

The Association of Metabolic Syndrome with Alcohol Consumption among Urban Chinese

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Abstract

Background: Along with economic improvement, China is experiencing increasing rates of non-communicable disease and a rise in alcohol consumption. While a modest intake of red wine has been shown to be health enhancing, the pathophysiology associated with excessive alcohol consumption is being increasingly recognized. The purpose of this study is to demonstrate the health consequences of alcohol consumption among middle-aged urban Chinese people.

Methods: This cross-sectional study included 793 subjects aged 44, 48 or 52 years, from urban community health centres and a local hospital, who participated in a survey, anthropometrics and blood chemistry. Multiple logistic regression analysis was used to obtain adjusted odds ratios (OR) between alcohol intake and medical history of diabetes and hypertension, metabolic syndrome and its five component variables.

Results: Metabolic syndrome (MetS) was detected in 53.5% and 42.8% of men and women, respectively, ($p < .05$), and regular alcohol consumption was found among 72.5% and 12.4% of men and women ($p < .00$). A weak association was found between consuming alcohol ≥ 2 times a week (or having quit) and MetS (OR = 1.7, 1.0, 2.9) and elevated blood pressure (OR = 1.8, 1.0, 3.1).

Conclusion: Alcohol consumption is an under-appreciated risk factor found in association with increased rates of metabolic syndrome and associated non-communicable diseases among urban residents in China.

Introduction

The benefits of China's economic growth have been unbalanced. Inequitable access to these benefits have left some portions of the population with unmet health, education and social needs. While increased urbanization has created opportunity for millions of people in China, it has also led to the emergence of an urban underclass, either among disenfranchised migrant workers or among long-time urban dwellers who have not fared well in the restructuring of state-owned enterprises (Zhou et al. 2003). The health status of these urban poor is a matter of great concern.

Among the middle-aged and elderly in China, a more lavish lifestyle has led to increased rates of obesity and sedentary living (Van de Poel et al. 2009). Rates of metabolic syndrome (MetS) and its correlates are increasing in China and other developing countries at an alarming rate (Anoop and Lokesh 2008; Popkin 2009; Strand et al. in press). These "diseases of affluence" are also of great concern as global economic growth is countered by global health declines (Popkin 2008). Along with economic improvement, China is experiencing a rise in alcohol consumption (Caetano and Laranjeira 2006; Cochrane et al. 2003). The pathophysiology associated with excessive alcohol consumption is being increasingly recognized (Schuckit 2009). Alcohol is associated with excess mortality from liver cancer, upper digestive cancer, liver disease and pancreatic disease (Mathurin and Deltenre 2009; Rehm et al. 2003).

The purpose of this study is to determine alcohol consumption patterns among middle-aged Chinese people and the health consequences associated with alcohol consumption.

Methods

Subjects

From August 2008 until January 10, 2009, we conducted a survey among three age cohorts, born in 1956, 1960 and 1964, in Yuci District (population 300,000), Jinzhong City, in Shanxi Province, China. These three birth cohorts were chosen as part of research into the influence of the 1960–61 Chinese famine on chronic disease in middle age. Two-thirds of the subjects were recruited through 16 of 19 community health centres (CHCs) in Yuci District. Subjects were recruited using the health record database of each CHC, which contains the names of all enrolled individuals in their capitulation area of approximately 16,000 persons per CHC. Subjects were recruited by phone invitation, by posters in the community and by word of mouth. Intensity of recruitment varied by centre, as did participation rate, with a high of 80% at one centre but a typical response rate of around 10%. Female response rate was higher because fewer women were employed and were thus available to participate. At the same time, one-third of the subjects were recruited through the Jinzhong hospital health examination centre. People being examined there are primarily healthy individuals whose employer arranges an annual physical exam at the site. Individuals with disease attend the outpatient department of this hospital, not the health examination centre. Verbal informed consent was obtained from each participant before data collection. This research was done under the authority of the Shanxi public health bureau and the Yuci public health bureau. It is a collaboration between the Shanxi Evergreen Service and the Jinzhong People's Hospital, with the cooperation of the Yuci Prefecture Women and Children's Hospital and the Luxi CHC. The research proposal was approved by the Research Ethics Board of the University of Western Ontario and the Jinzhong City Science Commission and Yuci Qu Public Health Bureau.

Survey

After two iterations of pilot-testing, a structured questionnaire with 36 questions was set and administered by trained research staff to all participants, assessing demographic data, personal and family medical history, physical activity habits, smoking, dietary intake, health knowledge about chronic disease (0–4 scale based on answers to four questions about diabetes and hypertension) and self-perceived health. Alcohol intake was surveyed (abstain, occasionally, quit more than a year, or twice a week or more). The quitters were categorized between occasional and frequent consumers, based on the assumption that their health was still affected by their drinking history. Indeed, upon questioning

it was found that the majority had quit because of a health problem (69% of the 26 quitters had done so because of a health problem, 25% to prevent disease and 6% because of a religious change). This classification is further justified by other researchers' observation that former drinkers have hazard rate ratios for several forms of cancer higher than that of current drinkers, suggesting that former drinkers quit primarily because of poor health (Nakashita et al. 2010; Schutze et al. 2011). Furthermore, 65.4% of the quitters reported their health as poor or mediocre and none reported their health as excellent. Although we did not discriminate between beer, spirit and wine, it is known that 45% alcohol spirits (*baijiu*) taken with a meal is the alcohol most commonly consumed.

Biochemistry

Overnight fasting blood samples were drawn by venipuncture to measure serum glucose, total cholesterol, triglycerides, high-density lipoproteins (HDL) and low-density lipoproteins (LDL). No freezing of blood samples was required and all were analyzed within three hours at the Jinzhong People's Hospital Laboratory on a Roche Diagnostics Modular P800 Analyzer (Roche Diagnostics, Germany) using the re-agent imported from Roche Diagnostics.

Anthropometrics

Subjects were weighed (without shoes) with light summer clothing, and, when the season changed, 1 to 2 kg was deducted to adjust for heavier fall and winter clothing. Standing height was measured in metres (without shoes) using the stadiometer attached to the scale (Su Hong Medical Equipment Company, Limited, Jiangsu, China). Measurements were taken to the nearest tenth of a centimetre.

Waist circumference was measured with the participant standing erect, using a standard tape measure (cm). Measurement was taken at the umbilicus, the tape being horizontal and passing just above the iliac crest. Body mass index was calculated as weight (kg) divided by height squared (m²).

After 30 minutes of rest and no smoking, at least two blood pressure measurements were obtained one minute apart by trained nurses and physicians, according to the American Heart Association recommendations (Pickering et al. 2005). All measurements were averaged. A standard mercury sphygmomanometer was used.

Metabolic Syndrome Criteria

Metabolic Syndrome (MetS) was defined using the NCEP ATP III criteria, which require the presence of three or more of the following risk determinants:

1. Increased waist circumference (≥ 90 cm for men, ≥ 80 cm for women)
2. Elevated triglycerides (≥ 1.7 mmol/L [150 mg/dL]) or treatment for this lipid abnormality
3. Low HDL cholesterol (< 1.03 mmol/L [< 40 mg/dL] in men, < 1.29 mmol/L [50 mg/dL] in women) or treatment for this lipid abnormality
4. Hypertension ($\geq 130 / \geq 85$ mmHg) or treatment for hypertension
5. Impaired fasting glucose (≥ 5.6 mmol/L [100 mg/dL]) or treatment for raised blood glucose

Statistical Analysis

A total of 793 subjects with complete data were used in the analysis. Kruskal-Wallis test and Pearson's chi-square test were used to test for differences between alcohol consumption categories and laboratory values (fasting blood glucose [FBG], triglycerides, cholesterol), medical history of diabetes and hypertension, metabolic syndrome and the five variables that constitute the metabolic syndrome. Multiple logistic regression analysis was used to obtain adjusted odds ratios and their 95% confidence intervals between alcohol intake and medical history of diabetes and hypertension, metabolic syndrome and its five component variables. These were adjusted for gender, age, income, cigarette consumption, family history of chronic disease and physical exercise. Analyses were performed using SAS 9.2 for Windows.

Results

The population surveyed represents a north China urban middle- to lower-class population (Table 1a) with a mean age of 48.6 and 48.4 years for men and women, respectively (Table 1b). Subjects are married (men 100%, women 98.1%) and living with two to three others in their home; nearly half have had nine or less years of education. Less than a third work in professional or clerical occupations. Some of the women are retired, mostly from defunct state-owned factories. Over 60% are living on less than five US dollars a day (\$1,825 per year).

Rates of smoking and alcohol consumption are 64.3% and 1.9% and 72.5% and 12.4% for men and women, respectively (Table 1a). Chronic disease knowledge is significantly higher among women than men.

There is a high amount of undiagnosed elevated blood pressure and elevated blood glucose, as shown by the discrepancy between measured blood pressure (in excess of 140/90 mm Hg) and measured blood glucose (FBG > 7.0 mmol/L) and the self-reported rates (Table 1a).

Table 1a. Demographic and clinical characteristics (as a percentage)

Characteristics	Male (n = 269)	Female (n = 524)
Occupation:		
Professional, clerical	29.7	27.2
Retired	1.1	17.4
Manual	49.4	29.7
Unemployed	11.5	21.2
≤ 9 years education*	48.1	43.8
Physical activity more than 150 min per week	40.4	38.1
Regular alcohol consumption**	72.5	12.4
Smoking **		
No	25.7	97.7
Quit (> 1 year)	10.0	0.4
Yes	64.3	1.9
Hypertension (BP > 140/90)**	49.8	31.7
Self-reported hypertension*	27.9	18.9
Diabetes (FBG > 7.0 mmol/L)*	15.2	7.6
Self-reported type 2 diabetes*	12.7	5.0
Metabolic Syndrome (ATPIII criteria)*	53.5	42.8

BP = blood pressure; FBG = fasting blood glucose.

* $p < .05$; ** $p < .0001$.

MetS was detected in 53.5% and 42.8% of men and women, respectively ($p < .05$) (Table 1a), and a positive association was found between consuming alcohol ≥ 2 times a week (or having quit) and MetS (OR = 1.7, 1.0, 2.9). The pathology associated with alcohol consumption and contributing

to the presentation of metabolic syndrome is primarily elevated triglycerides, elevated blood glucose and hypertension (Table 2), while only the latter is found to be statistically significant after controlling for lifestyle variables (Table 3). Increased waist circumference and elevated HDLs show no relationship or pattern with alcohol consumption. Rates of diagnosed diabetes and hypertension also increased with alcohol intake (Table 2), but neither remain significant after adjustment (Table 3).

Table 1b. Demographic and clinical characteristics [mean (SD)]

Characteristics	Male (n = 269)	Female (n = 524)
Age (years)	48.6 (3.1)	48.4 (3.1)
Waist (cm)**	91.6 (8.8)	86.1 (8.9)
Fasting blood glucose (mmol/L)**	6.02 (0.12)	5.54 (0.05)
Chronic disease knowledge score (0–4)*	2.84 (0.63)	2.95 (0.58)

* $p < .05$; ** $p < .0001$.

Table 2. Association between alcohol consumption and risk factors

	Do you drink alcohol on an ordinary day?								P-value ^a
	None (n = 533)		Occasional (n = 123)		Quit (n = 26)		≥ 2 times/week (n = 111)		
Fasting blood sugar (mmol/L)	5.28	(4.99, 5.77)	5.41	(5.03, 5.92)	5.30	(4.85, 5.71)	5.53	(5.18, 5.92)	.0102
Triglycerides (mmol/L)	1.40	(0.96, 2.02)	1.47	(0.98, 2.16)	1.92	(1.16, 2.78)	1.92	(1.32, 2.86)	< .0001
Total cholesterol (mmol/L)	4.54	(3.99, 5.22)	4.56	(4.16, 5.14)	4.56	(4.07, 5.31)	4.64	(4.11, 5.20)	.8693
Diagnosed by doctor to have diabetes	31	(5.8%)	12	(9.8%)	4	(15.4%)	13	(11.7%)	.0425
Diagnosed by doctor to have hypertension	101	(18.9%)	33	(26.8%)	11	(42.3%)	29	(26.1%)	.0076
Metabolic Syndrome	226	(42.4%)	60	(48.8%)	17	(65.4%)	65	(58.6%)	.0028
Triglycerides ≥ 1.7 mmol/L or medication	199	(37.3%)	51	(41.5%)	14	(53.8%)	63	(56.8%)	.0011
HDL (male < 1.03 mmol/L, female < 1.29 mmol/L)	229	(43.0%)	50	(40.7%)	13	(50.0%)	41	(36.9%)	.5425
Waist circumference (male ≥ 90 cm, female ≥ 80 cm)	405	(76.0%)	85	(69.1%)	18	(69.2%)	72	(64.9%)	.0633
SBP ≥ 130 mmHg or DBP ≥ 85 mmHg or medication	243	(45.6%)	68	(55.3%)	20	(76.9%)	73	(65.8%)	< .0001
Blood glucose ≥ 5.6 mmol/L or medication	169	(31.7%)	43	(35.0%)	7	(26.9%)	49	(44.1%)	.0727

Note. For continuous risk factors, entries represent median with 25th and 75th percentiles in parentheses; for binary risk factors, entries represent frequency with percentage in parentheses.

HDL = high-density lipoproteins; SBP = systolic blood pressure; DBP = diastolic blood pressure.

^aKruskal-Wallis test and Pearson's chi-square test were used to test for differences between alcohol consumption category for continuous and binary risk factors, respectively.

Different outcomes for the risk factors for occasional drinkers versus non-drinkers are not significant when adjustment is performed (Table 3). However the odds ratio of 1.7 (CI 1.0, 2.9) for MetS and 1.8 (CI 1.0, 3.1) for hypertension is higher among heavy drinkers or quitters, even after adjustment. The increased risk for elevated triglycerides of 1.2 among heavy drinkers or quitters is not found to be statistically significant.

Table 3. Association between alcohol consumption and risk factors after adjusting for potential confounders

	Occasional vs. None			Quit or ≥ 2 Times/Week vs. None				
	Odds Ratio	95% CI		P-value	Odds Ratio ^a	95% CI		P-value
Diagnosed by doctor to have diabetes	1.227	0.546	2.756	0.6210	1.148	0.485	2.720	0.7532
Diagnosed by doctor to have hypertension	1.504	0.886	2.553	0.1302	1.375	0.740	2.554	0.3140
Metabolic Syndrome	1.234	0.789	1.929	0.3572	1.706	1.007	2.890	0.0468
Triglycerides ≥ 1.7 mmol/L or medication	0.951	0.599	1.511	0.8321	1.225	0.718	2.088	0.4565
HDL (male < 1.03 mmol/L, female < 1.29 mmol/L)	1.047	0.673	1.631	0.8382	1.056	0.625	1.782	0.8393
Waist circumference (male ≥ 90 cm, female ≥ 80 cm)	1.025	0.624	1.685	0.9219	1.134	0.652	1.974	0.6552
SBP ≥ 130 mmHg or DBP ≥ 85 mmHg or medication	1.441	0.918	2.262	0.1125	1.779	1.037	3.053	0.0366
Blood glucose ≥ 5.6 mmol/L or medication	0.916	0.571	1.470	0.7160	1.052	0.615	1.798	0.8531

HDL = high-density lipoproteins; SBP = systolic blood pressure; DBP = diastolic blood pressure.

^aOdds ratios adjusted for gender, age, monthly income, cigarette consumption, family history of chronic diseases and physical exercise.

Discussion

The present study found a MetS prevalence among men of 58.6% among heavy drinkers, compared to 48.8% and 42.4% among occasional drinkers and abstainers, respectively. Regression analysis demonstrated a weak relationship between alcohol intake and both MetS and elevated blood pressure. Heavy drinkers were also found to have higher rates of diabetes and higher mean blood glucose levels than occasional drinkers or non-drinkers, showing a dose-response trend, but the statistical significance of these results declined or disappeared after adjusting for a host of lifestyle variables. This observation suggests that lifestyle variables may be confounding the relationship between alcohol intake and MetS, and that in fact it is lifestyle that determines both alcohol intake and rates of MetS. Our finding of alcohol consumption as one contributor to disease and even mortality in association with other lifestyle variables has been observed in other contexts (Jin et al. 2011).

While not able to demonstrate a causal relationship, these results do elevate the importance of alcohol intake as a significant lifestyle variable associated with MetS and other non-communicable diseases, in particular hypertension, triglycerides and glucose intolerance, among middle-age Chinese populations. This issue will be analyzed presently.

In China's alcohol culture, most drinking takes place with a meal, and solitary drinking is frowned upon (Hao et al. 1999). Alcohol is used to maintain good relations between people and to promote camaraderie among colleagues. These cultural attributes may prevent the development of alcoholism among some, but the social aspect also tends to add significant peer pressure to drinking events

resulting in binge drinking. The combination of consuming spirits of high alcohol content coupled with high volume leads to intoxication.

Alcohol misuse is defined as excess daily consumption (more than four drinks per day for men or more than three for women) or excess total consumption (more than 14 drinks per week for men or more than seven drinks per week for women) or both (National Institute on Alcohol Abuse and Alcoholism 2005). Although this study reports only the frequency of alcohol consumption and not volume, in China 200 mL (90 gm) or more of 48% alcohol is commonly consumed by men at meals and parties; this would be the equivalent of five drinks of spirits. Therefore, many of the 39% of the men in this study who drink more than twice a week were likely exceeding the alcohol misuse criteria of 14 drinks per week. Many Asians possess a genetic polymorphism that confers some protection against alcoholism (Chen et al. 1999), exhibited by the so-called Asian flush. This failure to rapidly metabolize alcohol actually results in faster and more prolonged intoxication, which may worsen the toxic effects that lead to organ damage (Wakabayashi and Masuda 2006).

Reporting on research from Russia, Zaridze et al. (2009) found a dose–response relationship between death due to pancreatic disease in Russian men ages 15–74 years who consumed three or more half-litre bottles of vodka per week, with a relative risk of 6.69, (CI 4.98–9.00). Kristiansen et al. (2008) found a high alcohol intake was associated with a higher risk of pancreatitis and in a dose–response manner. The relationship between alcohol consumption and glucose intolerance is likely chronic pancreatitis.

This recognition of the deleterious effects of alcohol (Schuckit 2009), especially spirits, as is most commonly consumed in Asian countries, challenges the conclusions of research in many Western settings arguing for the protective effects of alcohol consumption on MetS (Fan et al. 2008; Freiberg et al. 2004) at relatively low levels of alcohol intake (Alkerwi et al. 2009). Alcohol intake does increase insulin sensitivity (Avogaro et al. 2004), but it is also known to generate cellular oxidative stress (Dembele et al. 2009) and overwork pancreatic beta cells (Shin et al. 2002), so whatever benefits alcohol may confer seem to be lost at higher levels of alcohol intake. The present research found no harm from occasional alcohol intake compared to none, but also did not find occasional alcohol intake to be protective.

Wine has health-enhancing attributes due to polyphenols found in red wine – especially resveratrol in grape skins – and antioxidant benefits (Agarwal 2002; Opie and Lecour 2007). But there are also health risks in alcohol consumption (Kvaavik et al. 2010), especially binge drinking (Bagnardi et al. 2008; Malyutina 2002) and/or strong liquor (Hata and Nakajima 2000). Asian alcohol consumption favours strong liquor with high alcohol and calorie content. The result has been ignoring the influence of Asian hard liquor consumption habits on cardiovascular health. While light alcohol consumption was somewhat protective against MetS in Korea, there was a dose–response increase in the odds ratio with increasing alcohol consumption (Yoon et al. 2004). Likewise, in a study of Japanese factory workers with a mean age of 44, ethanol intake of 300 g/wk or more had an increased age-adjusted hazard ratio for an increased risk of MetS (Otsuka et al. 2011). Also in a Japanese population, a positive association of alcohol intake was found with blood pressure, triglycerides and HDL cholesterol among men with and without diabetes (Wakabayashi 2011). The work presented here demonstrated an association with alcohol intake and triglycerides, fasting blood glucose and hypertension, but statistical significance was limited, and only the latter was found significant after controlling for confounding factors. This is similar to what Jin et al. have demonstrated in a study in China, where they report that heavy drinkers (≥ 50.0 g/d), compared with non-drinkers, had higher blood pressure, elevated triglycerides and a 53% increased risk of having MetS (Jin et al. 2011). Yokoyama et al. (2007) have shown the risk of hard liquor to cardiovascular disease in Japan, results that concur with the present study. Together these results open up a new area of concern for the health and well-being of people in Asia.

China's economic development has created both possibilities and challenges. A recent report that the age-standardized prevalence of total diabetes in China is now 10.6% and 8.8% among men and women, respectively, highlights the urgency of the problem (Yang et al. 2010). In rural China there

is less chronic disease than in urban China (in 2008 7.9% of rural households reported a chronic disease, compared to 14.9% in urban ones), despite poorer health services and higher rates of premature self-discharge due to inability to pay in rural areas (27.59% vs. 11.58%) (Jian et al. 2010).

The 60% of studied subjects living on less than five US dollars a day (\$1,825 USD per year) actually represent middle- to lower-class status in urban Shanxi Province, where mean per capita disposable income in 2009 was \$2,153 and \$538 USD in urban rural areas, respectively (which is somewhat lower than total per capita income would be) (Zhang 2010). These are the men whom this study has identified as being less educated and poorer, and consuming more alcohol and tobacco, which contributes to compromised health. For men, harmful drinking patterns and alcohol-related morbidity and mortality follow a reversed socio-economic gradient (Schmidt et al. 2010).

Rates of non-communicable diseases are increasing rapidly in China, and strategies for their prevention are needed. Urbanization in China leads to a decrease in physical exercise of 32% (Ng et al. 2009). Remaining non-hypertensive was more likely among rural residents and those who became more physically active and quit drinking alcohol (Ahn et al. 2011). In a country like China, meeting many choices for the first time, creating environments that support behaviour change and providing incentives to reduce lifestyle-related health risks are essential (Maziak and Ward 2009). There is no apparent awareness of the health risks of hard liquor among the Chinese public. Furthermore, access to alcohol has few restrictions and controls, with no legal age limit for purchasing or consuming alcohol and no regulation of where alcohol can be sold. The second round of data collection in this study is currently under way, and will more thoroughly investigate alcohol intake patterns.

This study is limited by the relatively small number of subjects in each age cohort, particularly among men, which compromised statistical power. Selection bias was unavoidable as people self-selected to participate in the survey after being invited by their local community clinic. Recall bias was also present, as questions required recall of habits in the previous month or longer.

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