Metabolic Syndrome Components and Age-Related Cataract: The Singapore Malay Eye Study

Charumathi Sabanayagam,1,2 Jie Jin Wang,3,4 Paul Mitchell,5 Ava Grace Tan,5 E. Shyong Tai,5 Tin Aung,2,6 Seang-Mei Saw,2,7 and Tien Yin Wong2,4,6

PURPOSE. To examine the relationship between metabolic syndrome and its components, diabetes mellitus, high blood pressure (BP), obesity, and dyslipidemia, with age-related cataract.

METHODS. A population-based sample of 2794 Malay adults aged 40 to 80 years in Singapore was used for this analysis. Cataract (n = 1268) was defined as the presence of nuclear, cortical, or posterior subcapsular (PSC) cataract, from standardized grading of lens photographs or previous cataract surgery. Metabolic syndrome was defined as the presence of 3 of the following components: body mass index (BMI) ≥25 kg/m², triglycerides ≥1.7 m/M, high density-lipoprotein (HDL) cholesterol <1.0 mM in men and <1.3 mM in women, BP ≥130/85 mm Hg, or use of BP medication and diabetes mellitus.

RESULTS. Cataract prevalence increased with higher quartiles of blood glucose, systolic BP, and metabolic syndrome components (P trend < 0.0001). The multivariable odds ratio (OR) (95% confidence interval [CI]) of cataract was 1.89 (1.42–2.40) for diabetes, 1.92 (1.47–2.52) for high BP, and 1.27 (1.04–1.55) for metabolic syndrome. Of the individual metabolic syndrome components, high BP was associated with all three cataract types; diabetes was associated with cortical and PSC; low HDL, high BMI, and metabolic syndrome were associated with cortical cataract. The presence of both high BP and diabetes was associated with fourfold odds of having cataract (OR [95% CI] = 4.73 [2.16–10.34]).

CONCLUSIONS. Metabolic syndrome and its two key components, high BP and diabetes were associated with age-related cataract. (Invest Ophthalmol Vis Sci. 2011;52:2397–2404) DOI: 10.1167/iovs.10-6373

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Cataract, a leading cause of blindness and poor vision, is a major public health problem worldwide, particularly in Asia, home to half of the world’s population.1–3 Diabetes3,4 and hyperglycemia5,6 have long been recognized as risk factors for cataract. Studies have also documented an association between specific metabolic abnormalities including obesity,7–9 blood pressure,10,11 lipids,12,13 and specific types of cataract. Metabolic syndrome is a constellation of signs including obesity, high blood pressure, dyslipidemia, and hyperglycemia and is an established risk factor for diabetes and cardiovascular disease.14 Whether metabolic syndrome is a risk factor for cataract is uncertain. It has also been shown that there is substantial variation in the risk of diabetes within metabolic syndrome depending on the specific combinations of components.15 Recent studies have shown that metabolic syndrome is associated with ocular disorders including glaucoma,16 diabetic17 and nondiabetic retinopathy,18 and retinal microvascular signs.19 A few previous studies, all conducted among Western populations, have shown that metabolic syndrome is associated with cataract.20–23 The association between metabolic syndrome and its components with cataract has not been evaluated in Asian populations where the prevalence of diabetes is high.24 Furthermore, it is not known whether metabolic syndrome is associated with cataract in the absence of diabetes and if there is variability in the association between specific combinations of metabolic syndrome components and cataract. In the present study, we aim to assess the association between metabolic syndrome and its components with cataract in an adult Malay population in Singapore.

METHODS

Study Population

Data for this study were derived from the Singapore Malay Eye Study (SiMES), a population-based cross-sectional study of Malay adults aged 40 to 80 years in Singapore. Details of the study population and methods have been reported.25,26 In brief, 5600 individuals aged 40 to 80 years were selected by an age-stratified random sampling method from the computer generated random list of 16,069 Malay names provided by the Ministry of Home Affairs. Of the 4168 eligible individuals, 3280 participated in the study (78.7% response rate). After excluding data on key variables, 2794 provided complete data for the current analysis. Compared with those who were excluded from the final analysis, those who were included were younger, more likely to be current smokers, had lower levels of blood glucose or glycated hemoglobin (HbA1C), had higher levels of diastolic blood pressure (BP), and had lower prevalence of diabetes mellitus and hypertension. Tenets of the Declaration of Helsinki were followed, and ethics approval was obtained from the Singapore Eye Research Institute Institutional Review Board. Written informed consent was obtained from all participants.
Assessment of Cataract

Cataract was assessed from retroillumination lens photographs (EAS-1000; Nidek, Tokyo, Japan) and digital slit-lamp photographs (model DC-1 with FD-21 flash attachment; Topcon, Tokyo, Japan) after dilating pupils based on the Wisconsin Cataract Grading System at the University of Sydney by trained masked graders.27,28 Nuclear cataract was determined by comparing participant slit-lamp photographs with a set of four standard nuclear photographs with increasing opacity. Nuclear opacity worse than standard photograph no. 3 of the Wisconsin Grading System was defined as nuclear cataract.27 Cortical and posterior subcapsular (PSC) cataract were assessed by laying a grid with nine segments over the retroillumination photographs and estimating the percentage area involved by opacities in each of the nine segments for each of the subtypes. The total area of opacity involved was calculated for each eye. Cortical cataract was considered present if at least 5% of the total lens area was involved, and PSC cataract was defined if any such opacity was present at or near the lens posterior capsular membrane. Any cataract was defined as the presence, in at least one eye, of a nuclear, cortical, or PSC cataract or evidence of previous cataract surgery.

To test the robustness of our findings, we also examined the associations between metabolic syndrome and cataract using an alternative cataract definition, based on the Lens Opacity Classification System (LOCS) III.30,31 Accordingly, any cataract was defined as the presence, in at least one eye, of any nuclear (LOCS III score >4 for nuclear opalescence or >4 for nuclear color), cortical (LOCS III score >2 for cortical cataract), or PSC (LOCS III score >2 for PSC) cataract.

Assessment and Definition of Metabolic Syndrome Components

Metabolic syndrome was defined based on ATP-3 guidelines32 as the presence of three or more of the following components: (1) abdominal obesity (the abdominal obesity definition was modified using Asia Pacific WHO guidelines33 as body mass index [BMI] ≥25 kg/m²), (2) elevated blood triglycerides, ≥150 mg/dL (1.7 mM), (3) low HDL cholesterol, <40 mg/dL (1.0 mM) in men and <50 mg/dL (1.3 mM) in women, (4) high BP, ≥130/85 mm Hg or use of BP medications, and (5) diabetes mellitus defined as a casual plasma glucose ≥200 mg/dL (11.1 mmol/L) or a self-reported history of physician-diagnosed diabetes.34

Height was measured in centimeters using a wall-mounted measuring tape, and weight was measured in kilograms using a digital scale (SECA, model 782 2321009; Vogel & Halke, Hamburg, Germany). BMI was calculated as weight in kilograms divided by the square of height in meters squared (kg/m²). BP measurements were taken using a digital automatic blood pressure monitor (Dinamap model Pro Series DP110X-RW; 100V2; GE Medical Systems Information Technologies, Milwaukee, WI) on two occasions 5 minutes apart, after the participants were seated for at least 5 minutes. If these two BP measurements differed by >10 mm Hg systolic and 5 mm Hg diastolic, a third measurement was taken, and the average of the two closest readings was taken as the BP value. Forty milliliters of venous blood was collected to measure serum lipids, HbA1C, and casual glucose. All serum biochemistry tests were carried out at the National University Hospital Reference Laboratory.

Assessment of Covariates

Information on participant demographics, educational attainment, and personal and medical history was obtained using a standardized questionnaire administered by trained interviewers. Age was defined as the age at the time of examination and was categorized into four groups: 40–49, 50–59, 60–69, and 70–80 years. Education level was categorized into primary and below (≤6 years) and secondary and above (>6 years). Cigarette smoking was categorized into current or former smoker or never, and alcohol consumption into drinkers and nondrinkers.

Statistical Analysis

All statistical analyses were performed using commercial software (SAS v. 9.1, SAS, Chicago, IL). We compared selected baseline characteristics of the participants by metabolic syndrome status employing the χ² test or analysis of variance, as appropriate. We then calculated the odds ratio (OR) and 95% confidence interval (CI) of the metabolic syndrome components associated with any cataract in two separate models. In the first model we adjusted for age (years) and sex, whereas in the second multivariable model we additionally adjusted for categories of education and cigarette smoking. To assess the dose-response relationship of the various metabolic syndrome components (BP, plasma glucose, HbA1C, and BMI) with cataract, we assessed the associations between individual metabolic syndrome component and cataract by categorizing each component into quartiles for analysis. Tests for trend were performed modeling the exposure categories as an ordinal variable in the corresponding multivariable logistic regression models. We then analyzed the independent role of each metabolic syndrome component on cataract by including all the components of metabolic syndrome simultaneously in the multivariable model after checking for collinearity among independent variables in the model (a variance inflation factor greater than 2.5 was interpreted as indicating the presence of collinearity).35 We also assessed the association of metabolic syndrome components with specific subtypes of cataract in separate multivariable models comparing those without a specific type of cataract or history of cataract surgery as reference. For example, the association of metabolic syndrome components with cortical cataract was compared with those without cortical cataract or history of cataract surgery.

We performed several sets of supplementary analyses. First, we examined the association between components of metabolic syndrome and cataract by including each component separately and also in 32 possible combinations of components using individuals without any metabolic syndrome component as the reference group, in a regression model adjusted for age and sex. Second, in a subgroup analysis, we examined the association between metabolic syndrome components and cataract after stratifying the population by diabetes status. Interaction between diabetes status and each component of metabolic syndrome was tested by including cross-product interaction terms in the corresponding multivariable model. Third, we repeated the analysis (see Table 2) using the alternate cataract definition based on LOCS III scoring. Fourth, we repeated the analysis including only those with history of previous cataract surgery.

RESULTS

The prevalence of metabolic syndrome in this population was 42.7%. The prevalence of individual components of metabolic syndrome were 58.2% for abdominal obesity, 39.7% for elevated triglycerides, 27.5% for low HDL cholesterol, 80.2% for high BP, and 21.8% for diabetes. Table 1 shows characteristics of the participants by metabolic syndrome status. Participants with metabolic syndrome were more likely to be older, females, or primary or below educated, to have higher levels of total cholesterol, triglycerides, HbA1C, lower levels of LDL and HDL cholesterol, and a higher prevalence of diabetes and hypertension, but were less likely to smoke.

The cataract prevalence was 45.4% in the whole population. Cataract prevalence increased with increasing numbers of metabolic syndrome components in both men and women (Fig. 1). In Table 2 the prevalence of cataract increased with higher quartiles of serum glucose, HbA1C, systolic BP, and greater number of metabolic syndrome components (P trend <0.0001). After adjustment for age, sex, smoking status, and education, metabolic syndrome was significantly associated with cataract. Individual metabolic syndrome components, including diabetes, higher levels of plasma glucose,
HbA1c, systolic BP, and hypertension, were all significantly associated with cataract (Table 2).

Table 3 shows the independent association between each component of metabolic syndrome with cataract, simultaneously adjusting for other variables. Similar to Table 2, only high BP and diabetes were independently associated with cataract.

The prevalence of cortical, nuclear, and PSC cataract was 31.8%, 22.5%, and 16.3%, respectively. Table 4 shows the association between metabolic syndrome components and different subtypes of cataract. After adjusting for age and sex, high BP was associated with all three cataract subtypes; diabetes was associated with cortical and PSC cataract; low HDL and BMI ≥25 kg/m² were associated with cortical cataract. The presence of at least two metabolic syndrome components was positively associated with cortical cataract. BMI ≥25 kg/m² and presence of three and four metabolic syndrome components were negatively associated with nuclear cataract.

In a supplementary analysis we examined the association of various combinations of metabolic syndrome components with cataract (Table 5). Among the single components, high BP alone and in models including a combination of two components, groups including either high BP or diabetes were significantly associated with cataract (2.1, 2.2, 2.5, 2.6, 2.7). The presence of both high BP and diabetes was associated with fourfold odds of having cataract. In models including a combination of three components, only the group with diabetes, high BP, and obesity (3.1) showed a significant association with cataract. In models including a combination of four components, groups with high BP with obesity or diabetes (4.1, 4.2, 4.5) were significantly associated with cataract. The combination of diabetes, high BP, obesity, and low HDL (4.5) had the highest OR (7.2) for cataract among all possible combinations; as expected, the presence of all five components was significantly associated with cataract. In a second analysis, when we stratified participants by diabetes status, only high BP was significantly associated with cataract among those with and without diabetes (Table 6). No significant interaction was detected between diabetes and other components of metabolic syndrome (P interaction > 0.05 for high BP, low HDL, high triglycerides, and high BMI). In a third supplementary analysis, defining cataract (n = 1408) using the LOCS III classification, diabetes, high BP and metabolic syndrome were significantly associated with cataract (Supplementary Table S1, http://www.iovs.org/lookup/suppl/doi:10.1167/iovs.10-6373/-/DCSupplemental). In a fourth analysis, including only those with history of previous cataract surgery (n = 102), diabetes, elevated triglycerides, and metabolic syndrome were significantly associated with cataract surgery (data not shown).

**DISCUSSION**

In this population-based study of Malay adults, we found that metabolic syndrome and two of its principal components, diabetes and high BP, were significantly associated with cataract, assessed from lens photographs in a standardized manner. Of the individual metabolic syndrome components, high BP and diabetes showed to be major contributors to this association. Further, coexisting high BP and diabetes was associated with fourfold higher odds of cataract. Serum triglycerides or HDL, and BMI, were not associated with cataract. These associations persisted when we defined cataract using an alternate definition, based on LOCS III clinical grading.

The prevalence of metabolic syndrome in our study population, based on ATP-3 criteria, was 41.8%. Our finding of a positive association between metabolic syndrome, or two of its components, and presence of three and four metabolic syndrome components was negatively associated with nuclear cataract.
Diabetes mellitus†
- Absent: 2184 (886) 40.6 1.00 (reference) 1.00 (reference)
- Present: 610 (382) 62.6 1.95 (1.54–2.47) 1.89 (1.49–2.40)

Casual serum glucose (mmol) quartile
- 1 (2.2–4.7): 680 (229) 33.7 1.00 (reference) 1.00 (reference)
- 2 (4.8–5.4): 744 (316) 42.5 1.38 (1.05–1.82) 1.35 (1.02–1.77) 0.04
- 3 (5.5–7.0): 608 (328) 49.1 1.54 (1.17–2.04) 1.49 (1.13–1.98) 0.005
- 4 (7.1–32.1): 702 (395) 56.3 2.00 (1.52–2.64) 1.94 (1.47–2.57) <0.0001

HbA1C (%) quartile
- 1 (4.2–5.5): 789 (274) 34.7 1.00 (reference) 1.00 (reference)
- 2 (5.6–5.9): 621 (252) 40.6 1.17 (0.89–1.55) 1.15 (0.87–1.52) 0.32
- 3 (6.0–6.5): 672 (331) 49.3 1.31 (1.00–1.71) 1.28 (0.98–1.68) 0.07
- 4 (6.6–15.1): 712 (411) 57.7 1.92 (1.47–2.50) 1.85 (1.42–2.42) <0.0001

High BP (BP ≥ 130/85 mm Hg or use of BP medication)
- Absent: 554 (115) 20.8 1.00 (reference) 1.00 (reference)
- Present: 2240 (1153) 51.5 2.00 (1.54–2.61) 1.92 (1.47–2.52) <0.0001

Hypertension‡
- Absent: 714 (163) 22.8 1.00 (reference) 1.00 (reference)
- Present: 2080 (1105) 53.1 1.88 (1.51–2.34) 1.81 (1.45–2.26) <0.0001

Systolic BP (mm Hg) quartile
- 1 (84.5–129.0): 699 (178) 25.5 1.00 (reference) 1.00 (reference)
- 2 (129.1–144.0): 706 (272) 38.5 1.37 (1.04–1.82) 1.35 (1.02–1.79) 0.04
- 3 (144.1–162.9): 704 (363) 51.6 1.79 (1.35–2.35) 1.72 (1.30–2.27) 0.0002
- 4 (163.0–240.0): 685 (455) 66.4 2.16 (1.62–2.88) 2.06 (1.54–2.76) <0.0001

Diastolic BP (mm Hg) quartile
- 1 (48.5–71.0): 789 (358) 45.4 1.00 (reference) 1.00 (reference)
- 2 (71.1–79.0): 675 (309) 45.8 1.03 (0.79–1.34) 1.04 (0.80–1.36) 0.78
- 3 (79.1–86.9): 650 (294) 45.2 1.16 (0.88–1.52) 1.15 (0.88–1.51) 0.31
- 4 (87.0–130.0): 680 (307) 45.2 1.04 (0.80–1.36) 1.02 (0.78–1.33) 0.89

HDL (≥1.0 and ≤1.3 mmol/L in male and female)
- Absent: 2027 (909) 44.8 1.00 (reference) 1.00 (reference)
- Present: 767 (359) 46.8 1.20 (0.97–1.49) 1.19 (0.95–1.48) 0.13

Triglycerides (≥1.7 mmol/L)
- Absent: 1685 (765) 45.4 1.00 (reference) 1.00 (reference) 0.58
- Present: 1109 (503) 45.4 1.07 (0.88–1.30) 1.06 (0.87–1.29) 0.52

BMI (≥25.0 kg/m²)
- Absent: 1167 (543) 46.5 1.00 (reference) 1.00 (reference)
- Present: 1627 (725) 44.6 1.08 (0.89–1.32) 1.07 (0.88–1.30) 0.52

BMI (kg²/m²) quartile
- 1 (12.7–23.0): 699 (342) 48.9 1.00 (reference) 1.00 (reference) 0.58
- 2 (23.1–26.0): 712 (308) 43.3 0.87 (0.66–1.14) 0.87 (0.66–1.14) 0.30
- 3 (26.1–29.3): 685 (297) 43.4 0.91 (0.69–1.19) 0.89 (0.68–1.18) 0.42
- 4 (29.4–50.8): 698 (321) 46.0 1.16 (0.87–1.53) 1.13 (0.86–1.50) 0.38

Metabolic syndrome
- Absent: 1600 (669) 41.8 1.00 (reference) 1.00 (reference)
- Present: 1194 (599) 50.2 1.30 (1.07–1.59) 1.27 (1.04–1.55) 0.02

Number of metabolic syndrome components
- ≥1 component: 779 (279) 35.8 1.00 (reference) 1.00 (reference)
- 2 components: 821 (390) 47.5 1.57 (1.22–2.04) 1.56 (1.20–2.02) 0.008
- 3 components: 753 (340) 46.4 1.31 (1.00–1.71) 1.28 (0.98–1.67) 0.08
- 4 components: 308 (207) 56.3 2.17 (1.56–3.00) 2.09 (1.51–2.89) <0.0001
- 5 components: 93 (52) 55.9 2.56 (1.48–4.43) 2.48 (1.39–4.16) 0.002

BMI, body mass index; BP, blood pressure; CI, confidence interval; HDL, high-density lipoprotein; OR, odds ratio.
* Adjusted for age, sex, education, and smoking status.
† Diabetes was defined as a casual plasma glucose ≥ 200 mg/dL (11.1 mmol/L) or a self-reported history of physician-diagnosed diabetes.
‡ Hypertension was defined as systolic BP ≥ 140 and diastolic BP ≥ 90 mm Hg or use of BP medication.

Diabetes and high BP, with cataract is consistent with previous studies conducted in Western populations.21–25

Diabetes and hyperglycemia are established risk factors for cataract, as documented in several populations.2,3,5,21,22 Diabetologists have been shown to be associated with cataract in several Asian populations.2 Our finding of an association of diabetes with cortical and PSC cataract is consistent with previous clinical observations and findings from the Beaver Dam Eye Study,3 the Barbados Eye Studies,5,50 and the Blue Mountains Eye Study.5 Mechanisms linking diabetes and hyperglycemia to
An important finding was that high BP, either alone or in combination with other metabolic syndrome components, was significantly associated with cataract. High BP was associated with cataract even among those without diabetes and was associated with all three subtypes of cataract. Previous studies have reported inconsistent findings for the association between BP or hypertension and cataract. In the Physicians’ Health Study, systolic BP, but not diastolic BP or hypertension, was associated with cataract.1 Two European studies documented a positive association between high BP and cataract.22,23 In the Blue Mountain Eye Study, antihypertensive medication use was associated with cataract and cataract surgery.39 The mechanism linking hypertension and cataract is not clear. Inflammation and endothelial dysfunction could possibly play a role in the association between hypertension and cataract.

We found no significant associations between high-serum triglycerides or low-serum HDL and cataract. However, an association was observed between low HDL levels and cortical cataract. A few studies have reported associations of high-triglyceride levels with cataract overall in our study, a finding consistent with that from a Swedish mammography cohort21 but inconsistent with the finding of a positive association between BMI and cataract.47 High BMI was not associated with cataract overall in our study, a finding consistent with that from a Swedish mammography cohort21 but inconsistent with the finding of a positive association between BMI and cataract.

As a specific entity, metabolic syndrome showed a modest association with any cataract and cortical subtypes. Our finding is in keeping with previous reports from Caucasian populations.20–22 Tan et al.20 showed that metabolic syndrome was associated with cortical cataract in women.13 In the Framingham Offspring Heart Study, both low HDL and high triglyceride levels were associated with PSC cataract in men.12 Animal studies have shown accelerated diabetic cataract development in low HDL-cholesterol–induced rats.13 Inflammation and oxidative stress resulting from low HDL cholesterol levels could induce cataract formation.44–46 Alternatively, the association between low HDL cholesterol level and cortical cataract could also be due to chance. It has been shown that at comparable levels of BMI, Asians have higher risks of diabetes and cardiovascular disease. Epidemiologic reviews have shown inconsistent associations between BMI and cataract.47 High BMI was not associated with cataract overall in our study, a finding consistent with that from a Swedish mammography cohort but inconsistent with the finding of a positive association between BMI and cataract.47 In analysis stratified by cataract subtypes, BMI ≥25 kg/m² was positively associated with cortical cataract but not associated with nuclear cataract. Our finding of high BMI being associated with cortical cataract is consistent with a previous Blue Mountains Eye Study report.11 In the Shihpai Eye Study in Taiwan, BMI was negatively associated with nuclear cataract, consistent with our report.48

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associated with all three types of cataract in an elderly cohort of Australians in the Blue Mountains Eye Study. Paunksnis et al. reported an association between cataract and metabolic syndrome among middle-aged European men and women. Further, metabolic syndrome was shown to be associated with cataract extraction in an Italian hospital population and among Swedish women aged <65 years. Although several factors including insulin resistance, inflammation, and endothelial dysfunction could explain the association between metabolic syndrome or its components and cataract, our findings suggest that this association was primarily driven by the associations between cataract and either diabetes or high BP.

### Table 5. Association between Individual and Specific Combination of Metabolic Syndrome Components and Cataract

<table>
<thead>
<tr>
<th>Model</th>
<th>Absence of any component of metabolic syndrome</th>
<th>Individual components of metabolic syndrome</th>
<th>Combination of two components of metabolic syndrome</th>
<th>Combination of three components of metabolic syndrome</th>
<th>Combination of four components of metabolic syndrome</th>
<th>Combination of all five components of metabolic syndrome</th>
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<tbody>
<tr>
<td></td>
<td>Model 1</td>
<td>Model 1.1</td>
<td>Model 2.1</td>
<td>Model 3.1</td>
<td>Model 4.1</td>
<td>Model 5.1</td>
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<td>3.1</td>
<td>4.1</td>
<td>5.1</td>
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<tr>
<td></td>
<td>Age, Sex Adjusted OR (95% CI)</td>
<td>1.0 (reference)</td>
<td>4.73 (2.16-10.34)</td>
<td>2.30 (1.29-4.10)</td>
<td>2.95 (1.48-5.87)</td>
<td>3.09 (1.61-5.91)</td>
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<td>P</td>
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<td>0.005</td>
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<td>n (Cases)</td>
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<td>58 (74)</td>
<td>148 (90)</td>
<td>84 (53)</td>
<td>91 (52)</td>
</tr>
<tr>
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<td>Diabetes</td>
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<td>12 (6)</td>
<td>40 (25)</td>
<td>6 (5)</td>
<td>33 (8)</td>
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<td>High BP</td>
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<td>58 (74)</td>
<td>159 (82)</td>
<td>274 (109)</td>
<td>126 (51)</td>
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<tr>
<td></td>
<td>High BMI</td>
<td>91 (16)</td>
<td>159 (82)</td>
<td>39 (24)</td>
<td>75 (36)</td>
<td>126 (51)</td>
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<tr>
<td></td>
<td>High Triglycerides</td>
<td>53 (8)</td>
<td>37 (7)</td>
<td>3 (3)</td>
<td>40 (28)</td>
<td>60 (44)</td>
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<td>Low HDL</td>
<td>50 (5)</td>
<td>35 (4)</td>
<td>2 (0)</td>
<td>70 (44)</td>
<td>37 (7)</td>
</tr>
<tr>
<td></td>
<td>Metabolic Syndrome</td>
<td>BMI, body mass index; BP, blood pressure; HDL, high-density lipoprotein.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 6. Association between Components of Metabolic Syndrome and Cataract by Diabetic Status

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Diabetes Present (n = 610)</th>
<th>Diabetes Absent (n = 2184)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>n (Cases)</strong></td>
<td><strong>Multivariable Adjusted OR (95% CI)</strong></td>
<td><strong>n (Cases)</strong></td>
</tr>
<tr>
<td>High BP (BP ≥130/85 mm Hg or use of BP medication)</td>
<td>567 (367)</td>
<td>1675 (786)</td>
</tr>
<tr>
<td>HDL (&lt;1.0 and &lt;1.3 mmol/L in male and female)</td>
<td>229 (142)</td>
<td>538 (217)</td>
</tr>
<tr>
<td>Triglycerides (≥1.7 mmol/L)</td>
<td>277 (163)</td>
<td>832 (340)</td>
</tr>
<tr>
<td>BMI ≥25.0 kg/m²</td>
<td>413 (248)</td>
<td>1214 (477)</td>
</tr>
</tbody>
</table>

BMI, body mass index; HDL, high-density lipoprotein; OR, odds ratio.

* Adjusted for age, sex, education, smoking status; P interaction (diabetes × high BP) = 0.82, (diabetes × low HDL) = 0.48, (diabetes × high triglycerides) = 0.09. (diabetes × high BMI) = 0.66.
Limitations of our study should be mentioned. First, the cross-sectional nature of the study limits making causal inferences. However, given the plausible mechanism by which high BP, diabetes, or metabolic syndrome result in cataract, reverse causality may seem an improbable explanation. Second, our assessment of high BP was based on a single visit, and measurement error may have attenuated the true association. Third, there could have been unmeasured, and therefore unadjusted, confounding factors that could explain some of the associations observed in our study. Finally, the use of casual plasma glucose to define diabetes could certainly have resulted in misclassification of diabetes cases.

In conclusion, findings from this population-based study suggest that the metabolic syndrome and its two principal component factors, high BP and diabetes, are associated with age-related cataract in Asian Malay adults. These findings highlight the importance of tackling modifiable risk factors for the prevention of cataract.

References


