). Enabling factors included socioeconomic status (income) and health insurance. Behavior factors consisted of smoking, physical activity, and diet. Health was conceptualized as the presence or level of the metabolic syndrome or its components or Framingham risk and operationalized as the presence of abnormalities in any three of five measures: waist circumference, triglycerides, cholesterol, blood pressure, and fasting glucose level) (The National Cholesterol Education Program's Adult Treatment Panel III report, 2002), or the number of metabolic syndromes, or any of the components, or the Framingham risk score.

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Research questions

Research questions were:

1 What are the levels of predisposing and enabling factors, behavior and self-rated health, among Chinese adults with diabetes?

2 Are there age and gender differences in metabolic syndrome, its components, and Framingham risk scores among Chinese adults with diabetes?

3 What are the relationships between BMI and metabolic syndrome and the Framingham risk score among Chinese adults with diabetes?

4 What are the relationships between predisposing, enabling, and behavior, and the metabolic syndrome and its components among Chinese adults with diabetes?

Methods

Design and sample

A cross-sectional correlational design was used. Adults with self-reported type 2 diabetes who resided in two districts (Dong Cheng and Chao Yang districts) in Beijing, China, were invited to participate in the study. Beijing, the capital of China, has a population of approximately 15 million individuals, and residential areas are divided into five major districts. The criteria for inclusion were (1) age 50 years or older; (2) a diagnosis of diabetes; (3) ability to speak and read Mandarin; and (4) orientation to time, place, and person. Participants were recruited from six residential apartment complexes. Each residential apartment complex includes approximately 350–400 households. Most residents live with their spouse or children in apartments. A residential center is located on the first floor of each complex and is used by the neighborhood for social activities and health education. Flyers describing the study were posted in each residential complex and the complex administrators informed clients before the week of the study. A power analysis was performed to determine the sample size. A regression analysis with seven independent variables, a medium effect size (.25), a significance level of .05, and a power of .80 showed that a sample size of 65 was required (NQuery Advisor, version, 6.0, 2006). A final sample of 73 was recruited for the study. All study procedures were approved by the University Institutional Review Board (IRB) and the university in Beijing, China. All the participants signed a consent form.

Data were collected through face-to-face interviews using Chinese versions of questionnaires. The first author and a local registered nurse conducted the interviews and assessments (BP, weight/height, glucose, and lipid profile). After obtaining blood for a lipid profile and fasting glucose, participants were told to have breakfast at home (upstairs) and return to the center for an interview and examination. It took approximately 40–45 min to complete the interview and assessment. After completion of the study, towels and hygiene products were given to participants in appreciation of their time.

Measures

Predisposing and enabling factors. Predisposing and enabling factors were measured by a demographic questionnaire that included participants' age and gender, income, and health insurance. Body mass index (BMI) was obtained by measuring weight with a scale and height with a wall tape measure. BMI was calculated by dividing subjects' weight (measured in kilograms) by the square of their height (measured in meters) (National Institutes of Health, 1998). A subject was categorized as overweight if the body mass index was 24–27.9 kg/m2 and as obese if the body mass index was 28 kg/m2 or more, based on WHO (2000)—recommended BMI cut-off points for Chinese individuals.

Behavior. Smoking behavior and physical activity were measured using demographic questions from the National Health and Nutrition Examination Survey (1998). Participants were asked about their current and past smoking status and the number of cigarettes smoked each day. Physical activity was determined by asking participants about the length and frequency of their physical activity. The Centers for Disease Control and Prevention (CDC) (2007) and WHO (2008) recommend 30 or more minutes of moderate activity on 5 or more days of the week.

Diet was obtained from the diet subscale of the Revised Summary of Diabetes Self-Care Activities (SDSCA) (Toobert, Hampson, & Glasgow, 2000). The Revised SDSCA measures diet, exercise, blood sugar testing, foot care, smoking, self-care recommendations, and medications. Respondents were asked to report on the frequency with which they had performed various activities over the previous 7 days. The SDSCA has been used in several studies, and it has been reported to be a reliable and valid self-report measure of diabetes self-management (Toobert et al., 2000).

Health. Metabolic syndrome: Criteria for metabolic syndrome were based on the National Cholesterol Education Program Adult Treatment Panel III (2003) guidelines on the Diagnosis and Management of Metabolic Syndrome: An American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement (Grundy et al., 2005), and on WHO's (2000) recommendations for Asian populations. According to the guidelines, the presence of any three of the following five components indicates metabolic syndrome: elevated waist circumference (85 cm for Chinese men, 80 cm for Chinese women; WHO, 2000), elevated triglycerides≥150 mg/dL or drug treatment for elevated triglycerides; reduced HDL: <40 mg/dL in men and <50 mg/dL in women or drug treatment for reduced HDL; elevated BP: >130 mmHg systolic BP, or >85 mmHg diastolic BP or drug treatment for hypertension; and elevated fasting glucose: >100 mg/dL or drug treatment for elevated glucose or drug treatment for elevated glucose. Participants with three or more of the components were categorized as having metabolic syndrome (Grundy et al., 2005).

Waist circumference was measured using the Gantt tape by wrapping the tape around the area above the hipbone and below the rib cage over the umbilicus. Participants were asked to remove any large belts or clothing while the measurement was taken. Central obesity was defined as a waist circumference >85 cm in Chinese men and >80 cm in Chinese women (WHO, 2000).

Blood pressure was measured using a standardized blood pressure protocol based on the guidelines of The Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure (2003). A sphygmomanometer cuff was placed on the upper arm with the stethoscope bell on the upper antecubital fossa of the same arm. Participants were seated quietly for at least 5 min in a chair before blood pressure was taken. Phase I and V Korotkoff' sounds were used to determine systolic and diastolic blood pressure readings (The Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure, 2003). Participants were considered hypertensive if they used antihypertensive medications or had blood pressure ≥130/85 mmHg.

Fasting lipid profile and glucose: TC, HDL, LDL, triglycerides, and fasting glucose were obtained through capillary finger stick. The Cholestech LDX machine, a portable analyzer and test cassette system, was used to analyze the lipid profile and glucose. The accuracy and precision of the Cholestech LDX profiles are comparable to those obtained by reference methods routinely used in clinical diagnostic laboratories (Cholestech, 2004a, b). Calibration of the Cholestech LDX machine with control cartridges was performed to assure the accuracy of readings. The device also calculates TC/HDL ratio, and Framingham risk. Abnormal values of lipid profile and glucose were defined as follows: elevated triglycerides ≥150 mg/dL (1.7 mmol/L), reduced HDL<40 mg/dL (1.03 mmol/L) in men, <50 mg/dL (1.3 mmol/L) in women, and elevated fasting glucose ≥100 mg/dL (Grundy et al., 2005).

The Framingham risk score was used for cardiovascular risk assessment; this score is based on six major risk factors for CVD: age, blood pressure, smoking, diabetes, triglycerides, and HDL (Grundy et al., 1999). A higher score indicates a greater risk (Framingham Heart Study, 2008). The Framingham risk score for CHD risk assessment has been tested in a Chinese population (N=30,121) (Liu et al., 2004) and was found to be valid and useful for this population.

Self-rated health was measured using one item from the Medical Outcomes Study Short Form (SF-36), a widely used measure of health status. Participants were asked to rate their health as excellent, good, fair, or poor, with higher scores indicating better-perceived health.

A bilingual translator translated the English version of the demographic questionnaire and the SDSCA into Chinese and back translated both the demographic questionnaire and the SDSCA, with content equivalence analysis, and analysis of the translations and back translations. Bilingual meaning error checks were used to verify translation equivalence (Berry, 1993).

Analytic strategy

Descriptive statistics were used to characterize the sample based on predisposing, enabling, and behavior factors. T-tests were used to examine differences between gender and age groups (1= <65 years, 2=≥65 years). Pearson's correlation coefficient was used to examine the relationship among BMI, the number of metabolic syndrome, and the Framingham risk score. The presence or absence of metabolic syndrome (dichotomous data), the number of metabolic syndrome (continuous data), and metabolic syndrome components (waist circumference, BP, triglycerides, HDL, and glucose) were analyzed using logistic and hierarchical regressions. Logistic regression was used to examine the relationships among predisposing, enabling factors and behavior, and the presence or absence of metabolic syndrome (1=yes and 0=no). Hierarchical regression was used to examine the relationships and the number of metabolic syndrome (1–5, with 1=having 1 risk factor, 5=having 5 risk factors) and its individual components (waist circumference, triglycerides, cholesterol, blood pressure, and fasting glucose level). Independent variables included age, gender (0=male, 1=female), BMI (continuous variable), income, health insurance (0=no, 1=yes), smoking history (0=no, 1=yes), recommended physical activity (0=no, 1=yes), and diet (total mean scores). Metabolic syndrome was regressed on three blocks of variables. Predisposing factors (age, gender, and BMI) were entered in the first step of the regression analysis. Enabling factors (income and health insurance) were entered in the second step of the analysis. Behavior variables, consisting of smoking, physical activity, and diet, were entered in the third step of the analysis. The Framingham risk scores were not included in the analysis because the risk scores were based on age, blood pressure, smoking, triglycerides, and HDL, which would cause overlaps between independent and dependent variables. Assumptions of logistic and multiple regressions were checked before performing the analyses. The α level of significance was set at .05. SPSS 15.0 was used for the analyses.

Results

Characteristics of the participants

The mean age of the participants was 68 years (±7.66), with a range from 52 to 90 years; the majority (64.4%) were female. More than half had a junior high school education or less (see Table 1). Most (72.2%) were married and living with a spouse or children. More than half of the participants had a family monthly income of RMB1001-2000 ($145–$295) or less. The majority had health insurance.

Table 1. ***Demographic Characteristics (N=73)***

Variable	***N***	**%**
Gender		
Male	26	35.6
Female	47	64.4
Marital status[a]		
Married	52	72.2
Widowed	20	27.8
Education[a]		
No formal education	5	7.1
Elementary school	10	14.3
Junior high school	24	34.3
High school	19	27.1
College or associate degree	12	17.2
Monthly household income[a]		
<500 Yuan (poverty level)	5	6.9
500–1,000 Yuan	21	29.2
1,001–2,000 Yuan	23	31.9
2,001–3,000 Yuan	12	16.7
3,001–4,000 Yuan	5	6.9
4,001–5,000 Yuan	6	8.3

Variable	*N*	%
Health insurance	61	83.6
Smoking history	16	27.6
Moderate physical activity		
≥30 min, 5 times/week	37	50.7
Aerobic exercise		
≥20 min, 3 times/week		

Note. a Variable that has missing values.

The average length of time since a diagnosis of diabetes was 8.40 years (±6.65). Almost all participants took medications for diabetes and a small proportion received insulin treatment (Table 2). Some participants used both Western medicines and traditional Chinese medicines to treat diabetes. A low proportion (16.4%) of persons reported a known family history of diabetes; however, some did not know their parents' diabetes history. The majority of participants rated their health as fair or poor (76.7%).

Table 2. ***Health History (N=73)***

Variable	*N*	%
Heart disease told by physician	22	30.1
Hypertension told by physician	32	43.8
Visited your doctor in the past 12 months	57	78.0
Visited dentist in the past 12 months	12	39.7
Visited an eye doctor in the past 12 months	20	53.4
Used medicine for cholesterol	16	22.2
Used medicine for heart disease	22	37.0

Used medicine for hypertension	32	51.4
Visited traditional Chinese medicine doctor in the past year	27	37.5
Used traditional Chinese medicine for diabetes	22	31.9
Currently taking medicines for diabetes	66	90.4

Approximately a third of the participants reported having been told by a doctor that they had heart disease, and a larger proportion had been told they had hypertension. Many were taking medications for heart disease, high cholesterol, and hypertension, although not all were taking medications. Most of the participants had visited a physician in the past 12 months; half had visited an eye doctor, and fewer than half had visited a dentist or a traditional Chinese medicine doctor.

The mean BMI was 25.39 kg/m2 (±3.61); more than half of the participants were overweight and almost one-fifth were obese. A large proportion had central obesity (waist circumference >85 cm in men and >80 cm in women). Only 11% were currently smoking, but one-third had a history of smoking. Almost half of the participants did not meet the recommended physical activity guidelines and most participated in no regular exercise. Fruit and vegetable intake did not meet the recommended 5 servings per day (*M*=3.72, *SD*=3.13); foods high in fat or meat or whole milk were eaten on an average of 4.55 (±2.80) days in the past week.

Metabolic syndrome assessment indicated that the majority of persons in the study had high blood pressure, low HDL, high LDL, a high ratio of TC/HDL, and elevated fasting glucose (Table 3). Fewer had high triglycerides. The majority (85%) had three or more components of the metabolic syndrome.

Table 3. ***Metabolic Syndrome Components***

Variables	***N***	**%**
Waist circumference		
Male (>85 cm)	24	92.3
Female (>80 cm)	39	83.0

Triglycerides (>150 mg/dL)	25	36.8
HDL (mg/dL)	56	83.6
Male (<40 mg/dL)	20	87.0
Female (<50 mg/dL)	36	81.8
Hypertension (>130/85 mm Hg)	48	65.8
Glucose>100 mg/dL	58	80.6

Age and gender differences in metabolic syndrome components and Framingham risk scores

Older participants (≥65 years) had higher systolic blood pressure than middle-aged participants ($t=-2.78$, $p<.05$). Females had significantly higher levels of triglycerides than males ($t=-2.62$, $p<.05$). No significant differences were found between age groups or males and females in other metabolic syndrome components ($p>.05$). Also, no significant differences were found between males and females or between different age groups in the number of metabolic syndrome components. Using the Framingham risk score, males were at a significantly higher risk of developing heart disease than females ($t=3.15$, $p<.05$).

Relationships among body mass index, metabolic syndrome, and Framingham risk factors

BMI was significantly correlated with the number of metabolic syndromes ($r=.23$, $p=.05$). A higher BMI was positively related to a greater number of metabolic syndromes. BMI was not significantly associated with the Framingham risk score ($r=.01$, $p>.05$).

Relationships among predisposing, enabling, and behavior factors and metabolic syndrome components

Logistic regression was used to determine whether age, gender, income, health insurance, smoking history, meeting recommended physical activity guidelines, and diet were associated with the presence of metabolic syndrome. The analyses indicated that the overall model did not fit (−2 Log Likelihood=18.63, goodness of fit=8.79, $p>.05$) and was not predictive of the presence of metabolic syndrome.

A hierarchical linear regression was used to examine the association of these same variables and the number of metabolic syndrome components. The overall model was not significantly associated with the number of metabolic syndrome components ($R2=.07$, $F=.09$, $p>.05$).

Finally, hierarchical linear regression analyses were performed in five separate models to examine the relationships between these variables and each metabolic syndrome component (waist circumference, triglycerides, cholesterol, blood pressure, and fasting glucose level). The full multiple regression model, with all variables entered, explained 23% of the variance in systolic blood pressure, $R2=.23$, $F(8, 64)=2.42$, $p<.05$. Health behavior variables explained 7% of the variance in blood pressure after controlling for predisposing and enabling factors (Table 4). No significant associations of the variables were found with waist circumference, triglycerides, HDL, or glucose ($p>.05$).

Table 4. ***Hierarchical Multiple Regression of Significant Predictor Variables in Metabolic Syndrome Components (N=73)***

Variables	**Systolic blood pressure**		
	B	***SE***	^{a} **β**
Step 1. Age	0.99	0.32	.36*
Gender	13.04	6.00	.30*
BMI	1.23	.68	.21
Step 2. Income	−3.47	1.84	−.22*
Insurance	−1.50	6.83	−.03
Step 3. Smoking	14.01	7.16	.27*
Physical activity	5.56	4.88	.13
Diet	−0.04	0.10	−.05

Note. [a] Beta shown are for the last step. * $p<.05$. Step 1: $R^2=.11$, $\Delta R^2=.11$, $F(3, 69)=2.87$, $p<.05$. Step 2: $R^2=.16$, $\Delta R^2=.05$, $F(5, 67)=2.63$, $p<.05$. Step 3: $R^2=.23$, $\Delta R^2=.07$, $F(8, 64)=2.42$, $p<.05$.

Discussion

This study examined the relationships between predisposing, enabling, and behavior factors and the presence of metabolic syndrome and its components among Chinese older adults with diabetes. Most of these adults had multiple metabolic syndrome components. This was not surprising, since the entire sample had already been diagnosed with diabetes. Similarly, several large epidemiological studies of Chinese populations have found that the metabolic syndrome was prevalent in older adults in Beijing (He et al., 2006), and its components were related to diabetes in Chinese populations (Hu et al., 2007; Pan et al., 1997; Zhou, 2002). The large numbers of this sample who had metabolic syndrome components raise concern since older adults with the metabolic syndrome have higher odds ratios for CHD, stroke, and peripheral arterial disease than those without metabolic syndrome (He et al., 2007). Clearly, older adults with a high number of metabolic syndrome components should be advised to attend regular health screenings for prevention and early detection of CVD risk factors.

These adults with diabetes performed less physical activity than recommended by the CDC (2007) and the WHO (2008). Most did not engage in vigorous/aerobic activity, although the majority reported taking a brisk walk on several days of the week. This finding is consistent with a study that found that only 21.8% of the urban Chinese population met WHO's recommendation for physical activity (Muntner et al., 2005). Also, participants had a daily diet high in fat and low in vegetables and fruits on most days of the week. Chinese individuals have traditionally eaten a diet high in vegetables and low in meat, and before urbanization, walking and biking were traditional transportation modes for the majority of the people. The low physical activity and high-fat diet thus reflect China's dramatic socioeconomic changes in the past two decades: abundant food and urbanization have led to less leisure-time physical activity and an increase in obesity (Du, Lu, Zhai, & Popkin, 2002; Jia et al., 2002; Wong & Wang, 2006). The lifestyle changes found in our study among older Chinese adults with diabetes are consistent with previous studies reporting a trend toward a Western diet with a 5 times increase in the consumption of red meat, eggs, and oil, decreases in fruit and vegetable intake (Liu et al., 2000; Zhou, 2002), and an increase in the total fat intake from 88.1 g/day in 1983 to 97.4 g/day in 1999 (Zhao et al., 2008). These changes among adults who live in large cities like Beijing may have profound impacts on their health (Critchley, Liu, Zhao, Wei, & Capewell, 2004) and CVD risk.

Interestingly, using the Framingham risk score, males are at a higher risk of developing heart disease in 10 years than females. This is similar to other reports that the risk of ischemic heart disease mortality is higher in Chinese men than women (Schooling, Lam, Ho, Mak, & Leung, 2008). However, neither gender nor age was associated with the metabolic syndrome in the current study. This finding conflicts with previous studies that reported that Chinese women had a higher incidence of metabolic syndrome than men (Feng et al., 2006; Gu et al., 2005). In the current study, females had a higher level of triglycerides than males, but the difference was not significant. However, the nonsignificant finding may be related to the fact that the number of men was small.

Specific metabolic syndrome components were found at alarming levels. Most participants were overweight or obese and had hypertension, hyperglycemia, low HDL, high LDL, and a high ratio of TC/HDL. Therefore, they were at a high risk for CVD. A higher BMI was associated with an increased number of metabolic syndromes, which is consistent with the finding that BMI was associated with CVD risk factors among Chinese populations in mainland China (He et al., 2007; Hu et al., 2000). The findings are also congruent with obesity in Chinese populations reported by Critchley et al. (2004), Feng et al. (2006); and Gu et al. (2005).

The PRECEDE–PROCEED model of predisposing, enabling factors, and behavioral factors was associated with specific metabolic syndrome components but not with the presence or the number of the metabolic syndromes. The association of elevated blood pressure with older age and gender differences in triglycerides have been reported in epidemiological studies of Chinese populations (Hu et al., 2000; Muntner et al., 2004). Another factor that has been associated with systolic blood pressure and the prevalence of hypertension in Chinese populations is BMI (Hu et al., 2000). Predisposing, reinforcing, and behavior together were also significantly associated with systolic blood pressure. A previous epidemiological study found that Chinese individuals with diabetes tended to be older, with higher incomes and less education, and they had hypertension, high BMI, and a high waist-to-hip ratio (Pan et al., 1997). The lack of association of predisposing, enabling, and behavior factors with the level or presence of metabolic syndrome may be attributable to the fact that this was a small, homogeneous sample already diagnosed with diabetes. Larger samples may be required to identify predictors of the presence and level of metabolic syndrome.

The study has several limitations that restrict the generalizability of the findings. The data were obtained through face-to-face interviews, using self-reports of physical activity, smoking, and diabetes management; thus, social desirability may have biased the findings. Also, convenience sampling may have limited the representativeness of the sample, and the sample was small for performing multivariate analyses. Finally, the Framingham risk score is based on US adults, not adults living outside the United States, and thus may not be appropriate for Chinese.

Despite its limitations, the study findings are consistent with epidemiological studies of Chinese populations. The participants had major metabolic syndrome risks similar to the risks of the general adult population of China. Further, the Chinese adults with diabetes in our study who had multiple metabolic syndrome components were at a higher risk for CVD.

Future studies are needed to explore ways of measuring the metabolic syndrome and its clinical implications for Chinese populations. In particular, the role of physical activity and diet in development of the metabolic syndrome in Chinese older adults with diabetes should be further examined using a culturally appropriate measurement, for example, types of physical activities and diet that are relevant to Chinese older adults. Gender differences in metabolic syndromes and its components also need to be examined in future research.

Implications for public health nurses

Nurses need to ensure culturally appropriate content, examples, health beliefs, outcomes, and strategies in program development. This may require obtaining input from an emic perspective, that is, a person from within the group, population, or culture of focus. Community health workers or lay health workers are one example of this inclusion. Using Chinese society examples is another method. Evaluation must be based on participant, qualitative, and clinical outcomes, as well as provider and statistical outcomes of programs.

The results found in this study provided evidence of the importance of public health education for reducing the risk factors related to CVD and promoting healthy behaviors in older Chinese adults. Chinese nurses play an active role in these efforts, for example, they plan and implement community-based programs aimed at increasing public awareness of physical activity and a healthy diet (low fat and low sodium), weight control programs, and regular health screenings (e.g., blood pressure, BMI, cholesterol, glucose) to promote healthy behaviors and reduce the risk of developing diabetes, metabolic syndrome, and CVD. In order to design an endemic-based CVD prevention program for Chinese adults, public health nurses need to obtain health data on genetics, environmental factors, and quality of life, which were not collected in the current study. Data collection of PROCEED variables would assist public health nurses in examining how these factors contribute to or interact with health and quality of life. Evidence-based programs can further be developed for fully understanding the effects of predisposing, reinforcing, and enabling factors, genetics, behavior, and environment on health. Culturally appropriate interventions can then be targeted to reducing risk factors and improving health and quality of life.

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