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A culturally appropriate diet and lifestyle intervention can successfully treat the components of metabolic syndrome in female Pakistani immigrants residing in Melbourne, Australia

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Abstract

This study was designed to test the effectiveness of a culturally appropriate diet and lifestyle intervention to treat metabolic syndrome in female Pakistani immigrants residing in Melbourne, Australia. Forty Pakistani women with metabolic syndrome (aged 20-50 years) completed a 12-week culturally appropriate diet and exercise program. Results indicate that, before intervention, participants were sedentary, taking 4000 ± 22.6 steps per day, and had an obese-classified body mass index (BMI) of 29.2 ± 0.46 kg/m^2 (BMI was categorized in accordance with guidelines specifically designed for Asians) and high waist circumference of 132 ± 25.95 cm. Participants were hypertensive (systolic, 135 ± 1.3 mm Hg; diastolic, 86 ± 0.68 mm Hg), were dyslipidemic (total cholesterol, 6.8 ± 0.15 mmol/L; triglycerides, 2.9 ± 0.09 mmol/L), and had elevated blood glucose (6.4 ± 0.33 mmol/L) and fasting blood insulin (45 ± 6.3 μU/mL) levels. After the 12-week culturally appropriate intervention, activity increased (8600 ± 596.7 steps per day, $P < .05$); and BMI (27.8 ± 0.45 kg/m^2), blood pressure (systolic, 125 ± 1.4 mm Hg; diastolic, 80 ± 0.6 mm Hg), cholesterol (5.5 ± 0.1 mmol/L), blood glucose (5.9 ± 0.33 mmol/L), and blood insulin (24.14 ± 1.8 μU/mL) levels were all significantly reduced ($P < .05$). This study revealed that the Pakistani female migrants who had metabolic syndrome and its components can successfully be treated via a culturally appropriate diet and lifestyle intervention. The success of the current program raises the possibility that other high-risk ethnic groups can also be treated with a culturally appropriate program.

1. Introduction

The concept of metabolic syndrome was proposed to highlight the simultaneous occurrence of risk factors for cardiovascular disease and type 2 diabetes mellitus [1]. It is considered a disorder characterized by a clustering of cardiovascular risk factors, which include central/abdominal obesity, elevated blood pressure, elevated plasma glucose levels, and dyslipidemia [1-3].

Metabolic syndrome is an emerging clinical challenge and important public health issue [3]. It is estimated that metabolic syndrome affects approximately 25% to 30% of the world population [4]. One of the primary risk factors for metabolic syndrome is abdominal/central obesity. Weight gain exposes individuals to major components of metabolic syndrome, namely, obesity and insulin resistance. Therefore, the high prevalence of metabolic syndrome is largely attributed to the alarmingly increasing rates of obesity across the world [5-10].

A high-risk population for the development of metabolic syndrome is the South Asian migrants (people from Pakistan, India, and Bangladesh). The prevalence of metabolic syndrome has been shown to be much higher in South Asian migrants when compared with African Caribbean and white European migrants [11-15]. It has been established that metabolic syndrome can increase the risk of developing cardiovascular disease 4-fold in Punjabi Indians [9,12]. According to reports primarily from the United Kingdom, the prevalence of metabolic syndrome ranges from 29% to 50% in migrant South Asians [16,17]. It has also been shown that South Asians are twice as likely to develop cardiovascular disease when they have metabolic

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syndrome when compared with those who do not [17]. Although studies on migrant South Asian women are limited, the data that do exist suggest that the rate of mortality due to cardiovascular disease is higher in migrant South Asian women when compared with men [15,16]. As a subsample of the South Asian population, Pakistanis tend to have a higher rate of hyperinsulinemia and insulin resistance when compared with people of other ethnic backgrounds. Furthermore, the prevalence of cardiovascular disease in migrant Pakistanis living in the United Kingdom, United States, and South Africa is 50% higher when compared with the general population of the host country [18-20].

Generally, migration and lifestyle change (such as an increase in energy-dense foods and a reduction in physical activity) lead to a higher prevalence of metabolic syndrome in migrant populations when compared with the host population [21]. As weight gain has been shown to be the strongest predictor of metabolic syndrome [22], weight control is important in preventing the onset or reducing the severity of the syndrome [23]. It has been shown that losing weight or stopping weight gain using an improved diet and increased physical activity may reduce the overall risk of the disorder [24-26]. The treatment of the disorder must be a multifaceted process with a primary focus on therapeutic lifestyle change; in more advanced cases, however, pharmacologic intervention may also be required [22,23]. Although there is growing evidence that South Asians as an ethnic group seem to be particularly predisposed to the development of type 2 diabetes mellitus and cardiovascular disease, there has been little investigation of culturally appropriate and effective methods of treating obesity and the symptoms of metabolic syndrome in these population groups [27].

The current study aimed to develop and test the effectiveness of a diet and physical activity intervention implemented based on the principles of cultural competence in a Pakistani female migrant population residing in Melbourne who had one or more risk factors for the metabolic syndrome.

2. Methods

2.1. Recruitment and inclusion criteria

The inclusion criteria for the study were as follows: all candidates must have been Pakistani-born women who were 20 to 60 years, were residing in Melbourne permanently, and had migrated to Australia more than 5 years ago. In addition, all subjects must have presented at least 1 component of the metabolic syndrome (according to the National Cholesterol Education Program Adult Treatment Panel III criteria: elevated blood pressure, elevated blood glucose levels, obesity, and increased waist circumference) [1]. It is well documented that recruitment of research subjects from ethnic minorities is difficult [28]. Difficulties include achieving an adequate sample size, obtaining relevant population denominators, and determining appropriate sampling and recruitment strategies [29]. Because of these difficulties, standard random sampling techniques are time consuming and too expensive to be used successfully. Therefore, in this study, a convenience sample of women meeting the inclusion criteria was used. Subjects were recruited using nonrandom strategies; the study was advertised through local and community papers, and snowballing techniques were specifically targeted in geographic areas known to have high concentrations of Pakistani migrants [30]. On entry into the study, subjects completed a questionnaire requesting demographic and health details. They also completed a food frequency questionnaire adapted from the National Nutrition Survey [31]. The physical activity and sedentary behavior questionnaire used in this study was adopted from the National Heart Foundation Risk Factor Prevalence study that was conducted in 1989 in collaboration with the Commonwealth Department of Community Services and Health [32]. This same questionnaire was also used on the Iranian population residing in Melbourne in a cardiovascular disease study [32].

2.2. The intervention program

To overcome the barriers previously noted in the literature for health promotion in culturally and linguistically diverse (CALD) populations, the development of the program including the written modules was informed by the principles of cultural competence to facilitate health promotion in CALD communities [33,34]. These involve (1) engaging the consumers and sustaining reciprocal relationships, (2) identifying leadership within the target population, (3) knowing the community, and (4) a shared responsibility. This was achieved by using a bilingual educator/facilitator and materials translated into the language of the target population (Urdu); using existing informal networks to identify and intervene with the target population; using peer education on a one-on-one basis or in small groups, including family members; and allowing for limited access to transport, time restrictions, and family commitments by holding sessions in the participants' homes. Differences in cultural understandings were addressed with the use of a bilingual educator from the same cultural group as the participants who therefore had an in-depth knowledge of the Pakistani culture and predominant religion.

For the intervention, written materials were delivered as modules. These were adapted from the "Easing the transition" food and nutrition program for refugees [35] and "Change of Heart" study, a behavioral program for the treatment and prevention of cardiovascular disease [36]. In this intervention, a peer education model was used [35] in which a female facilitator led small groups of migrant women through a specially designed educational and behavioral program we called the *Step to good health* program. The facilitator was a trained nutritionist with expertise in obesity management. The diet and lifestyle intervention program was implemented over a 12-week period. The program was based on 12 weekly modules, each module with a different focus and goal to achieve. The goals of the intervention program were multifaceted, including an overall decrease in energy intake and increase in physical activity. Each module consisted of individual dietary counseling and researcher-participant interaction. The 12 modules were given the following titles: *Variety is the spice of life*, *Which fat to choose*, *Achieving a healthy weight*, *Let's go shopping*, *Cooking up a storm*, *Eating away from home*, *Fill up on fibre*, *Flavour without salt*, *Water and our body*, *New foods and healthy eating habits*, and *Let's understand the food pyramid*. The modules aimed to increase the participants' self-efficiency and self-regulatory skills. On average, participants were counseled for 4 hours per week. Three hours constituted one-to-one interaction, with the remaining hour of contact occurring via the telephone. The weekly counseling sessions included a half-hour introduction to an allocated "objective of the week." The physiologic and pathologic aspects relating to the objective were then discussed. Later on in the session, the previous week's objective would ordinarily be reviewed after a discussion on why it was or was not achieved. All written materials were available in Urdu.

At the commencement of the intervention program, the subjects were requested to take a minimum of 10000 nonaccumulative steps daily; that is, participants were requested to take 10000 steps in 1 period (approximately 30-40 minutes of brisk walking) of physical activity, rather than throughout the entire day as was the case for baseline data collection (thus, pedometers were only worn at the time of physical activity). Participants were requested to do so 6 days a week as part of the diet and lifestyle intervention [24,25].

2.3. Study design

The study design included preintervention (control period: weeks 0-12) and postintervention (week 24) measurement of outcome variables. Therefore, baseline data were collected at week 0. The duration of the control period was 12 weeks; thus, no contact occurred between the researchers or participants (ie, no diet or lifestyle education was provided) during the control period. All parameters were remeasured at week 12, before the commencement of the planned intervention. The diet and lifestyle intervention program was implemented for 12 weeks, after which all the above parameters were remeasured at week 24.

2.4. Outcome variables

2.4.1. Anthropometric measurements

Anthropometric measurements were taken according to standard technique and equipment [37]. Measurements were taken with the subjects in light clothing and without shoes. Measurements were taken twice, and the average of the measurements was used as the final reading. Waist circumference was measured at the midway point between the lowest rib and the iliac crest to the nearest 0.1 cm. Weight was measured in kilograms to the nearest 0.5 kg. Height was measured in centimeters to the nearest of 0.5 cm on a portable stadiometer. Body mass index (BMI) was calculated via the use of the following formula: BMI = weight (in kilograms)/height (in meters)^2; a BMI of 25 or greater was considered as an obese BMI. Measurements were ranked based on the World Health Organization's (WHO's) ethnic-specific guidelines [38]. Importantly, literature has established that South Asians are susceptible to the development of metabolic syndrome at an even lower waist circumference when compared with other ethnic populations. In light of this, the WHO has established different BMI criteria for Asians, where a BMI of 23 is considered overweight and a BMI of 25 or more is considered obese [37-39].

2.4.2. Physical activity measurement

Physical activity was measured by pedometer (OMRON HJ-005, Bannockburn, IL). All subjects were requested to clip the pedometer to the top of their pants, as units must have been horizontal to the ground for them to function correctly. Baseline data on the subjects' physical activity levels were collected from 9 AM to 9 PM every day (subjects only ever removed the pedometers for water activities, such as having a shower) for 5 consecutive days, and an average of the steps per day was calculated.

2.4.3. Blood pressure measurements

The blood pressure (both systolic and diastolic) of all subjects was measured using an automated digital BP monitor (OMRON T5) that was cuffed to the right arm of each subject. The participants were allowed to rest for 5 minutes before the taking of blood pressure measurements; readings were taken twice (5 minutes apart), and the average was recorded. *Hypertension* was defined as "the presence of a systolic blood pressure of 135 or greater and a diastolic blood pressure of 85 or above, or the use of hypertensive medication" [1].

2.4.4. Biochemical measurements

Ten milliliters of venous blood samples was collected from the right arm of subjects in a resting seated position; blood was collected from the antecubital vein via the venipuncture technique (Becton Dickson blood collection set, North Ryde, NSW, Australia). Blood sampling was performed early in the morning after a 12-hour fast. Blood was collected in both serum separator tubes (for serum determination) and fluoride oxalate (for plasma determination). Blood was transported to the laboratory on ice packs within 2 hours of collection. Blood was then centrifuged at 3000*g* for 10 minutes. Serum was then collected into aliquots and frozen at −80°C for further analysis of total cholesterol, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol, and triglycerides. Similarly, plasma was collected into aliquots and kept frozen at −80°C for further analysis of blood insulin and glucose.

Total serum cholesterol, HDL-C, and plasma triglycerides were determined via the use of colorimetric kits (Thermo

Table 1
Anthropometric and blood measurements

Variables	Week 0	Week 12	Week 24	*P* value
Physical activity (steps per day)	4000 ± 22.6 Range, 2000-5500	4484.1 ± 167.4 Range, 2612-6000	8617.4 ± 596.8 Range, 8000-12560	4.1×10^{-9}
BMI (kg/m^2)	29.2 ± 0.46	29.14 ± 0.46	27.8 ± 0.45	.043
Total cholesterol (mmol/L)	6.8 ± 0.15	6.63 ± 0.14	5.5 ± 0.10	4.1×10^{-9}
Triglycerides (mmol/L)	2.9 ± 0.09	2.6 ± 0.08	1.97 ± 0.10	1.9×10^{-8}
Plasma glucose (mmol/L)	6.4 ± 0.33	6.3 ± 0.31	5.9 ± 0.33	5.1×10^{-7}
Plasma insulin (μU/mL)	45 ± 6.3	48.711 ± 4.5	24.14 ± 1.8	1.1×10^{-11}

Mean values for physical activity, blood pressure, BMI, blood lipids, plasma glucose, and plasma insulin for all subjects over the course of the intervention. Values are mean ± SEM.

Electron, Sydney, Australia) in accordance with the manufacturer's instructions. Low-density lipoprotein cholesterol was then calculated via the Friedewald and Fredrickson equation [40]. Fasting plasma insulin was measured via the use of the Linco Human Insulin RIA Kit (Linco Research, St. Charles, MO) in accordance with the manufacturer's instructions. Plasma glucose was determined using a commercial glucose oxidase reagent and standard (Thermo Electron) following the manufacturer's instructions.

2.5. Statistical analysis

The SPSS statistical package (version 12.0; SPSS, Chicago, IL) was used for the purposes of statistical analysis in this study. The study power was calculated to detect a difference due to the intervention of a 9% fall in systolic blood pressure, on the basis of a previous pilot study. All data were expressed as mean ± standard error of mean (SEM). Data collected at weeks 0, 12, and 24 were analyzed using *t* tests. A *P* value less than .05 was considered statistically significant. The project was approved by the Human Ethics Committee of Victoria University (HRETH.SET 04/03).

3. Results

The attrition rate for this study was 25%. Initially, 53 subjects were selected; however, 13 withdrew. All participants who withdraw from the study did so before the commencement of the intervention at week 12; data pertaining to withdrawn participants were excluded from week 12 to week 24 comparisons. Results were derived from 40 subjects in total. The group selected for participation in this study had a mean age of 37.6 ± 4.3 years. The number of years residing in Australia ranged from 5 to 17 years. All subjects were married, with 2 to 6 children, and residing with their husband or in-laws. All subjects had completed primary and secondary education; half the participants had also some form of tertiary education. Fifty percent of the participants were fluent (able to communicate, read, and write efficiently) in English, 25% were average (able to communicate, read, and write at a basic level), and the final 25% had poor (unable to communicate, read, or write) English skills.

Our results are indicated in Table 1. They show that, before intervention, participants were sedentary, taking 4000 ± 22.6 steps per day, and were obese based on the WHO criteria for Asians, with an average BMI of 29.2 ± 0.46 kg/m^2 and high waist circumference of 132 ± 25.95 cm. Participants were hypertensive (systolic, 135 ± 1.3 mm Hg; diastolic, 86 ± 0.68 mm Hg) (Fig. 1) and dyslipidemic, displaying high levels of cholesterol and triglycerides (6.8 ± 0.15 and 2.9 ± 0.09 mmol/L, respectively). Consistent with dyslipidemia, HDL levels were also low, at 0.94 ± 0.07 mmol/L. Furthermore, blood glucose (6.4 ± 0.33 mmol/L) and fasting blood insulin (45 ± 6.3 μU/mL) levels were high. At week 12, the above-mentioned parameters were remeasured and analyzed. No significant differences in the measured risk factors were observed after the control period of 12 weeks.

At week 24 (end of the intervention of period), there were significant improvements in physical activity (8617.4 ± 596.8 steps per day), BMI (27.8 ± 0.45 kg/m^2), and blood pressure (systolic, 125 ± 1.4 mm Hg; diastolic, 80 ± 0.6 mm Hg.) ($P < .05$, Fig. 1). Average cholesterol levels were significantly reduced (5.5 ± 0.10 mmol/L) ($P < .05$); similarly, triglyceride levels were reduced to 1.97 ± 0.10 mmol/L ($P < .05$). Furthermore, blood glucose and blood insulin levels were

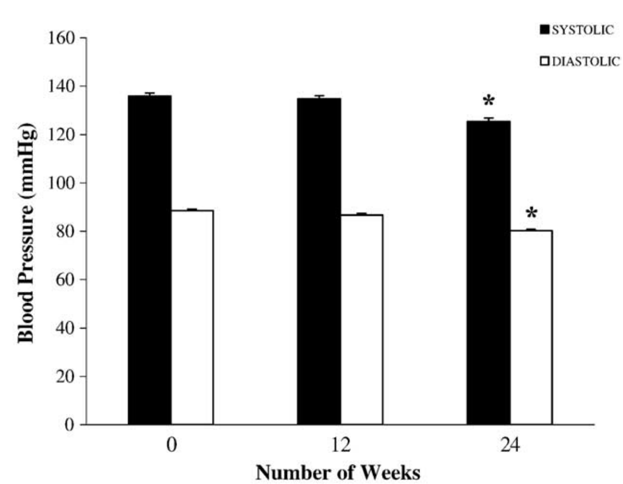

Fig. 1. Mean systolic and diastolic blood pressure measurement (in millimeters of mercury) from 40 subjects. Week 0 represents the baseline data at the time of collection, week 12 represents the beginning of the intervention program, and week 24 represents the completion of the intervention. Data presented as mean ± SEM of blood pressure values. *Significant change after the intervention at week 24. $P < .001$.

significantly reduced to 5.9 ± 0.33 mmol/L ($P < .05$) and 24.14 ± 1.8 μU/mL ($P < .05$), respectively.

4. Discussion

The major outcome of this study was the development and trial of a successful intervention for the treatment of the metabolic syndrome in a high-risk ethnic population. To our knowledge, this is the first intervention directed at treating the risk factors of metabolic syndrome using a culturally appropriate lifestyle intervention in Pakistani immigrant women. Chowdhury and colleagues [41] have highlighted the importance of the prevention of diabetes, cardiovascular disease, and, implicitly, metabolic syndrome in South Asians. These authors also commented on the limited research into how healthy lifestyle education, improved dietary information, and increased physical activity can be implemented in this community [27]. In the current study, the principles of cultural competence were applied to overcome the cultural barriers in place for Pakistani women to make the lifestyle changes necessary to lose weight and reduce the risk of metabolic syndrome. Cultural competence is "a set of congruent behaviours, attitudes and policies that come together in a system, agency, or among professionals and enable that system, agency or those professions to work effectively in cross cultural situations" [33]. However, the principles of cultural competence have not been widely applied to diet and exercise interventions for migrant populations; and no such intervention studies exist for Pakistanis. Various cultural and sex barriers exist for female Pakistanis attempting lifestyle change to reduce weight and improve health; importantly, no studies that we know of have addressed these barriers previously [16].

Baseline data from this study suggest that our target population has the various risk factors for metabolic syndrome; this was expected, as the presence of factors contributing to metabolic syndrome was a part of the inclusion criteria. Our results have shown that the average BMI of participants were classified as obese; and, on average, participants had high levels of abdominal obesity and had hypertension, dyslipidemia (elevated triglycerides and decreased levels of HDL-C), increased levels of blood cholesterol, and elevated fasting plasma insulin and glucose. Thus, as expected, all the requisite components of metabolic syndrome were observed in the female Pakistani population investigated. Research has indicated that increased levels of fasting insulin and the presence of dyslipidemia are characteristics of South Asian blood analyses [18-20]. Research has indicated that a high fasting insulin level is a strong predictor of cardiovascular disease; it can also be used as an estimation of insulin sensitivity. It was also demonstrated in the Quebec Cardiovascular Study that hyperinsulinemia is an independent risk factor for ischemic heart disease in men. Furthermore, it has been suggested that the presence of high fasting insulin levels in South Asians is indicative of an underlying state of insulin resistance [42]. In fact, it has been suggested that plasma insulin levels in migrant Indians are 2-fold higher when compared with those in Europeans (41 vs 19 μU/mL) [19]. However, these studies were not clear as to whether their findings were applicable to both sexes or to the male/female population alone.

4.1. Limitations of the study

The intervention developed in this study could be applied to any other ethnic groups, with certain limitations. Limited in the sense that this intervention must be modified to suit the population being examined. As discussed in this paper, the prevalence of metabolic syndrome and cardiovascular disease is quite high in Pakistani immigrant populations; thus, it is quite likely that the same intervention program used in this study could successfully be used in other Pakistani immigrant populations. This could occur within the absence of a control group, which was in part addressed by the use of a 12-week run-in period.

Another limitation is the general sex bias observed in this study. Men were not examined for cultural and social reasons. The researcher responsible for data collection in this project was female; this presents difficulties in terms of communication and interaction with men. Despite this, it is emphasized that this study was designed specifically for women. Pakistani women are primarily responsible for food preparation; thus, the education of women was seen as the best method in providing overall benefits to the entire family.

Representativeness of the sample: It is submitted that this select sample is fairly representative of the Pakistani community residing in Melbourne, Australia, although precise data regarding age, number of years residing in Australia, and employment status cannot be easily obtained for comparative purposes. The application of the culturally competent diet and lifestyle program developed in the current study is unlikely to find use in other populations in its current form because it was specifically designed for use with Pakistani women. It may find application with a larger sample of Pakistani women, as the interaction with a facilitator of the same culture is an important component of the intervention. Furthermore, a longer-term follow-up also needs to occur to test the sustainability of the intervention.

A final limitation of this study was the type of physical activity that participants could engage in. As discussed in this paper; participants were not able to access public leisure facilities and were therefore limited to walking. It would be possible to achieve even more significant results if the physical activity component of the intervention program was vigorous in nature.

4.2. Future research

Intensive research has been conducted on human nutrition; however, there is still limited evidence as to how to develop suitable dietary and physical activity interventions for CALD migrant groups [14]. Many studies have recommended lifestyle modification as a means of losing weight and maintaining overall good health, but more research is required to develop best practice with these populations.

It is strongly suggested that future studies of similar nature should be conducted on a larger scale, in affiliation with medical centers. Furthermore, such studies should be conducted over a longer period, thus allowing for an assessment of the long-term sustainability of any such diet and lifestyle intervention.

4.3. Conclusion

This study has demonstrated that the implementation of a culturally appropriate diet and lifestyle intervention in a metabolic syndrome–affected population can actively reduce and limit the effect and severity of the syndrome. Our findings are consistent with the findings of other research studies with high body fat levels, disturbed lipid profiles, and high fasting insulin levels, as can be seen consistently across Pakistani populations. Diet and lifestyle modification is the first line of defense against various chronic diseases, metabolic syndrome included. Culturally appropriate diet and lifestyle intervention programs ideally should be implemented at an early stage (preferably on migration) so as to encourage healthy eating and physical activity. Education in the migrants' native language is necessary to create awareness about metabolic syndrome and preventative measures so as to reduce the impact and effects of obesity on various populations. Furthermore, leisure activities in which individuals from culturally sensitive backgrounds can participate should be promoted as a means of endorsing a physically active lifestyle.

References

[1] Expert Panel On Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults. Executive summary of the third report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). JAMA 2001;285:2486-97.

[2] Stone NJ, Saxon D. Approach to treatment of the patient with metabolic syndrome; lifestyle therapy. Am J Cardiol 2005;96:15-21.

[3] Lakka HM, Laaksonen DE, Tuomilehtho J. The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. JAMA 2002:2709-16.

[4] Cameron AJ, Dianna J, Magliano DJ, Zimmet PZ, Welborn T, Shaw JE. The metabolic syndrome in Australia: prevalence using four definitions. J Diabres 2007;02:002.

[5] Carr DB, et al. Intra-abdominal fat is a major determinant of the National Cholesterol Education Program Adult Treatment Panel III criteria for the metabolic syndrome. Diabetes 2004;53: 2087-94.

[6] Reaven GM. Role of insulin resistance in human disease. Diabetes 1988;37:1595-607.

[7] Despres JP. Abdominal obesity as important component of insulin resistance syndrome. Nutrition 1993;9:452-9.

[8] Lorenzo C, et al. Central adiposity determines prevalence differences of the metabolic syndrome. Obes Res 2003;11:1480-7.

[9] Misra A, Vikram NK. Insulin resistance syndrome (metabolic syndrome) and obesity in Asian Indians: evidence and implications. Nutrition 2004;20:482-91.

[10] Banerji MA, Faridi N, Atluri R, Rochelle LC, Lebovich HE. Body composition, visceral fat, leptin, and insulin resistance in Asian Indian men. J Clin End Metab 1999;84:137-44.

[11] Tillin T, Forouhi N, Johnston DG, McKeigue PM, Chaturvedi N, Godsland IF. Metabolic syndrome and coronary heart disease in South Asians, African-Caribbeans and white Europeans: a UK population-based cross-sectional study. Diabetologia 2005;48:649-56.

[12] Williams R, Bhopal R, Hunt K. Health of Punjabi ethnic minority in Glasgow: a comparison withe general population. JECH 1993;47:96-102.

[13] Pomerleau J, McKeigue PM, Chaturvedi N. Factors associated with obesity in South Asian, Afro-Caribbean and European women. Int J Obes Relat Metab Disord 1999;23:25-33.

[14] McKeigue PM. Metabolic consequences of obesity and body fat pattern: lessons from migrant studies. Ciba Found Symp 1996;201: 54-64, 188-193.

[15] Jafar TH, et al. Ethnic differences and determinants of diabetes and central obesity among South Asians of Pakistan. Diabetes Medicine 2004;21:716-23.

[16] Mellin-Olsen T, Wandel M. Changes in food habits among Pakistani immigrant women in Oslo, Norway. Ethnicity and Health 2005;10:311-39.

[17] Farooqi A, et al. Attitudes to lifestyle risk factors for coronary heart disease amongst South Asians in Leicester: a focus group study. Fam Pract 2000;17:293-7.

[18] McKeigue PM, Pierpoint T, Ferrie JE, Marmot MG. Relationship of glucose intolerance and hyperinsulinaemia to body fat pattern in South Asians and Europeans. Diabetologia 1992;35:785-9.

[19] Ramachandran A. Diabetes and obesity—the Indian angle. IJMR 2004:661-7.

[20] McKeigue PM, Shah B, Marmot MG. Relation of central obesity and insulin resistance with high diabetes prevalence and cardiovascular risk in South Asians. Lancet 1991;337:382-6.

[21] Kolt GS, Schofield GM, Rush EC, Oliver M, Chadha NK. Body fatness, physical activity, and nutritional behaviours in Asian Indian immigrants to New Zealand. Asia Pac J Clin Nutr 2007;16:663-70.

[22] Grundy SM, Cleeman JI, Daniels SR. Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung and Blood Institute Scientific Statement. Circulation 2005;112:2735-52.

[23] Grant RW, Meigs JB. The management of metabolic syndrome. Panminvera Medica 2005;47:219-28.

[24] Thompson PD, et al. Exercise and physical activity in the prevention and treatment of atherosclerotic cardiovascular disease. Circulation 2003;346:393-403.

[25] Clinical guidelines on the identification, evaluation and treatment of overweight and obesity in adults—the evidence report, National Institutes of Health. Obes Res 1998;6:51S-209S.

[26] Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults. Third report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III): final report. Circulation 2002;106:3143-421.

[27] O'Hare JP, et al. Evaluation of delivery of enhanced diabetes care to patients of South Asian ethnicity: the United Kingdom Asian Diabetes Study (UKADS). Diabet Med 2004;21:1357-65.

[28] Chaturvedi N, McKeigue PM. Method for epidemiological surveys of ethnic minority groups. JECH 1994;48:107-11.

[29] Rankin J, Bopal R. Understanding of heart disease and diabetes in a South Asian community: cross-sectional study testing the 'snowball' sample method. Public Health 2001;115:253-60.

[30] ABS (2001-b) "Migration Australia 1999-2000." Abc Cat No 3412.0 Canberra: ABS.

[31] The National Nutrition Survey (NNS) 1995 Australia, (ABS Cat. No. 4802.0).

[32] The National Heart Foundation Australia. Risk factor prevalence study. Survey number 3 1989, Canberra. National Heart Foundation of Australia and Australian Institute of Health. 141.

[33] National Health and Medical Research Council (NHMRC). Cultural competency in health: a guide for policy, partnerships and participation. Canberra: Commonwealth of Australia; 2005.
[34] National Health and Medical Research Council (NHMRC). Increasing cultural competency for healthier living and environments. *NHMRC Discussion Paper* 2005.
[35] Easing the transition: a resource guide for health and settlement workers, supporting those who have recently arrived in Australia to maintain a healthy lifestyle. The Victorian Foundation for Survivors of Torture; 2000.
[36] Change of heart. Deakin University and South West Primary Care Partnership, Victoria 2004.
[37] World Health Organisation, Western Pacific Region. The Asia-Pacific perspective. Redefining obesity and its treatment. WHO/IASO/IOTF; 2000.
[38] World Health Organisation. The Asia-Pacific perspective. Redefining obesity and its treatment. International Diabetes Institute, Health Communication Australia Pty Ltd; 2000.
[39] World Health Organisation. Measuring obesity. Classification and description of anthropometric data. Report on a WHO consultation on the epidemiology of obesity. Copenhagen, Denmark: WHO Regional Office for Europe, Nutrition Unit; 1988.
[40] Friedewald WT, Levy RI, Fredrickson DS. Estimations of the concentration of low-density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clin Chem 1972;18:499-502.
[41] Chowdhury TA, Grace C, Kopelman PG. Preventing diabetes in South Asians. BMJ 2003;327:1059-60.
[42] Lemieux L, et al. Total cholesterol/HDL cholesterol ratio vs LDL cholesterol/HDL cholesterol ratio as indices of ischemic heart disease risk in men (The Quebec Study). Arch Intern Med 2001;161:2685-92.