Letter to the Editor

Clustering of Non-communicable Diseases Risk Factors in Healthy Adults Aged 35 Years and Older in Shenzhen, China*

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We assessed the prevalence of non-communicable diseases (NCDs) risk factors with a focus on their clustering among healthy adults in Shenzhen, China. Data from the 2011 China Health and Nutrition Survey, comprising a regionally representative sample of 806 healthy adults aged 35 years or older, were obtained to determine the prevalence of five risk factors for NCDs. The prevalence of current smoking, central obesity, impaired fasting glucose, borderline hypertension, and borderline high total cholesterol was 19.97%, 28.29%, 4.47%, 10.55%, and 36.10%, respectively. A total 63.77% of participants had at least one risk factor. Upon examination of risk factor clustering, we observed that 7.57% of participants had at least three risk factors. Using this threshold as a cutoff, clustering of risk factors was associated with sex [odds ratio (*OR*) = 3.336, 95% confidence interval (*CI*): 1.782 to 6.246], physical activity (*OR* = 1.913, 95% *CI*: 1.009 to 3.628), and BMI (*OR* = 7.376, 95% *CI*: 3.812 to 14.270). The prevalence of risk factors for NCDs is fairly high among healthy adults in Shenzhen, with a clustering tendency.

Key words: Non-communicable diseases; Healthy adults; Prevalence; Risk factors

The leading causes of death among people in China are non-communicable diseases (NCDs)[1]. Tobacco smoking, central obesity, borderline high total cholesterol (TC), borderline hypertension, and raised fasting glucose levels are well known shared modifiable risk factors for the major NCDs. The national standards for the prevention and control of chronic diseases, issued by the Ministry of Health of the People's Republic of China, lists these five risk factors as critical to the control of NCDs. These risk factors are more prevalent and easier to detect than NCDs. Therefore, assessing epidemiological status by identifying the distribution of risk factors among different population in a region is the first of three planning steps recommended by the World Health Organization (WHO) for the prevention and control of NCDs and their risk factors. Information on a regional risk factor profile could also aid in predicting the future burden of disease. This in turn helps to make a strong case for high-level advocacy and constitutes an evidence base for planning interventions at policy, environmental, and health system levels.

There have been reports from the United States on clustering of risk factors among the population[2]. This clustering phenomenon may predispose Americans to a higher burden of NCDs than populations with lower clustering tendencies. At the same time, previous studies have highlighted the need for local, high-quality epidemiological data on the burden of NCDs and their risk factors, particularly in Shenzhen where such data are scarce[3]. However, systematic analysis of the clustering of all major risk factors is lacking, making it difficult to establish a regional representation of healthy people in Shenzhen. Therefore, we conducted a cross-sectional study to obtain a comprehensive profile of the epidemiologic distribution of selected risk factors for NCDs among healthy residents of Shenzhen.

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The present cross-sectional study was conducted as a part of the China Health and Nutrition Survey at the Center for Chronic Disease Control of Shenzhen. The ethics committee of the Center for Chronic Disease Control of Shenzhen approved the study. The survey is described in detail elsewhere[4]. In brief, the survey used a multistage stratified cluster random sampling method to select a representative sample of permanent residents in eight different districts of the city of Shenzhen. The first stage of sampling was stratified by district and population distribution on the basis of Shenzhen population data from 2010, which involved the random selection of 12 streets from the 8 districts. In the second stage, one residential community was randomly selected from each selected street. In the third stage, about 75 households were randomly selected from the residential communities selected in the earlier stage. In the last stage, eligible family member from each designated household was recruited.

The eligibility criteria were set as follows: a man or non-pregnant woman; aged 35 years or above; living in Shenzhen for more than 5 years; and confirmed not to have hypertension, diabetes, high TC, cancer, severe liver disease, systemic lupus erythematosus, or kidney diseases. From February to July 2011, according to the eligibility criteria, a total of 882 adults were selected from designated households and invited to participate in the study. We excluded 76 individuals because they did not provide questionnaire-derived information or fasting blood or anthropometry data. Finally, 806 participants were enrolled in the study. The population size was relatively small because of the limited number of healthy adults in the region. Structured questionnaires were used to collect information on sociodemographic characteristic variables and health parameters. Height, body weight, waist circumference (WC), and blood pressure of all participants were recorded. Fasting blood glucose (FBG) and TC concentrations were measured using commercially available kits.

Each participant was also categorized as a habitual drinker, non-habitual drinker, or non-drinker[4]. In this study, the term 'moderate- to vigorous-intensity physical activity' was defined as physical activity causing at least some sweating or shortness of breath, whereas the term 'light physical activity' was defined as causing no sweating or shortness of breath[4]. Physical activity was further categorized as moderate- to vigorous-intensity physical activity performed once a week or more. Current smoking was defined as self-reported use of tobacco products every day or on some days, at the time the survey was conducted[4]. We defined impaired fasting glucose as a value of 6.1-6.9 mmol/L[5], and borderline hypertension was defined as systolic blood pressure (SBP) 130-139 mmHg or diastolic blood pressure (DBP) 85-89 mmHg[6]. Borderline high TC was defined as having a TC value ≥ 5.2 mmol/L and < 6.2 mmol/L. Body mass index (BMI) was defined as weight (kg) divided by the square of height (m) and was classified into the following categories according to the accepted Chinese BMI standard: underweight (BMI < 18.5 kg/m^2), normal weight (18.5 ≤ BMI < 24.0 kg/m^2), overweight (24.0 ≤ BMI < 28.0 kg/m^2), and obese (BMI ≥ 28.0 kg/m^2). Two sets of cutoff values were used to define central obesity in terms of WC: ≥ 90 cm for men and ≥ 85 cm for women on the basis of specific guidelines for central obesity.

The mean and standard deviation of continuous variables were expressed as mean ± SD, and percentage was calculated for the categorical variables. Age and other anthropometric characteristic differences between groups by sex were determined using a Student *t*-test. The chi-squared test or Fisher's exact test was used to determine significant differences in proportions among categorical variables. We then determined the number of selected risk factors for each participant at the time of the survey (from 0 to 5). In addition, Spearman analysis was performed to identify possible predictors of the number of selected risk factors. Multiple logistic regression analysis was done to obtain odds ratios (*ORs*) and their confidence intervals (*CIs*) for clustering of three or more selected risk factors. Statistical analysis of the data was performed using IBM SPSS version 21.0 software (IBM Corp., Armonk, NY, USA). All statistical analyses were two-tailed and P < 0.05 was considered statistically significant.

Table 1 summarizes the sociodemographic and other characteristics of the 806 participants who were included in the final analysis. Of the included participants, 44.17% were men, 55.83% were women, the mean age was 48.94 ± 11.32 years, 51.24% had attained a senior high school or higher education, 94.54% were currently married, and 48.26% were employed. The rate of current smoking was 19.98%, habitual drinking was 6.70%, and 83.87% of participants reported engaging in regular physical activity. In terms of anthropometric measures, the mean levels of average BMI, SBP, DBP, WC, TC, and FBG for the 806 participants were 23.38 ± 3.04 kg/m^2, 110.64 ± 11.71 mmHg, 72.89 ± 7.76 mmHg, 81.71 ± 8.83 cm, 4.85 ± 0.81 mmol/L, and 5.17 ± 0.51 mmol/L, respectively.

The prevalence of risk factors is shown in Table 2. Of the five risk factors studied, borderline high TC had the highest prevalence. More than 40% of men had TC values ≥ 5.2 mmol/L and < 6.2 mmol/L. The prevalence of other risk factors, in descending order, was as follows: central obesity, 28.29%; current smoking, 19.97%; borderline hypertension, 10.55%; and impaired fasting glucose, 4.47%. A lower current smoking prevalence was found among women, who engaged in regular physical activity, were habitual drinkers, had normal weight, and were homemakers. The prevalence of central obesity and borderline high TC was significantly higher among participants aged 45-69 years. The prevalence of central obesity was significantly higher in those who were obese and overweight. The prevalence of borderline hypertension was found to be significantly higher among obese individuals.

We examined the clustering (presence of multiple risk factors in an individual) of selected risk factors in our sample. With respect to the number of the selected risk factors per healthy adult, only 36.23% of participants had none; 37.22% had one risk

Table 1. Socio-demographic and Other Characteristics of Participants in the Study

Characteristics	General (*n* = 806)	Women (*n* = 450)	Men (*n* = 356)	Statistics	*P*
Age (years)	48.94 ± 11.32	48.22 ± 10.28	49.85 ± 12.47	t = 1.973	0.049
BMI (kg/m^2)	23.38 ± 3.04	23.33 ± 2.93	23.44 ± 3.18	t = 0.544	0.587
SBP (mmHg)	110.64 ± 11.71	109.97 ± 12.52	111.48 ± 10.56	t = 1.854	0.064
DBP (mmHg)	72.89 ± 7.76	71.71 ± 7.82	74.38 ± 7.44	t = 4.945	< 0.001
WC (cm)	81.71 ± 8.83	79.43 ± 8.27	84.59 ± 8.68	t = 8.608	< 0.001
TC (mmol/L)	4.85 ± 0.81	4.81 ± 0.82	4.91 ± 0.78	t = 1.704	0.089
FBG (mmol/L)	5.17 ± 0.51	5.13 ± 0.49	5.21 ± 0.53	t = 2.265	0.024
Physical activity, *n* (%)					
Yes	676 (83.87)	424 (94.22)	252 (70.79)	χ^2 = 80.698	< 0.001
No	130 (16.13)	26 (15.78)	104 (29.21)		
Smoking status, *n* (%)					
Current smoker	161 (19.98)	2 (0.44)	159 (44.66)	χ^2 = 243.119	< 0.001
Others[a]	645 (80.02)	448 (99.56)	197 (55.34)		
Drinking habit, *n* (%)					
Non-drinker	517 (64.14)	344 (76.44)	173 (48.60)	χ^2 = 67.751	< 0.001
Non-habitual drinker	235 (29.16)	89 (19.78)	146 (41.01)		
Habitual drinker	54 (6.70)	17 (3.78)	37 (10.39)		
Marital status, *n* (%)					
Unmarried	11 (1.36)	9 (2.00)	2 (0.56)	χ^2 = 10.644	0.005
Currently married	762 (94.54)	415 (92.22)	347 (97.47)		
Ever-married	33 (4.10)	26 (5.78)	7 (1.97)		
Educational level, *n* (%)					
0 year	24 (2.98)	21 (4.67)	3 (0.84)	χ^2 = 25.912	< 0.001
1-6 years	131 (16.25)	84 (18.67)	47 (13.20)		
7-9 years	238 (29.53)	129 (28.67)	109 (30.62)		
10-12 years	312 (38.71)	177 (39.33)	135 (37.92)		
≥ 12 years	101 (12.53)	39 (8.66)	62 (17.42)		
Employment status, *n* (%)					
Unemployed	32 (3.97)	16 (3.56)	16 (4.49)	χ^2 = 86.338	< 0.001
Retired	179 (22.21)	90 (20.00)	89 (25.00)		
Others	64 (7.94)	32 (7.11)	32 (8.99)		
Homemaker	142 (17.62)	129 (28.67)	13 (3.65)		
Employed	389 (48.26)	183 (40.66)	206 (57.87)		

Note. Data are expressed as mean ± SD if not indicated. BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; WC: Waist circumference; TC: total cholesterol; FBG: fasting blood glucose. [a]Never smoker and ex-smoker.

factor, 18.98% had two risk factors, and 7.57% had three or more of the selected risk factors. Overall, the mean number of selected risk factors per healthy adult was 0.99 (median 1). To investigate the relationships between number of selected risk factors and potential influencing factors, Spearman rank correlation analysis was performed. The number of selected risk factors was associated with age (r_s = 0.172, P < 0.001), BMI (r_s = 0.414, P < 0.001), sex (r_s = 0.307, P < 0.001), physical activity (r_s = -0.152, P < 0.001), educational level (r_s = -0.074, P = 0.035), and alcohol drinking status (r_s = 0.096, P = 0.006).

The presence of three of the selected risk factors was considered the threshold for identifying a clustering phenomenon because beyond this threshold, the prevalence dropped suddenly. The association of clustering with various sociodemographic and other factors was examined (Table 3). These findings were similar in multiple logistic regression analysis, when adjusting for potential confounding factors. The risk factors that were most commonly associated with clustering included male sex (*OR* = 3.336, 95% *CI*: 1.782 to 6.246), physical activity (*OR* = 1.913, 95% *CI*: 1.009 to 3.628), and obese or overweight (*OR* = 7.376, 95% *CI*: 3.812 to 14.270).

Table 2. Prevalence (%) of Selected NCDs Risk Factors in Shenzhen Healthy Adults

Characteristics	Current Smoking	Central Obesity	Impaired Fasting Glucose	Borderline Hypertension	Borderline High Total Cholesterol
Total	19.97 (17.3-22.8)	28.29 (25.3-31.5)	4.47 (3.2-6.0)	10.55 (8.6-12.8)	36.10 (32.8-39.5)
Gender					
Men	44.66 (39.6-44.9)	30.89 (26.2-35.8)	5.34 (3.3-8.0)	12.08 (9.0-15.7)	40.17 (35.2-45.3)
Women	0.44 (0.1-1.4)	26.22 (22.3-30.4)	3.78 (2.3-5.8)	9.33 (6.9-12.3)	32.89 (28.7-37.3)
Physical activity					
Yes	15.53 (12.9-18.4)	26.78 (23.5-30.2)	4.73 (3.3-6.5)	10.36 (8.2-12.8)	35.50 (32.0-39.2)
No	43.08 (34.8-51.7)	36.15 (28.2-44.6)	3.08 (1.0-7.0)	11.54 (6.8-17.8)	39.23 (31.1-47.8)
Age (years)					
≥ 70	21.56 (11.8-34.1)	39.22 (26.6-52.9)	9.80 (3.6-19.9)	19.61 (10.3-31.8)	31.37 (19.8-44.8)
45-69	19.31 (15.5-23.5)	32.80 (28.2-37.6)	4.76 (2.9-7.2)	11.64 (8.7-15.1)	43.12 (38.2-48.1)
35-44	20.42 (16.6-24.7)	22.28 (18.3-26.7)	3.45 (1.9-5.6)	8.22 (5.7-11.3)	29.71 (25.2-34.4)
Drinking habit,					
Non-drinker	40.74 (28.3-54.0)	28.82 (25.0-32.8)	3.87 (2.4-5.8)	11.03 (8.5-13.9)	35.39 (31.4-39.6)
Non-habitual drinker	29.36 (23.8-35.4)	28.94 (23.4-34.9)	4.68 (2.5-7.9)	9.36 (6.1-13.5)	36.59 (30.6-42.9)
Habitual drinker	13.54 (10.8-16.7)	20.37 (11.1-32.3)	9.26 (3.4-18.9)	11.11 (4.6-21.2)	40.74 (28.3-54.0)
BMI					
Obese	25.86 (15.8-38.0)	89.66 (80.1-95.8)	6.89 (2.2-15.3)	24.14 (14.4-36.1)	46.55 (34.1-59.3)
Overweight	20.22 (15.7-25.4)	58.02 (52.0-63.9)	5.73 (3.3-9.0)	14.89 (10.9-19.5)	39.69 (33.9-45.7)
Normal weight	17.70 (14.4-21.4)	5.31 (3.5-7.6)	3.54 (2.1-5.5)	6.86 (4.8-9.4)	33.63 (29.4-38.1)
Underweight	38.24 (23.2-55.0)	0.00	2.94 (0.2-12.3)	2.94 (0.2-12.3)	23.53 (11.5-39.4)
Educational level					
0 year	12.50 (3.3-29.3)	37.50 (20.1-57.4)	12.50 (3.3-29.3)	25.00 (10.8-44.3)	29.17 (13.7-48.8)
1-6 years	17.56 (11.7-24.7)	33.59 (25.9-41.9)	5.34 (2.3-10.1)	7.63 (3.9-13.0)	41.98 (33.7-50.5)
7-9 years	26.05 (20.8-31.9)	29.41 (23.9-35.4)	2.59 (1.0-5.0)	12.18 (8.4-16.7)	34.87 (29.0-41.1)
10-12 years	16.99 (13.1-21.4)	25.32 (20.7-30.3)	4.81 (2.8-7.6)	8.65 (5.9-12.1)	35.26 (30.1-40.7)
≥ 12 years	19.80 (12.8-28.3)	25.74 (17.9-34.8)	4.95 (1.8-10.3)	12.87 (7.3-20.3)	35.64 (26.7-45.3)
Employment status					
Unemployed	15.62 (5.9-30.6)	18.75 (7.9-34.4)	3.13 (0.2-13.0)	9.38 (2.4-22.5)	43.75 (27.5-60.9)
Retired	17.87 (12.7-23.9)	31.28 (24.8-38.3)	6.88 (4.1-11.7)	13.97 (9.4-19.5)	42.46 (35.4-49.8)
Others	31.25 (20.8-43.2)	23.44 (14.2-34.7)	1.26 (0.1-6.7)	9.38 (3.8-18.1)	31.25 (20.8-43.2)
Homemaker	4.93 (2.1-9.3)	32.39 (25.1-40.4)	3.52 (1.3-7.4)	9.86 (5.7-15.5)	32.39 (25.1-40.4)
Employed	24.94 (20.8-29.4)	26.99 (22.7-31.5)	4.11 (2.4-6.4)	9.51 (6.9-12.7)	34.70 (30.1-39.5)

Note. Data are expressed as % (95% confidence interval). BMI: body mass index.

Table 3. Association of Socio-demographic and Other Factors with Clustering of Three or More Selected Risk Factors in Shenzhen Healthy Adults

Characteristic	*OR* (95 % *CI*)	Adjusted *OR* (95% *CI*)[a]
Gender		
Men	3.925 (2.178-7.072)	3.336 (1.782-6.246)
Women	1 (reference)	1 (reference)
Physical activity	2.584 (1.449-4.607)	1.913 (1.009-3.628)
No	1 (reference)	1 (reference)
Yes		
BMI		
Obese or Overweight	7.142 (3.733-13.663)	7.376 (3.812-14.270)
Normal weight or Underweight	1 (reference)	1 (reference)

Note. BMI: body mass index. [a]Adjusted for age, employment status, household per capita, education level, drinking status, and marital status.

Our study demonstrated that the prevalence of current smoking, central obesity, impaired fasting glucose, borderline hypertension, and borderline high TC among healthy adults aged ≥ 35 years in Shenzhen were 19.97%, 28.29%, 4.47%, 10.55%, and 36.10%, respectively. Individual clustering of multiple risk factors, evidenced by the presence of at least two risk factors among nearly a quarter of the adults in our study, suggests that a large number of adults living in Shenzhen are at risk for developing NCDs. Previous studies have demonstrated that cardiovascular disease incidence and all-cause mortality increased markedly in the presence of risk factor clustering[7]. In the National Health and Nutrition Examination Survey Epidemiologic Follow-Up Study, the age-, race-, sex-, and education-adjusted relative risks of coronary heart disease in adults with one, two, three, four, or five risk factors (hypertension, high blood cholesterol, diabetes, overweight, and current smoking) were 1.6, 2.2, 3.1, and 5.0, respectively, during 21 years of follow-up, compared with individuals who had no risk factors[8]. These findings indicate that healthy behaviors are associated with lower mortality and a lower risk of NCDs. Appropriate public health interventions should be implemented in Shenzhen to reduce high-risk health behaviors and thereby lower the prevalence of biological risk factors for NCDs to which these behaviors can lead, such as borderline hypertension, impaired fasting glucose, and borderline high TC. The number of these NCD risk factors was associated with age, BMI, sex, physical activity, educational level, and alcohol drinking status in this study. Other researchers have corroborated the findings of this work[9]. The clustering phenomenon in our sample was associated with sex, physical activity, and BMI. Sex, physical activity, and BMI were independent risk factors for borderline hypertension, impaired fasting glucose, and borderline high TC[1,10]. These associations are pivotal for the design of targeted public health intervention programs.

In conclusion, the prevalence of the studied risk factors for NCDs is fairly high among healthy adults in Shenzhen, with a clustering tendency. Our findings suggest that a significant increase in NCDs among the city's population can be expected in near future if an effective response is not mounted in Shenzhen. A lack of regional action will in turn create increased burden to health care services and loss of productivity owing to death and disability among workers at peak working age. It is imperative that public health policies and interventions are implemented immediately to reduce these risk factors. Such policies and interventions should particularly target inadequate physical activity levels and individuals who are obese or overweight.

The authors declare that they have no conflicts of interest.

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