Modification of the Relationship Between Simple Anthropometric Indices and Risk Factors by Ethnic Background

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Current targets for body mass index (BMI) and waist circumference (WC) may not be appropriate for those of South Asian origin. The objectives of this study were to determine whether the relationship between BMI and WC with risk factors for cardiovascular disease (CVD) is the same for men and women of South Asian and European descent. Apparently healthy men and women of European (n = 88) and South Asian (n = 93) descent were recruited from 3 hospital communities and assessed for BMI, WC, waist-to-hip ratio (WHR), blood pressure (BP), lipids, insulin, glucose, and CRP. The study cohort was stratified by sex, and regression analyses were performed with individual risk factors as outcomes and ethnicity with either BMI or WC as predictors adjusting for age and height (WC only). BMI and WC were similar between the European and South Asian men and women. South Asian men had significantly higher values for total cholesterol (TC), low-density lipoprotein-cholesterol (LDL-C), triglycerides (TG), total cholesterol:high-density lipoprotein-cholesterol (HDL-C) and CRP, and significantly lower values of HDL-C. South Asian women had significantly higher values for TG, TC:HDL-C and CRP and significantly lower values of HDL-C, glucose, systolic BP and diastolic BP. In men, ethnicity was an independent predictor for all risk factors except for glucose and insulin, after adjusting for either BMI or WC independent of age and height. For women, ethnicity was an independent predictor for all risk factors except for total cholesterol (WC model only) and insulin (BMI model only), after adjusting for either BMI or WC independent of age and height. The relationship between BMI or WC and risk factors is such that men and women of South Asian descent present with a more adverse risk profile than those of European descent at the same BMI and/or WC.

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THE PREVALENCE of obesity is increasing worldwide and in developing populations not traditionally associated with obesity, namely those from Asia.[1] This is of great concern as obesity imparts a significant risk for cardiovascular disease (CVD) risk factors,[2-5] atherosclerosis,[6,7] some cancers,[8,9] mortality,[10-12] and significantly contributes to health care expenses.[13,14] Those of South Asian origin are of particular concern as they comprise the largest ethnic group in the world and are undergoing a rapid westernization of their culture.[15] While accurate data on the prevalence of obesity in these populations is not available, it has been estimated to range from 7.0% to 13.3% in men and 15.6% to 23.7% in women.[16,17] Those of South Asian origin who reside in western countries may be at greater risk as the environmental change is more pronounced.[18]

Much of the information regarding obesity has been derived from investigations of populations of primarily European descent. These studies have resulted in the recommendation of specific anthropometric targets to identify those at risk and initiate intervention strategies.[12,19] However, there is evidence that these targets may not apply to those of non-European origin. A number of investigations have reported that those of South Asian descent have a higher percentage of body fat at a similar body mass index (BMI) than those of European descent.[20,21] It has also been suggested that the metabolic consequences of excess body fat in South Asian men and women carries with it a different consequence compared with those of European descent.[22] To date, no ethnic specific anthropometric targets exist, rather targets derived from populations of European origin are inappropriately applied to men and women of South Asian descent. In addition, this population is at greater risk for CVD.[23] Thus, further investigation is required in this population to identify the health implications of excess body fat. The objectives of this study were to determine whether the relationship between BMI and waist circumference (WC) with metabolic risk factors for CVD is the same for men and women of South Asian and European descent.

MATERIALS AND METHODS

Study participants (men and women) were recruited from staff, students, volunteers, and their friends of 3 local hospitals and the surrounding communities. Apparently healthy participants were eligible if they were over 18 years of age and either of European or South Asian descent. Ethnicity was determined by interview; potential participants were asked the origins of their parents and grandparents. Only those individuals who reported having all known ancestors of either European or South Asian descent were invited to participate. A sample size of convenience was limited to 100 participants of each ethnicity. Participants were excluded if they reported having either diabetes mellitus (DM), CVD, taking medications that would affect the risk factors under assessment, currently smoking, or had increased abdominal girth not related to increased adiposity (for example, pregnancy, peritoneal dialysis, or ascites). Participants with untreated hyperlipidemia or elevated blood glucose were not excluded. All participants read and provided informed consent before commencing the study. The study was approved by the Providence Health Care Ethics Committee.

Participants underwent an assessment that included medical history, BMI, WC, hip circumference (HC), blood pressure (BP), and fasting blood samples to be analyzed for plasma total cholesterol (TC), low-density lipoprotein-cholesterol (LDL-C), high-density lipoprotein-cholesterol (HDL-C), triglycerides (TG), insulin, glucose, and C-reactive

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Table 1. Anthropometric Data and Metabolic Risk Factors for European and South Asian Men

	European (n = 35)	South Asian (n = 34)
Age (yr)	36.5 ± 9.6 (19-56)	38.2 ± 12.7 (19-67)
Height (m)	1.77 ± 0.07 (1.64-1.90)	1.74 ± 0.07 (1.62-1.95)
BMI (kg/m^2)	25.7 ± 3.5 (19.6-35.8)	25.9 ± 3.8 (18.9-35.5)
Waist circumference (cm)	88.5 ± 9.7 (72.2-113.6)	88.4 ± 11.2 (61.9-110.5)
Hip circumference (cm)	100.4 ± 5.2 (91.7-114.4)	98.1 ± 6.9 (88-113.3)
Waist-to-hip ratio	0.88 ± 0.07 (0.77-1.00)	0.90 ± 0.08 (0.66-1.08)
Total cholesterol (mmol/L)	4.04 ± 0.82 (1.98-5.70)	5.09 ± 1.14‡ (2.56-7.06)
LDL-C (mmol/L)	2.33 ± 0.78 (0.87-3.91)	3.07 ± 0.92† (0.74-4.02)
HDL-C (mmol/L)	1.24 ± 0.24 (0.80-1.84)	1.08 ± 0.20† (0.63-1.48)
Triglycerides (mmol/L)§	0.85 (0.33-3.45)	1.53‡ (0.57-11.43)
TC/HDL-C	3.37 ± 0.96 (1.94-6.17)	4.92 ± 1.73‡ (2.35-9.62)
Glucose (mmol/L)§	5.5 (3.5-6.6)	5.2 (3.2-7.4)
Insulin (pmol/L)§	70 (27-138)	65 (22-240)
Systolic BP (mm Hg)	119 ± 11 (103-141)	114 ± 14 (93-152)
Diastolic BP (mm Hg)	75 ± 9 (58-93)	72 ± 10 (51-98)
C-reactive protein (mg/dL)§	0.54 (0.11-7.25)	1.01* (0.18-11.2)

NOTE. (ranges).
*$P < .05$ compared with European.
†$P < .01$ compared with European.
‡$P < .001$ compared with European§ median value.

protein (CRP) at a later date. Plasma and serum samples were kept frozen at −70°C until analyzed.

Weight was measured to the nearest 0.1 kg on a balance beam scale, and participants were asked to remove their shoes and any heavy items from their pockets. Height was measured at the same time to the nearest 0.5 cm. BMI was calculated as weight (kg) divided by height (m) squared. WC was measured (to the nearest 0.1 cm) directly over the skin at the point of maximal narrowing of the trunk as viewed from the anterior position with the participant standing upright after a normal expiration. Hip circumference was measured (to the nearest 0.1 cm) over undergarments at the point of greatest gluteal protuberance as observed from the lateral view. Waist-to-hip ratio (WHR) was calculated by dividing WC by HC. Blood pressure was measured in the left arm after 5 minutes of seated rest using an appropriately sized cuff. A second measurement was taken 5 minutes later. The average of the 2 measures was used in analyses.

Serum TC, HDL-C, TG, glucose and insulin were measured using standard procedures in a certified clinical laboratory. LDL-C was calculated using the Friedewald equation.[24] The TC/HDL-C ration was calculated by dividing TC by HDL-C. Serum CRP was measured using high sensitivity chemi-illuminescence on an Immulite 1 (Diagnostics Products Corp, Los Angeles, CA), with a sensitivity of 0.2 mg/L.

Data are reported as the mean ± SD. Comparisons between groups were analyzed using an independent samples 2-tailed *t* test. TGs, insulin, glucose, and CRP were log-transformed for analyses with median values presented. Transformed data were used for all figures where applicable. Categorical data were analyzed using the Pearson chi-square test. Pearson correlation coefficients were determined for

Table 2. Anthropometric Data and Metabolic Risk Factors for European and South Asian Women

	European (n = 53)	South Asian (n = 59)
Age	41.4 ± 11.7 (22-65)	32.3 ± 11.4† (17-63)
Height (m)	1.65 ± 0.07 (1.53-1.88)	1.59 ± 0.06‡ (1.45-1.75)
BMI (kg/m^2)	26.7 ± 5.8 (18.8-39.8)	25.0 ± 4.7 (15.1-36.2)
Waist circumference (cm)	81.4 ± 12.6 (65.5-119.4)	78.8 ± 11.4 (57.2-102.7)
Hip circumference (cm)	105.1 ± 10.6 (86.9-129.3)	99.5 ± 8.9† (81.0-119.3)
Waist-to-hip ratio	0.77 ± 0.06 (0.70-1.04)	0.79 ± 0.07 (0.58-0.92)
Total cholesterol (mmol/L)	4.34 ± 0.92 (2.55-6.59)	4.55 ± 1.02 (3.00-8.64)
LDL-C (mmol/L)	2.31 ± 0.87 (0.82-4.45)	2.64 ± 0.97 (0.69-6.96)
HDL-C (mmol/L)	1.60 ± 0.34 (0.93-2.94)	1.39 ± 0.35† (0.83-2.57)
Triglycerides (mmol/L)§	0.79 (0.39-2.63)	0.91* (0.40-3.82)
TC/HDL-C	2.81 ± 0.78 (1.47-4.54)	3.44 ± 1.08‡ (1.69-6.13)
Glucose (mmol/L)§	5.3 (4.4-6.7)	4.9† (4.0-7.1)
Insulin (pmol/L)§	60 (27-124)	52 (22-148)
Systolic BP (mm Hg)	116 ± 16 (89-162)	104 ± 12‡ (78-144)
Diastolic BP (mm Hg)	72 ± 15 (48-96)	67 ± 9† (43-93)
C-reactive protein (mg/dL)§	0.69 (0.17-9.91)	1.82† (0.14-17.2)
Postmenopausal (%)	13 (25)	7 (12)

*$P < .05$ compared with European.
†$P < .01$ compared with European.
‡$P < .001$ compared with European§ median value.

Table 3. Results of Multiple Linear Regression Analyses in Men Using Risk Factors of the Metabolic Syndrome as the Dependent Variable

		Independent Variable Coefficients			Independent Variable Coefficients	
Dependent Variable	r^2	BMI	Ethnicity	r^2	WC	Ethnicity
TC	.335	0.076*	1.011‡	.352	0.027*	0.963‡
LDL-C	.254	0.042	0.707†	.266	0.013	0.659†
HDL-C	.285	−0.027‡	−0.159†	.257	−0.009†	−0.156†
Log triglycerides	.431	0.034‡	0.282‡	.444	0.013‡	0.284‡
TC/HDL-C	.396	0.170‡	1.519‡	.406	0.060‡	1.460‡
Log glucose	.045	0.000	−0.017	.056	0.000	−0.015
Log insulin	.303	0.031‡	0.005	.376	0.013‡	0.005
Log CRP	.254	0.036†	0.245†	.241	0.012*	0.252*

NOTE. All analyses have been adjusted for age and height (WC only).
$^*P < .05$, †$P < .01$, ‡$P < .001$.

BMI or WC with the CVD risk factors assessed within each sex and ethnicity. Regression analysis was performed within each sex with the various CVD risk factors (TC, HDL-C, TC/HDL-C, log TG, log insulin, log glucose, log CRP) as dependent variables and an interaction term of either BMI-ethnicity or WC-ethnicity as the independent variable. If no interaction was found, then a second regression analysis was performed, with either BMI or WC and ethnicity as the independent variables. The regression analyses were repeated again adjusting for age and further adjusted for height in those models with WC as an independent variable. Analyses were conducted a second time after removing those individuals who had hyperlipidemia (n = 3 for men and n = 2 for women) to remove a potential bias of treatment patterns by ethnicity. As this did not change the results, the data are presented including these individuals. All tests were conducted with P value set at .05 for significance using SPSS version 10.0 software (SPSS, Chicago, IL).

RESULTS

After excluding smokers and participants taking medications known to affect CVD risk factors, a total of 88 Europeans (35 men and 53 women) and 93 South Asians (34 men and 59 women) were analyzed. Tables 1 and 2 outline the age, anthropometric values, and metabolic risk factors for men and women, respectively. BMI, WC, and WHR were similar between the European and South Asian men and the European and South Asian women. South Asian women were significantly younger, shorter, and had a smaller HC than the European women. South Asian men had significantly higher values for TC, LDL-C, TG, TC/HDL-C, and CRP and significantly lower values of HDL-C. South Asian women had significantly higher values for TG, TC/HDL-C, and CRP and significantly lower values of HDL-C, glucose, systolic, and diastolic BP.

Both BMI and WC were positively associated with TC, LDL-C, log TG, TC/HDL-C, log insulin, and diastolic BP and negatively associated with HDL-C in the European men, while BMI and WC were positively associated with log TG, log insulin, systolic, diastolic BP and log CRP in South Asian men ($P < .05$ for all). In European women, BMI and WC were positively associated with log TG, TC/HDL-C, log glucose, log insulin, systolic and diastolic BP, and log CRP and in South Asian women, BMI and WC were positively associated with log TG, log glucose, log insulin, diastolic BP, and log CRP and negatively associated with HDL-C ($P < .05$ for all).

Tables 3 and 4 outline the results of the multiple linear regression analyses for men and women, respectively. Interaction terms of either ethnicity-BMI or ethnicity-WC were not significant predictors of any of the CVD risk factors for either sex. For men, ethnicity was an independent predictor for all risk factors analyzed except for log glucose and log insulin, after adjusting for either BMI or WC independent of age and height (WC only). For women, ethnicity was an independent predictor for all risk factors analyzed except for TC (WC model only) and log insulin (BMI model only), after adjusting for either BMI or WC independent of age and height (WC only). There

Table 4. Results of Multiple Linear Regression Analyses in Women Using Risk Factors of the Metabolic Syndrome as the Dependent Variable

		Independent Variable Coefficients			Independent Variable Coefficients	
Dependent Variable	r^2	BMI	Ethnicity	r^2	WC	Ethnicity
TC	0.154	−0.002	0.399*	0.163	−0.005	0.308
LDL-C	0.143	0.003	0.485†	0.146	−0.003	0.430*
HDL-C	0.161	−0.019†	−0.232†	0.219	−0.011‡	−0.256†
Log triglycerides	0.330	0.016‡	0.119‡	0.397	0.008‡	0.083†
TC/HDL-C	0.236	0.036*	0.820‡	0.246	0.018*	0.825‡
Log glucose	0.223	0.002†	−0.021†	0.205	0.001*	−0.022†
Log insulin	0.328	0.021‡	−0.034	0.338	0.010‡	−0.077*
Log CRP	0.457	0.058‡	0.410‡	0.503	0.028‡	0.385‡

NOTE. All analyses have been adjusted for age and height (WC only).
$^*P < .05$, †$P < .01$, ‡ $P < .001$.

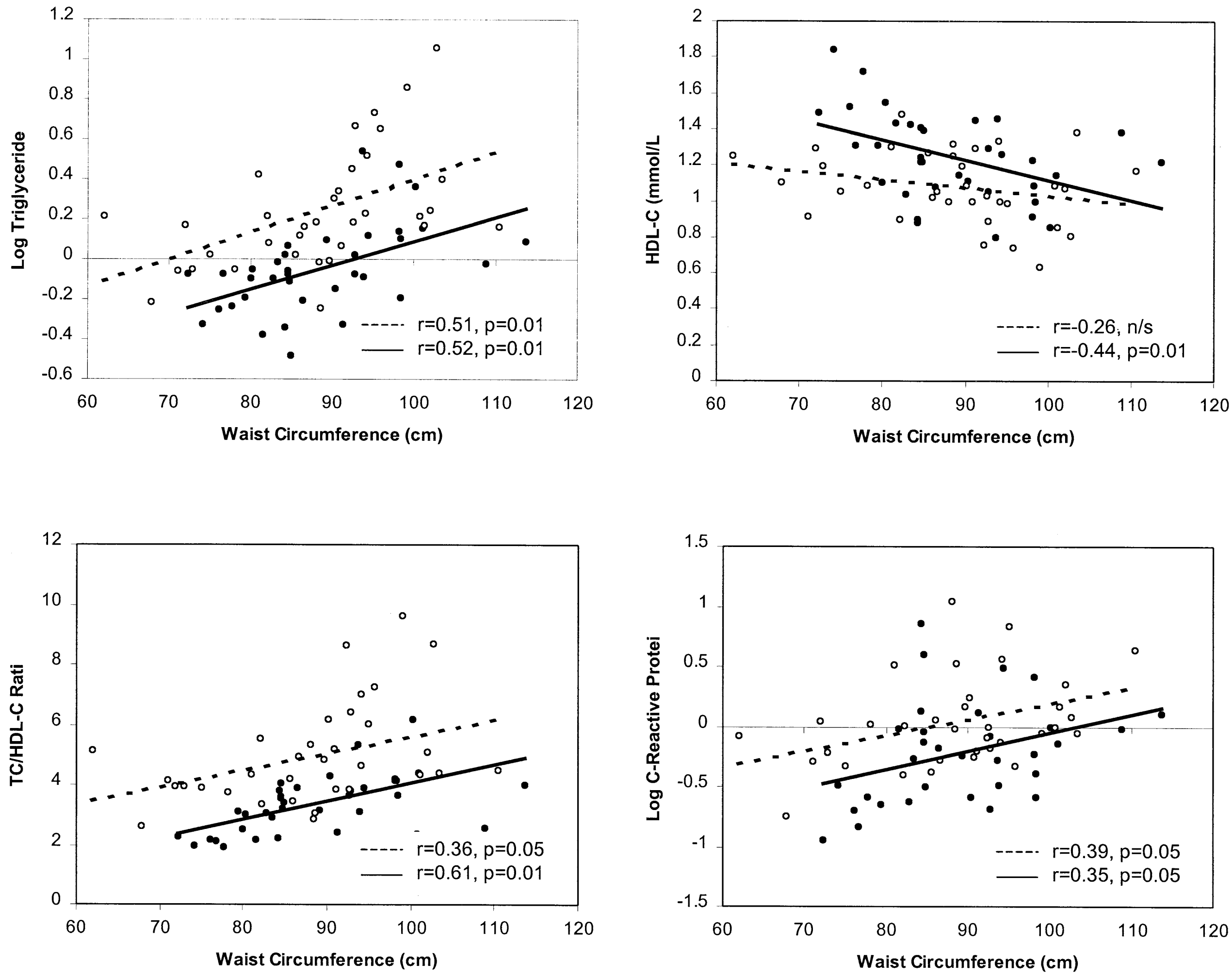

Fig 1. Comparison of the relationship of various metabolic risk factors (TG, HDL-C, TC/HDL-C ratio, and CRP) and WC between European and South Asian men. European, ●; and solid line; South Asian, ○ and dashed line.

was a trend for the models using WC as an independent variable to explain a greater proportion of the variance in the various risk factors than those models using BMI.

Figures 1 and 2 outline the impact that ethnicity has on the relationships between WC and metabolic risk factors: log TG, HDL-C, TC/HDL-C, and log CRP for men and women, respectively.

DISCUSSION

The presentation of increased body fat is a common predecessor for a number of CVD risk factors. Therefore, targets for BMI and WC are used to identify those at increased risk based on the point at which the risk of mortality is substantially increased, or as a marker for adverse levels of CVD risk factors.[4,12,25,26] Our results indicate that ethnic background was a significant modifier of the relationship between both BMI and WC with various CVD risk factors. In particular, ethnicity itself was a significant predictor of TC, HDL-C, TC/HDL-C, TG, and CRP in men and HDL-C, TC/HDL-C, TG, glucose, and CRP in women independent of either BMI or WC after adjusting for age and height. Therefore, at a given BMI or WC, South Asian men and women presented with higher values of these CVD risk factors.

Many investigations comparing men and women of South Asian and European origin have concentrated on the differences in CVD risk factor levels and have not comprehensively addressed the influence of excess body fat. These studies indicate that at similar or lower values of BMI, South Asian men and women present with significantly higher levels of TG, glucose, insulin, BP, CRP, lower levels of HDL-C and a higher prevalence of DM, hypertension, and dyslipidemia than European men and women.[23,27-29] This finding even extends to the prevalence of diabetes and atherosclerosis as assessed by ultrasonography of the carotid artery.[23,29] Despite the findings of these studies, none adequately controlled for differences in anthropometric measures between the 2 ethnic groups.

Only 2 previous studies have directly compared the relationship between anthropometric measures and CVD risk factors in South Asian and European men and women.[30,31] The first study used multivariate analysis to identify predictors of HDL-C, TG,

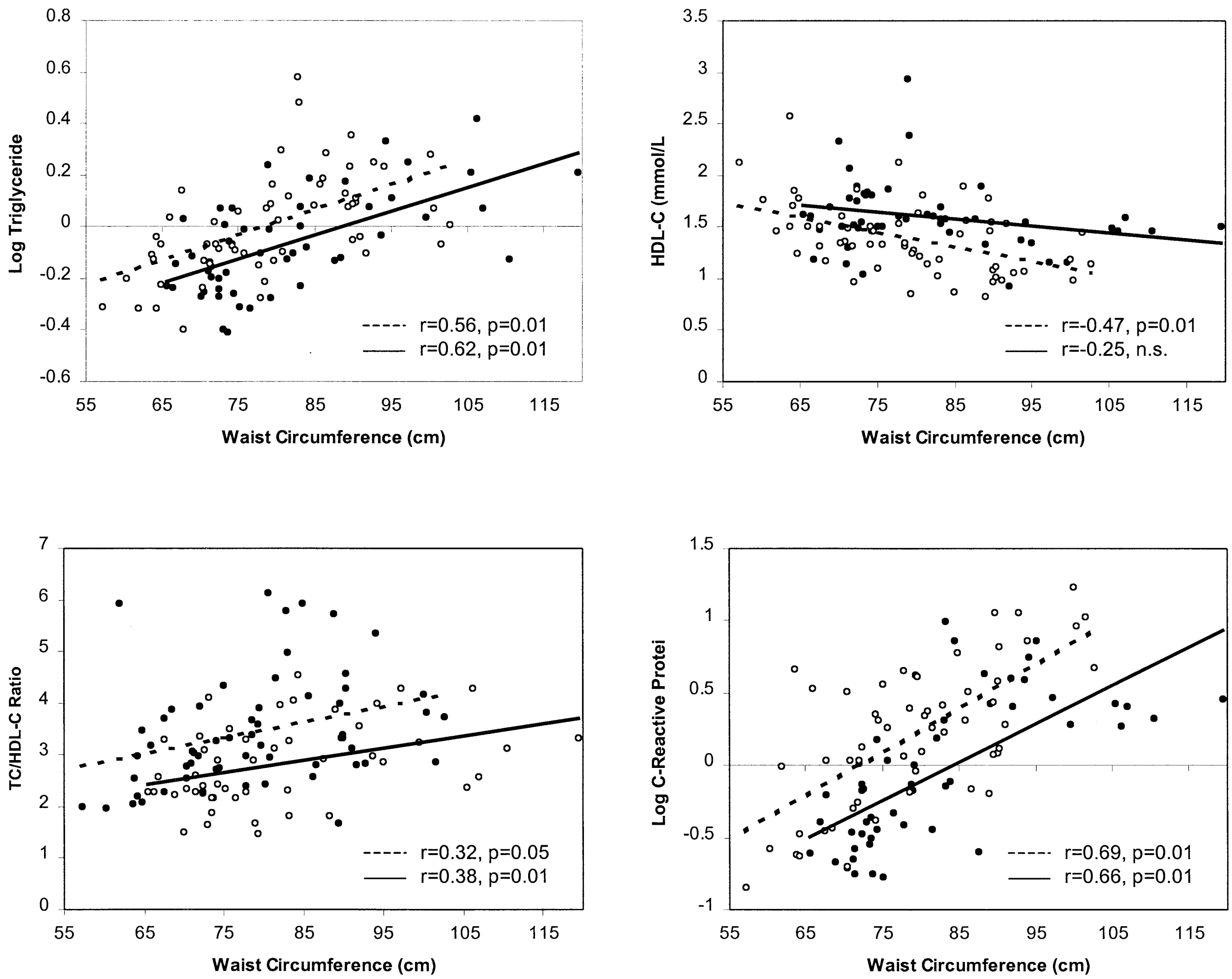

Fig 2. Comparison of the relationship of various metabolic risk factors (TG, HDL-C, TC/HDL-C ratio, and CRP) and WC between European and South Asian women. European, ● and solid line; South Asian, ○ and dashed line.

and 2-hour glucose concentration in men and women of South Asian and European origin living in the United Kingdom.[30] In this study, ethnicity significantly interacted with WC to predict 2-hour glucose in men and HDL-C, TG, and 2-hour glucose in women, indicating significantly different relationships between these 2 groups. In the second study, Chandalia et al[31] investigated the effects of ethnicity on the relationships between percent body fat and truncal skinfold thickness with insulin sensitivity in South Asian and European men. They found that while the slopes of the relationships were the same, ethnicity was a significant predictor of insulin sensitivity, regardless of which anthropometric measure was used, such that South Asian men had lower insulin sensitivity at a given percent body fat or truncal skinfold thickness than the European men. Our results confirm that ethnicity is a significant modifier in the relationship between simple anthropometric measures and CVD risk factors and extends it to both men and women and other CVD risk factors not previously reported.

The notion that ethnicity modifies the relationship between anthropometric measures and CVD risk factors has been more widely studied in populations of Chinese origin. These studies have found that elevated levels of CVD risk factors occur at lower BMI and WC values than that in European descent populations.[30,32] Comparing Chinese and European men and women, we previously reported that ethnicity was a significant predictor of TC, LDL-C, TG, and TC/HDL-C in men independent of WC, and that ethnicity significantly interacted with WC to predict TG, TC/HDL-C, insulin levels, and glucose in women.[2]

Previous reports have indicated that South Asian men and women tend to have higher percentages of body fat at a similar BMI.[20,21] In addition, South Asians tend to accumulate more body fat around their abdomen for a given BMI.[18,22] This is consistent with our results, as the models with WC explained a greater variance of the CVD risk factors than those with BMI. In the current study, there was no significant interaction between ethnicity and either BMI or WC. Therefore, the slopes of the relationship between the anthropometric measures and risk factors were similar between the 2 ethnic groups. Despite the absence of an interaction, ethnicity remained a predictor of the metabolic risk factors independent of anthropometric and age differences. As visceral adipose tissue is strongly associated with CVD risk factors,[4] different amounts of visceral fat between these ethnic groups may, in part, explain these findings. It is possible that additional body fat in the South Asian men and women is preferentially deposited around the abdomen. In fact, a previous study reported a greater amount of visceral fat in 10 Indian men compared with 10 European men matched for age, weight, and height.[33] While these results were not significant ($P = .16$), it is likely the study was under powered. Further investigation is needed to identify ethnic differences in adipose tissue deposition.

As ethnicity is a discriminate marker that reflects both environmental and physiologic differences, it is not possible to draw definitive conclusions regarding the possible mechanism of these results. Possible cultural differences must be considered, as well as diet and activity status; however, these factors were not assessed in the present study. In addition, ethnicity was determined through interview regarding participants' knowledge of their parents, grandparents, and ancestors. This method of self-report may have limitations in that some individuals may not be aware of their true parentage. However, as the incidence of nonpaternity is reported to be low,[34] this should not impact our results.

Despite demonstrating a clear influence of ethnicity on the relationship between both BMI and WC with many CVD risk factors, this was not consistent for all CVD risk factors. It is possible that the sample size may have limited the ability to detect ethnicity as a predictor for these other risk factors and therefore draw definitive conclusions. As this is a cross-sectional study, we cannot determine if these findings hold true with the accumulation in body fat over time. Future investigations should aim at determining BMI and WC targets for populations of different ethnic backgrounds.

Conclusions

Given that South Asians tend to have a higher prevalence of CVD than those of European descent,[23,35] understanding how excess body fat relates to established CVD risk factors is important to developing appropriate anthropometric targets to screen individuals at increased risk. The application of European-derived targets to this population will inadequately identify those at risk and result in delayed intervention. Our results clearly indicate that ethnic background significantly modifies the relationship between common anthropometric indices (BMI and WC) and CVD risk factors, such that men and women of South Asian descent may present with a more adverse risk profile than those of European descent at the same BMI and/or WC.

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REFERENCES

1. World Health Organization: Obesity: Preventing and managing the global epidemic. World Health Organization Technical Report Series, vol 894. Geneva, Switzerland, World Health Organization, 2000
2. Lear SA, Chen MM, Frohlich JJ, et al: The relationship between waist circumference and metabolic risk factors: Cohorts of European and Chinese descent. Metabolism 51:1427-1432, 2002
3. Reeder BA, Senthilselvan A, Despres JP, et al: The association of cardiovascular disease risk factors with abdominal obesity in Canada. Canadian Heart Health Surveys Research Group. CMAJ 157:S39-S45, 1997
4. Pouliot MC, Despres JP, Lemieux S, et al: Waist circumference and abdominal sagittal diameter: Best simple anthropometric indexes of abdominal visceral adipose tissue accumulation and related cardiovascular risk in men and women. Am J Cardiol 73:460-468, 1994
5. Despres JP, Moorjani S, Tremblay A, et al: Relation of high plasma triglyceride levels associated with obesity and regional adipose tissue distribution to plasma lipoprotein-lipid composition in premenopausal women. Clin Invest Med 12:374-380, 1989
6. McGill HC Jr, McMahan CA, Herderick EE, et al: Obesity accelerates the progression of coronary atherosclerosis in young men. Circulation 105:2712-2718, 2002
7. Lakka TA, Lakka HM, Salonen R, et al: Abdominal obesity is associated with accelerated progression of carotid atherosclerosis in men. Atherosclerosis 154:497-504, 2001
8. Michaud DS, Giovannucci E, Willett WC, et al: Physical activity, obesity, height, and the risk of pancreatic cancer. JAMA 286:921-929, 2001
9. Wolk A, Gridley G, Svensson M, et al: A prospective study of obesity and cancer risk (Sweden). Cancer Causes Control 12:13-21, 2001
10. Garrison RJ, Castelli WP: Weight and thirty-year mortality of men in the Framingham Study. Ann Intern Med 103:1006-1009, 1985
11. Manson JE, Willett WC, Stampfer MJ, et al: Body weight and mortality among women. N Engl J Med 333:677-685, 1995
12. Calle EE, Thun MJ, Petrelli JM, et al: Body-mass index and mortality in a prospective cohort of U.S. adults. N Engl J Med 341:1097-1105, 1999
13. Birmingham CL, Muller JL, Palepu A, et al: The cost of obesity in Canada. CMAJ 160:483-488, 1999
14. Wolf AM, Colditz GA: The cost of obesity: The US perspective. Pharmacoeconomics 5:34-37, 1994
15. Janus ED, Postiglione A, Singh RB, et al: The modernization of Asia. Implications for coronary heart disease. Council on Arteriosclerosis of the International Society and Federation of Cardiology. Circulation 94:2671-2673, 1996
16. Zargar AH, Masoodi SR, Laway BA, et al: Prevalence of obesity in adults—An epidemiological study from Kashmir Valley of Indian Subcontinent. J Assoc Physicians India 48:1170-1174, 2000
17. Misra A, Pandey RM, Devi JR, et al: High prevalence of diabetes, obesity and dyslipidaemia in urban slum population in northern India. Int J Obes Relat Metab Disord 25:1722-1729, 2001
18. Singh RB, Rastogi SS, Rao PV, et al: Diet and lifestyle guidelines and desirable levels of risk factors for the prevention of diabetes and its vascular complications in Indians: A scientific statement of The International College of Nutrition. Indian Consensus Group for the Prevention of Diabetes. J Cardiovasc Risk 4:201-208, 1997
19. Lean ME, Han TS, Morrison CE: Waist circumference as a measure for indicating need for weight management. BMJ 311:158-161, 1995
20. Dudeja V, Misra A, Pandey RM, et al: BMI does not accurately predict overweight in Asian Indians in northern India. Br J Nutr 86:105-112, 2001
21. Deurenberg-Yap M, Schmidt G, van Staveren WA, et al: The paradox of low body mass index and high body fat percentage among Chinese, Malays and Indians in Singapore. Int J Obes Relat Metab Disord 24:1011-1017, 2000
22. McKeigue PM, Shah B, Marmot MG: Relation of central obesity

and insulin resistance with high diabetes prevalence and cardiovascular risk in South Asians. Lancet 337:382-386, 1991

23. Anand SS, Yusuf S, Vuksan V, et al: Differences in risk factors, atherosclerosis, and cardiovascular disease between ethnic groups in Canada: The Study of Health Assessment and Risk in Ethnic groups (SHARE). Lancet 356:279-284, 2000

24. Friedewald WT, Levy RI, Fredrickson DS: Estimation of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem 18:499-502, 1972

25. Lean ME, Han TS, Seidell JC: Impairment of health and quality of life in people with large waist circumference. Lancet 351:853-856, 1998

26. Overweight, Obesity, and Health Risk: National Task Force on the Prevention and Treatment of Obesity. Arch Intern Med 160:898-904, 2000

27. Chambers JC, Eda S, Bassett P, et al: C-reactive protein, insulin resistance, central obesity, and coronary heart disease risk in Indian Asians from the United Kingdom compared with European whites. Circulation 104:145-150, 2001

28. Forouhi NG, Sattar N, McKeigue PM: Relation of C-reactive protein to body fat distribution and features of the metabolic syndrome in Europeans and South Asians. Int J Obes Relat Metab Disord 25: 1327-1331, 2001

29. Gupta M, Doobay AV, Singh N, et al: Risk factors, hospital management and outcomes after acute myocardial infarction in South Asian Canadians and matched control subjects. CMAJ 166:717-722, 2002

30. Patel S, Unwin N, Bhopal R, et al: A comparison of proxy measures of abdominal obesity in Chinese, European and South Asian adults. Diabet Med 16:853-860, 1999

31. Chandalia M, Abate N, Garg A, et al: Relationship between generalized and upper body obesity to insulin resistance in Asian Indian men. J Clin Endocrinol Metab 84:2329-2335, 1999

32. Ko GT, Chan JC, Woo J, et al: Simple anthropometric indexes and cardiovascular risk factors in Chinese. Int J Obes Relat Metab Disord 21:995-1001, 1997

33. Chowdhury B, Lantz H, Sjostrom L: Computed tomography-determined body composition in relation to cardiovascular risk factors in Indian and matched Swedish males. Metabolism 45:634-644, 1996

34. Sasse G, Muller H, Chakraborty R, et al: Estimating the frequency of nonpaternity in Switzerland. Hum Hered 44:337-343, 1994

35. Sheth T, Nair C, Nargundkar M, et al: Cardiovascular and cancer mortality among Canadians of European, south Asian and Chinese origin from 1979 to 1993: An analysis of 1.2 million deaths. CMAJ 161:132-138, 1999