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# Relationship Between the Metabolic Syndrome and the Development of Hypertension in the Hong Kong Cardiovascular Risk Factor Prevalence Study-2 (CRISPS2)

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**BACKGROUND**
The metabolic syndrome is a predictor of diabetes and coronary events. We hypothesized that it also predicts hypertension.

**METHODS**
A total of 1,944 subjects (901 men and 1,043 women; age 46 ± 12 years) from the Hong Kong Cardiovascular Risk Factor Prevalence Survey were recruited in 1995–1996 and restudied in 2000–2004. The prevalence of hypertension and factors predicting its development were determined.

**RESULTS**
In 2000–2004, hypertension was found in 23.2% of the men and 17.2% of the women. Of the 1,602 subjects who were normotensive at baseline, 258 subjects developed hypertension after a median interval of 6.4 years. According to the National Cholesterol Education Program (NCEP) and International Diabetes Federation (IDF) criteria, the hazard ratios associated with the metabolic syndrome were 1.89 (95% confidence interval (CI): 1.41–2.54) and 1.72 (95% CI: 1.24–2.39), respectively. The positive and negative predictive values of the metabolic syndrome for identifying subjects who will develop hypertension in this population were 34.7 and 85.4% (NCEP criteria), and 33.1 and 85.5% (IDF criteria), respectively. The development of hypertension was related to the number of components of the metabolic syndrome (other than raised blood pressure), present in men ($P = 0.003$) and in women ($P = 0.001$). Using multivariate analysis, age, baseline systolic blood pressure (SBP), body mass index (BMI), and the triglycerides/high-density lipoprotein (HDL) ratio were found to be significant predictors of the development of hypertension. Compared with optimal blood pressure, the hazards of developing hypertension associated with normal or high-normal blood pressure were 2.31 (95% CI: 1.68–3.17) and 3.48 (95% CI: 2.52–4.81), respectively.

**CONCLUSIONS**
Blood pressure, when not optimal, is the predominant predictor of hypertension. The metabolic syndrome contributes to the risk, especially when blood pressure is optimal.

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Hypertension is an important cardiovascular risk factor and a major health problem worldwide. In the United States, 29.3% of the population has hypertension, but only 36.8% of people with hypertension have good blood pressure control.[1] There is a need for improvement because controlling blood pressure markedly reduces cardiovascular risk.

Although there are many drugs that effectively lower blood pressure, it is not a cure. Curable forms of hypertension are of low prevalence. In the vast majority of hypertensive patients, the cause of hypertension is multifactorial. Therefore, there is a need to identify modifiable factors that lead to the development of hypertension.

The metabolic syndrome is a cluster of cardiovascular risk factors including central obesity, high blood pressure, raised blood glucose and triglyceride levels, and low high-density lipoprotein (HDL) cholesterol levels.[2,3] In recent years, the syndrome has been found to be useful in identifying people predisposed to diabetes and coronary heart disease.[4–6] It is not known whether the syndrome also predicts the development of hypertension. As high blood pressure is a component of this syndrome, we set out to examine the association of the metabolic syndrome and its components with the development of hypertension in a Chinese population.

## METHODS

The Hong Kong Cardiovascular Risk Factor Prevalence Study is a unique and comprehensive study of cardiovascular risk factors

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among the general population in Hong Kong.[6] In 1995–1996, 2,895 Chinese in Hong Kong (1,412 men and 1,483 women, aged 25–74) were selected randomly by their telephone numbers. The study protocol was approved by the Ethics Committee of the University of Hong Kong Faculty of Medicine. This method has been validated locally, and it was shown that those who did not attend were closely matched in all other respects (in terms of demographics, health, socioeconomic status, and risk factors) to those who were enrolled. The participation rate was 37.1%. In 2000–2004, the subjects were contacted for the follow-up study, the Hong Kong Cardiovascular Risk Factor Prevalence Study-2 (CRISPS2). Patient recruitment was temporarily stopped in 2003 because of the Severe Acute Respiratory Syndrome.

The participants came in the morning having fasted overnight. They were asked about their age, occupation, smoking and alcohol-drinking habits, and history of cardiovascular diseases, hypertension, and diabetes. All participants gave written informed consent. Height was measured to the nearest 0.5 cm and weight to the nearest 0.1 kg (DETECTO Instrument, MO). Waist and hip circumferences were measured two times to the nearest 0.5 cm and the arithmetic means were adopted for subsequent analyses. Waist circumference was measured halfway between the xiphisternum and the umbilicus, whereas hip circumference was measured at the level of the greater trochanters.

Blood pressure was measured in the right arm manually using a mercury sphygmomanometer. The subjects sat for at least 10 min and three measurements were taken at 5-min intervals. The first measurement was to familiarize the subject with the procedure; the mean of the second and third readings was used for data analysis. The Korotkoff V sound was used to determine diastolic pressure. A subject was classified hypertensive if the systolic blood pressure (SBP) was ≥140 mm Hg, or the diastolic blood pressure (DBP) was ≥90 mm Hg, or if the subject had previously been diagnosed with hypertension and was taking antihypertensive medications. We used the European Society of Hypertension and the European Society of Cardiology definition of optimal (SBP < 120 mm Hg and DBP < 80 mm Hg), normal (SBP 120–129 mm Hg and/or DBP 80–84 mm Hg), and high-normal (SBP 130–139 mm Hg and/or DBP 85–89 mm Hg) blood pressure.[7] Venous blood (20 ml) was taken for blood biochemistry and lipid profile. Lipids were measured on a Hitachi 912 analyzer as described previously.[6] Low-density lipoprotein (LDL) cholesterol was calculated using Friedewald's equation if the total triglycerides did not exceed 4.5 mmol/l (400 mg/dl). Otherwise, LDL was determined by a direct assay using selective micellary solubilization of LDL by a nonionic detergent in an enzyme-coupled colorimetric assay automated on a Hitachi 912 analyzer. As plasma triglycerides and HDL cholesterol are closely correlated, we calculated the triglyceride to HDL ratio for multivariate analysis. The ratio is a surrogate marker for small dense LDL, the more atherogenic form of LDL, and is therefore a strong predictor of myocardial infarction.[8,9] An oral glucose tolerance test was performed with blood taken before and 2 h after ingestion of 75 g anhydrous glucose dissolved in 200 ml distilled water. Glucose was measured by the hexokinase method on the Hitachi 912 analyzer. Insulin was measured by microparticle enzyme immunoassay (Abbott Laboratories, Tokyo, Japan). The homeostasis model assessment estimate of insulin resistance (HOMA-IR) was calculated using the formula: fasting plasma glucose (mmol/l) × fasting insulin (mIU/l)/22.5.[10] A subject was considered to be diabetic if the fasting plasma glucose concentration was ≥7.0 mmol/l (126 mg/dl), or if the 2-h oral glucose tolerance test plasma glucose concentration was ≥11.1 mmol/l (200 mg/dl), or if the subject had been diagnosed to have diabetes previously and was receiving medications for diabetes.

The National Cholesterol Education Program (NCEP) criteria for the metabolic syndrome were met if at least three of the following were satisfied (i) waist circumference ≥90 cm (35 inches) in Asian men or ≥80 cm (31 inches) in Asian women; (ii) triglyceride concentration ≥150 mg/dl (1.7 mmol/l); (iii) HDL <40 mg/dl (1.03 mmol/l) in men or <50 mg/dl (1.29 mmol/l) in women; (iv) blood pressure ≥130/85 mm Hg; (v) fasting glucose ≥100 mg/dl (5.6 mmol/l).[2] Receiving specific treatment was counted as fulfilling the criterion. The International Diabetes Federation (IDF) criteria for the metabolic syndrome resemble the NCEP criteria except that central obesity, defined using sex and ethnic specific cut points, must be present.[3]

*Data analysis.* Baseline characteristics among different groups were compared using Student's unpaired *t*-test or Chi-square test as appropriate. The prevalence of hypertension was directly standardized for age based on the Hong Kong Census in 2001.[11] In the 1,602 subjects who were normotensive initially, predictors of the development of hypertension were determined using Cox proportional hazards regression. Age and sex were adjusted for in univariate models. The other variables examined included smoking, body mass index (BMI), waist circumference, waist-to-hip ratio, SBP and DBP, fasting and 2-h plasma glucose, triglycerides, HDL, triglycerides/HDL ratio, HOMA-IR, fasting insulin, metabolic syndrome (NCEP or IDF criteria), and the number of metabolic syndrome components (other than raised blood pressure) present in an individual. Variables were entered stepwise in multivariate analysis. $P < 0.1$ was required for entering a variable into the model and $P < 0.05$ to remain in the model. Analyses were performed using SPSS 11.0 for Windows (SPSS, Chicago, IL); a $P$ value < 0.05 (two-tailed) was considered statistically significant.

## RESULTS

Attempts were made to contact all the 2,895 subjects who participated in CRISPS1. A total of 1,944 subjects (901 men, 1,043 women; age 52 ± 12 years; response rate = 67.2%) participated in this study (CRISPS2). The 951 nonparticipants included 120 who withdrew consent, 121 who chose not to reply or show up, 6 pregnant women who were excluded, 78 who had emigrated, 89 who were confirmed dead according to the Hong Kong Death Registry, and 537 who could not be traced.

Participants and nonparticipants did not differ significantly in age, BMI, LDL, drinking habit and the frequencies of hypertension, stroke, and ischemic heart disease. However, those subjects who reenrolled were more likely to be female (54 vs. 47%

in nonparticipants), married (85 vs. 77%) and nonsmokers (77 vs. 70%) ($P$ < 0.001 for all). They were also slightly less likely to be diabetic (9 vs. 12%, $P$ = 0.04), which might explain the lower plasma triglyceride ($P$ = 0.002), and higher plasma HDL ($P$ = 0.004) levels.

The age-adjusted overall prevalence of hypertension in 1995–1996 and 2000–2004 was 18.1% and 23.2% in men, and 16.9 and 17.2% in women, respectively. Out of 1,602 subjects who were not hypertensive at baseline, 258 subjects were found to be hypertensive at follow-up. Their characteristics are shown in **Table 1**. Compared with those who remained normotensive, these hypertensive subjects were older, more likely to be male and smokers, had higher BMI, waist circumference, waist-to-hip ratio, fasting plasma glucose, plasma glucose at 2 h in an oral glucose tolerance test, plasma triglycerides, HOMA-IR, fasting plasma insulin, and lower levels of HDL. **Table 2** shows the results of Cox regression analysis of the predictors of the development of hypertension. Five subjects could not be included in this analysis because of missing data. When single factors were considered, age, BMI, waist circumference, waist-to-hip ratio, baseline SBP or DBP, fasting plasma glucose, plasma glucose at 2 h in an oral glucose tolerance test, plasma triglycerides, HDL, triglycerides/HDL ratio, HOMA-IR, and fasting plasma insulin were all significantly related to the development of hypertension. The hazard ratio associated with the metabolic syndrome by the NCEP and IDF criteria, excluding those who were already hypertensive at baseline, were 1.89 (95% confidence interval (CI): 1.41–2.54) and 1.72 (95% CI: 1.24–2.39), respectively. The development of hypertension was related to the number of components of the metabolic syndrome other than raised blood pressure, in men ($P$ = 0.003) and in women ($P$ = 0.001) (**Figure 1**). Using multivariate analysis, age, baseline SBP, BMI, and the triglycerides/HDL ratio were found to be significant predictors. If the triglycerides/HDL ratio is not entered into the model, plasma triglycerides become a significant predictor (hazard ratio 1.20 (95% CI: 1.06–1.36)). A BMI of ≥25 was associated with a hazard ratio of 1.41 (95% CI: 1.09–1.83), after adjusting for age, sex, presence of diabetes, smoking status and baseline SBP.

Among 1,602 subjects who were not hypertensive at baseline, the blood pressure was optimal in 974 subjects, normal in 251 subjects and high-normal in 119 subjects. The proportion of

**Table 1 | Baseline characteristics of participants who were normotensive at baseline in relation to blood pressure status at follow-up**

| | Normotensive at follow-up | Hypertensive at follow-up | *P* value |
|---|---|---|---|
| Number (%) | 1,344 (84) | 258 (16) | — |
| Age (y) | 42.3 ± 10.8 | 50.2 ± 10.8 | <0.001 |
| Males (%) | 44 | 55 | 0.001 |
| Systolic blood pressure (mm Hg) | 111 ± 12 | 123 ± 11 | <0.001 |
| Diastolic blood pressure (mm Hg) | 70 ± 8 | 77 ± 8 | <0.001 |
| Body mass index (kg/m$^2$) | 23.5 ± 3.3 | 25.0 ± 3.3 | <0.001 |
| Waist circumference (cm) | 76.7 ± 9.3 | 81.5 ± 9.2 | <0.001 |
| Waist-to-hip ratio | 0.8 ± 0.1 | 0.9 ± 0.1 | <0.001 |
| Fasting glucose (mg/dl) | 92.8 ± 15.9 | 101.3 ± 32.1 | <0.001 |
| OGTT 2-h glucose (mg/dl) | 113.2 ± 40.4 | 128.5 ± 65.6 | 0.001 |
| Triglycerides (mg/dl) | 94.7 ± 56.3 | 124.8 ± 85.0 | <0.001 |
| HDL (mg/dl) | 49.8 ± 12.4 | 46.7 ± 12.7 | <0.001 |
| HOMA-IR | 1.0 (0.7–1.6) | 1.3 (0.8–1.9) | <0.001 |
| Fasting insulin (mIU/l) | 4.4 (3.0–6.7) | 5.4 (3.7–8.0) | <0.001 |
| Ever smoking (%) | 22 | 28 | 0.04 |
| Alcohol drinking[a] (%) | 11 | 16 | 0.06 |
| Physical activity[b] (%) | 34 | 34 | 1.00 |

Data are shown as means ± SD, medians (interquartile ranges), or percentages. Student's unpaired *t*-test, Mann–Whitney test and chi-square test were used as appropriate.
[a]At least once a week. [b]Taking exercise at least once a week in the past month. To convert mg/dl to mmol/l, multiply by 0.056 for glucose, 0.011 for triglycerides and 0.026 for HDL.

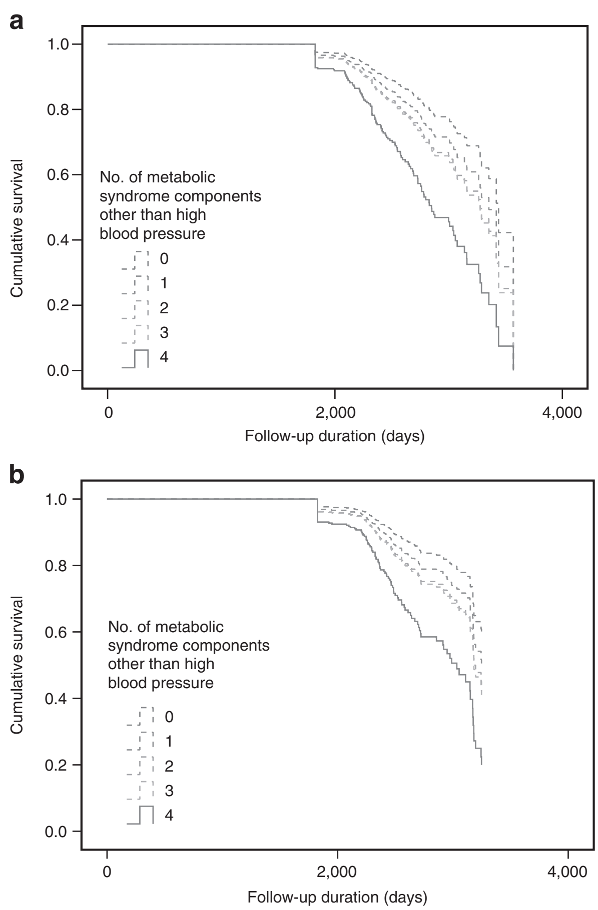


**Figure 1 |** Survival without hypertension in subjects with increasing number of components of the metabolic syndrome at baseline. (**a**) Men; (**b**) women.

**Table 2 | Baseline predictors of the development of hypertension over a median of 6.4 years of follow-up**

| Predictor | Univariate model[a] | | Multivariate model[b] (Cases = 256, *N* = 1,593) | | Multivariate model for men[b] (Cases = 140, *N* = 728) | | Multivariate model for women[b,c] (Cases = 116, *N* = 865) | |
|---|---|---|---|---|---|---|---|---|
| | Hazard ratio (95% CI) | *P* value | Hazard ratio (95% CI) | *P* value | Hazard ratio (95% CI) | *P* value | Hazard ratio (95% CI) | *P* value |
| Age, per year | 1.07 (1.06–1.08) | <0.001 | 1.05 (1.04–1.06) | <0.001 | 1.05 (1.03–1.07) | <0.001 | 1.05 (1.03–1.07) | <0.001 |
| Gender (0 = male, 1 = female) | 0.88 (0.69–1.13) | 0.31 | NI | | – | – | – | – |
| Smoking (0 = never, 1 = ever) | 0.82 (0.60–1.12) | 0.2 | NI | – | NI | – | NI | – |
| Body mass index, per kg/m$^2$ | 1.11 (1.07–1.15) | <0.001 | 1.06 (1.02–1.10) | 0.002 | 1.09 (1.04–1.15) | 0.001 | NI | – |
| Waist circumference, per cm | 1.03 (1.02–1.05) | <0.001 | NI | – | NI | – | NI | – |
| Waist-to-hip ratio (×100, per 1 unit) | 1.04 (1.02–1.05) | <0.001 | NI | – | NI | – | NI | – |
| Systolic blood pressure, per mm Hg | 1.06 (1.05–1.08) | <0.001 | 1.06 (1.04–1.07) | <0.001 | 1.06 (1.04–1.08) | <0.001 | 1.06 (1.04–1.08) | <0.001 |
| Diastolic blood pressure, per mm Hg | 1.06 (1.05–1.08) | <0.001 | NI | – | NI | – | NI | – |
| Fasting glucose, per 10 mg/dl | 1.04 (1.01–1.08) | 0.02 | NI | – | NI | – | NI | – |
| OGTT 2-h glucose, per 10 mg/dl | 1.03 (1.02–1.05) | <0.001 | NI | – | NI | – | NI | – |
| Triglycerides, per 10 mg/dl | 1.03 (1.02–1.04) | <0.001 | NI | – | 1.02 (1.00–1.04) | 0.01 | NI | – |
| HDL, per 10 mg/dl | 0.83 (0.74–0.91) | <0.001 | NI | – | NI | – | 0.83 (0.71–0.97) | 0.02 |
| Triglycerides/HDL ratio, per 1 unit | 1.23 (1.13–1.34) | <0.001 | 1.14 (1.04–1.25) | 0.002 | NI | – | NI | – |
| HOMA-IR, per 1 unit | 1.07 (1.03–1.11) | 0.001 | NI | – | NI | – | NI | – |
| Fasting insulin, per mIU/l | 1.02 (1.00–1.03) | 0.009 | NI | – | NI | – | NI | – |
| Metabolic syndrome (NCEP criteria) | 1.89 (1.41–2.54) | <0.001 | NI | – | NI | – | NI | – |
| Metabolic syndrome (IDF criteria) | 1.72 (1.24–2.39) | 0.001 | NI | – | NI | – | NI | – |
| Number of metabolic syndrome components other than raised blood pressure | 1.24 (1.09–1.41) | <0.001 | NI | – | NI | – | NI | – |

HOMA-IR, homeostasis model assessment estimate of insulin resistance; IDF, International Diabetes Federation; NCEP, National Cholesterol Education Program; NI, Not included in the model; OGTT, oral glucose tolerance test.
[a]Predictors were age- and sex-adjusted, except for age, which was sex-adjusted, and sex, which was age-adjusted. [b]Stepwise (forward) Cox proportional hazards model was used. $P < 0.1$ was necessary for a variable entering into the model and $P < 0.05$ for staying in the model. [c]Additionally adjusted for menopausal status and use of hormone replacement therapy. Subjects with missing data were excluded in the multivariate model.

subjects who developed hypertension at follow-up was 7.4% in the optimal group, 25.5% in the normal group and 44.1% in the high-normal group ($P < 0.001$). The rate of progression to hypertension in these three groups was 1.1, 3.9, and 7.1% per year, respectively. Compared with optimal blood pressure, the hazards of developing hypertension associated with normal or high-normal blood pressure were 2.31 (95% CI: 1.68–3.17) and 3.48 (95% CI: 2.52–4.81) fold, respectively. In subjects with optimal blood pressure at baseline, the NCEP and IDF metabolic syndrome were associated with sex- and age-adjusted hazard ratios of 2.09 (95% CI: 1.10–3.96) and 2.24 (95% CI: 1.15–4.36), respectively, for the development of hypertension. In subjects with normal blood pressure, the corresponding hazard ratios were 1.34 (95% CI: 0.74–2.42) and 1.41 (95% CI: 0.74–2.67). In subjects with high-normal blood pressure, the corresponding hazard ratios were 1.10 (95% CI: 0.72–1.69) and 0.98 (95% CI: 0.61–1.60).

The sensitivity and specificity of the metabolic syndrome for identifying subjects who will develop hypertension in this population were 16.3 and 94.1% (NCEP criteria), and 17.1 and 93.4% (IDF criteria), respectively. The positive and negative predictive values of the metabolic syndrome for identifying subjects who will develop hypertension were 34.7 and 85.4% (NCEP criteria), and 33.1 and 85.5% (IDF criteria), respectively.

The components of the metabolic syndrome are defined by cutoff points. Receiver operating characteristic curves were drawn for these components as continuous variables. The areas under the receiver operating characteristic curves were 0.62 (waist), 0.74 (SBP), 0.67 (DBP), 0.65 (glucose), 0.60 (triglycerides), and 0.55 (HDL) in men, and 0.66 (waist), 0.81 (SBP), 0.75 (DBP), 0.57 (glucose), 0.64 (triglycerides), and 0.57 (HDL) in women. The area under the receiver operating characteristic curve for age was 0.69 in men and 0.73 in women.

## DISCUSSION

The Hong Kong Cardiovascular Risk Factor Prevalence Study is a large and unique cohort of urbanized Hong Kong Chinese subjects, with more than 12,000 person-years of follow up.[6] Analysis of the baseline data has shown that hypertension and diabetes are common in Hong Kong, and there is a clustering of cardiovascular risk factors. It has particularly highlighted the importance of obesity and its close relationship with insulin resistance diabetes, dyslipidemia, and hypertension. Although cross-sectional studies are useful, there is a need for prospective data on cardiovascular risk factors in Chinese populations. One large follow-up study in China showed that vascular disease was a major cause of death, and hypertension was a leading modifiable risk factor of death among Chinese adults aged 40 years and over.[12] It suggested that the prevention and control of hypertension could reduce total mortality by 11.7%. The Guangzhou Biobank Cohort Study has followed >100,000 elderly people in Guangzhou, China since 2003.[13] The findings at baseline showed that raised blood glucose, even within the normal range, was associated with dyslipidemia and hypertension.[14]

In this prospective study, we identified a number of factors that are related to the development of hypertension. These include age, history of hypertension in a parent, indices of obesity, baseline blood pressure, blood glucose, lipids, and indices of insulin resistance. Multivariate analysis narrows this list to age, history of hypertension in a parent, baseline SBP, BMI, and the triglycerides/HDL ratio. Our results echo those of the Strong Heart Study in which abdominal obesity and abnormal lipid profile are the major predictors of development of arterial hypertension after 8 years in a group of American Indian subjects with initial blood pressure in the optimal range.[15] Raised blood pressure, triglycerides, and low HDL are all related to obesity,[16,17] and constitute the definition of the metabolic syndrome.[2,3] Thus, the metabolic syndrome is not only a predictor of the development of type 2 diabetes but is also a predictor of hypertension, even in this population which is generally not obese by Western standards. In a large number of people in the general population, hypertension and diabetes share a common etiology. Our findings are consistent with other recent cross-sectional studies in Chinese that point to the clustering of hypertension with obesity and other cardiovascular risk factors.[18,19] In our cohort, obesity precedes the development of hypertension, underlining its causal relationship with the latter. Indeed, weight reduction in those who are overweight and hypertensive is the most effective nonpharmacological means for reducing high blood pressure.[20–22] A significant proportion of adults in Hong Kong[6] and China[23] has the metabolic syndrome and thus the epidemic of obesity has become an important public health problem in China,[24] as in developed countries.

Visceral obesity is held to be a more important predictor of cardiovascular and metabolic complications than obesity per se. In our study, however, BMI appears to be a better predictor of hypertension than waist circumference or waist-to-hip ratio. This may be because plasma triglycerides and HDL correlate closely with abdominal obesity and therefore reduce the contribution of the latter in a multivariate model.

The positive predictive value of the metabolic syndrome for the development of hypertension is modest, but the negative predictive value is high. A person without the metabolic syndrome is unlikely to develop hypertension in the next few years. The receiver operating characteristic analysis suggested that age and blood pressure remain the best predictor of development of hypertension. Nevertheless, the other components of the metabolic syndrome contribute incrementally to the development of hypertension.

We found that high-normal blood pressure was associated with a greatly increased risk of progression to hypertension. This is consistent with observations from other prospective studies.[25,26] In these individuals, the presence or absence of the metabolic syndrome no longer predicts the development of hypertension. Baseline blood pressure, when not optimal, is the predominant risk factor for the development of hypertension. The metabolic syndrome becomes significant only when the baseline blood pressure is low enough that its increase over time is unlikely to reach the hypertensive range. The high lifetime risk of hypertension in individuals with high-normal blood pressure is a strong reason behind the advice to institute therapeutic lifestyle changes to prevent or retard the progression to hypertension.[27] Our findings suggest that bringing down the blood pressure from the high-normal category to the optimal category may dramatically reduce the risk of developing hypertension. Clinical trials are needed to confirm this. Blood pressure lowering therapy is already indicated in people with diabetes or renal disease who have a blood pressure above 130/80 mm Hg.[27] Arguably, in individuals at high cardiovascular risk who have blood pressure in the pre-hypertension range, lowering blood pressure may be beneficial, as the relationship between blood pressure and cardiovascular event risk is continuous.[28]

In summary, the Hong Kong Cardiovascular Risk Factor Prevalence Study has documented, over a period of 10 years, cardiovascular risk factors in a cohort of subjects drawn from the general population. We have shown in this prospective study that the metabolic syndrome predicts the development of hypertension in people with optimal blood pressure. When the blood pressure is higher than optimal, the baseline blood pressure is the predominant factor that predicts the development of hypertension. Cardiovascular risk factors are no longer uncommon in China and are associated with urbanization and a drastic decrease in physical activity.[29] Obesity has been postulated as the leading modifiable cause of cardiovascular disease in Asia.[30] Therefore, appropriate weight control in the general population is warranted. The modification of lifestyle factors at the population level is a challenge, but is necessary to prevent cardiovascular events and complications.

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