

Metabolic syndrome and insulin resistance in an urban and rural adult population in Sri Lanka

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Abstract

Background: To assess the prevalence of metabolic syndrome and insulin resistance in an urban and rural population in Sri Lanka.

Methods: A cross sectional study conducted in 3 health areas selected randomly, one in rural and 2 in urban. In each sector, 180 adults between 30-59 years equally from both sexes were included. Blood pressure, weight, height and waist circumference were measured in each participant. Fasting blood samples were taken to assess plasma glucose (FPG), triglyceride (TG), high density lipoprotein (HDL), insulin and HbA1C. Insulin resistance was detected by the homeostasis model assessment method (HOMA-IR).

Results: From total 345 participants, 46.1% were men and 52.9% women. Prevalence of metabolic syndrome was 25.8% (23.9% in men and 27.4% in women; $P = 0.27$). Prevalence of each component of MetS in studied population was: 62.9% for central obesity, 28.1% for high TG, 35.9% for low HDL, 40% for high BP, 18.8% for high FPG, 3.9% for high HbA1C, 44.1% for overweight and 9.3% for obesity. Hyperinsulinaemia and insulin resistance was 26.9% and 22.3% respectively. Age, high BMI, waist circumference, FPG, TG, BP, HbA1C, insulin and low HDL significantly higher with subjects with MetS ($P = 0.000$). Hyperinsulinaemia and insulin resistance was significantly higher in rural sector, obese, centrally obese, high BP and high TG subjects.

Conclusion: One fourth of study population had metabolic syndrome, hyperinsulinaemia and insulin resistance. Metabolic syndrome was strongly associated with hyperinsulinaemia and insulin resistance. Need urgent action to reduce risk in developing type-2 diabetes and cardiovascular diseases in this population.

Keywords: metabolic syndrome, insulin resistance, hyperinsulinaemia

Introduction

Metabolic syndrome (MetS) is a complex disorder with high socioeconomic cost that is considered a worldwide epidemic. The metabolic syndrome is a cluster of the most dangerous heart attack risk factors: diabetes and raised fasting plasma glucose, abdominal obesity, high cholesterol and high blood pressure (1-3). Although there are various definitions for metabolic syndrome, recent review concluded that the definition incorporating International Diabetes Federation (IDF) and American Heart Association / National Heart, Lung and Blood Institute (AHA / NHLBI) is the most suitable for practical use in clinical medicine (1).

People with metabolic syndrome are twice as likely

to die from and three times as likely to have heart attack or stroke and have a fivefold greater risk of developing type 2 diabetes compared with people without the syndrome (4). In addition, there is a five fold greater risk of developing type 2 diabetes. MetS would add to the 230 million people worldwide who already have diabetes, one of the most common chronic diseases worldwide and the fourth or fifth leading cause of death in the developed world. The clustering of cardiovascular disease (CVD) risk factors that typifies the metabolic syndrome is now considered to be the driving force for a new CVD epidemic.

Insulin resistance is associated with multiple risk factors for atherosclerosis, including hypertension, dyslipidemia, and glucose intolerance or type 2 diabetes mellitus. Clustering of these risk factors in subjects with

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obesity has been called “syndrome X” (5), “deadly quartette” (6), “insulin resistance syndrome” (7), or “visceral fat obesity syndrome” (8). Hyperinsulinemia is a good marker of insulin resistance in subjects without significant hyperglycemia and is used for epidemiologic studies.

Insulin resistance and central obesity are considered as significant underlying factors of MetS, which predisposes the global epidemics of type 2 diabetes and cardiovascular diseases (CVD). Genetics, physical activity, ageing, a pro-inflammatory state and hormonal changes may also have a causal effect, but the role may depend on ethnicity (9).

It is estimated that around 20-25 percent of the world’s adult population have metabolic syndrome (4). Prevalence of metabolic syndrome has been reported to be between 12.8% to 41.1% in different parts of the world (10,11). Studies in Sri Lanka showed that the prevalence of metabolic syndrome was between 27.1% to 29.5% (12,13). Many factors including: female gender, increasing age, urban living, higher socio-economic status and physical inactivity were reported as important associated factors (12). According to the World Health Organisation, Non Communicable Diseases (NCDs) are estimated to account for 65% of all deaths in Sri Lanka, accounting 30% of CVD and 4% of diabetes. About 39%, 9%, 22% and 5% of adults are suffering from raised blood pressure, raised blood sugar, overweight and obesity respectively (14).

However, early identification of patients and treatment with appropriate medical and educational programs can be an effective step in controlling and reducing the incidence of metabolic syndrome and in turn cardiovascular diseases and diabetes. In Sri Lanka, last national survey was conducted in 2005-2006. The aim of this study was to assess the recent prevalence of MetS and insulin resistance in an urban and rural population in Sri Lanka to implement suitable interventions to prevent development of diabetes and cardiovascular diseases.

Materials and methods

The study population was healthy adults (both male and female) between 30-59 years. Calculated sample size was 360; 180 from each urban and rural sector considering 27% of the prevalence of MetS, 95% of precision, 1.1 design effect and 10% non-response rate. A total of 360 adults; 180 from each sector were included in the study. Three Medical Officer of Health (MOH) areas were selected from the Western Province; 2 urban and 1 rural. Ten Public Health Midwives (PHM) were randomly selected from each MOH area to draw the sample. Each selected PHM in the urban MOH areas and rural MOH areas were asked to recruit 9 and 18 healthy adults respectively within the PHM area, starting from randomly selected one starting

point, equal numbers from male and female, from each age groups (30-39, 40-49 and 50-59). All the selected adults were asked to attend the relevant MOH office on the predetermined date. Body weight, height and waist circumference were checked. Body mass index (BMI) was estimated as weight in kilograms/height in meters (2). BMI was categorized using both WHO (15) and Asian (16) cut-off levels for comparison purposes. Blood pressure (BP) was measured by a standardized automated measurement system after the participant had been seated for 5 minutes. The mean of 2 readings was used for analysis.

After 12 hour of fasting, blood samples were taken in the morning. All blood samples were labeled and dispatched to the MRI laboratory and samples were centrifuged. Then serum samples were frozen without preservative at $\leq 20^{\circ}\text{C}$ and sent to the laboratory of Mickagowa University, Japan for analysis in dry ice. Triglyceride (TG), fasting plasma sugar (FPG), high density lipoprotein (HDL), HbA1C and plasma insulin level were measured using an enzymatic colorimetric method with kits. New International Diabetes Federation definition was used to define MetS for this study (17). Metabolic syndrome was defined as presence of central obesity (defined as waist circumference ≥ 90 cm for male and ≥ 80 cm for female) plus any two of the following four factors. High triglycerides – TG ≥ 150 mg/dl; low HDL cholesterol – HDL < 40 mg/dl in males and < 50 mg/dl in females; high blood pressure – BP systolic ≥ 130 mmHg or BP diastolic ≥ 85 mmHg; high fasting plasma glucose – FPG ≥ 100 mg/dl.

Hyperinsulinaemia was defined as fasting plasma insulin level $\geq 10\mu\text{IU}/\text{MI}$ (18). Overweight, obesity, and high HbA1C was defined as BMI ≥ 25.0 , BMI ≥ 30.0 (15) and $\geq 6.5\%$ respectively (19). Insulin resistance was assessed using the homeostasis model assessment (HOMA-IR) originally described by Mathew et al (20). HOMA-IR was calculated using the following formula: $\text{HOMA-IR} = (\text{mmol}/\text{L} \times \mu\text{U}/\text{ml}) / 22.5$. Insulin resistance was defined as HOMA-IR > 2.5 .

Study period was between February to June 2012. Ethical clearance was obtained from the ethical committee of Medical Research Institute. Differences were tested by using analysis of variance and chi square test; significance values were taken at 0.05 level. All data were analyzed by using SPSS for Windows, version 16.0 (SPSS Inc, Chicago).

Results

A total 345 study subjects were included in the study and response rate was 95.8%. From total participants, 159 (46.1%) were men and 186 (53.9%) women. Table 1 shows

that the prevalence of metabolic syndrome was 25.8% and there was no significant difference between men and women (23.9% in men and 27.4% in women; P=0.27). It showed significantly increased prevalence of metabolic syndrome with increasing age in total sample, and women. The highest prevalence of metabolic syndrome was seen in age group 50-59 years in total sample, in men and women (35%, 29% and 41% respectively).

Prevalence of each component of MetS in studied population was: 62.9% for central obesity, 28.1% for high TG level, 35.9% for low HDL, 40% for high BP, 18.8% for high FPG, 3.9% for high HbA1C, 26.9% for high insulin, 44.1% for overweight and 9.3% for obesity (Table 2). It showed increased prevalence of central obesity with increasing age. The prevalence of central obesity was significantly higher in women than in men (77.4% vs 45.9%; P=0.000). Central obesity showed highest prevalence in age group 50-59 years in total sample, in men and women (68.3%, 51.6% and 85.2% respectively). High TG and high FPG was significantly more prevalent in men than women

(37.1% vs 20.4%; P=0.000, and 27% vs 11.8%; P=0.000 respectively). Conversely low HDL, overweight and obesity was significantly higher in women than men (44.6% vs 25.8%; P=0.000, 50.5% vs 36.5%: P=0.006 and 13.4% vs 4.4%: P=0.003 respectively). The highest prevalence of high BP, high FPG and high insulin was seen in age group of 50-59.

In total study subjects, 30.4% were normal (none of the MetS components were present), 30.1% had one component, 18% two, 6.4% three, 2.9% four and 12.3% had five components of metabolic syndrome (Table 3).

Factors that can affect the prevalence of MetS are shown in Table 4. Among these factors, age, BMI, waist circumference, systolic BP, diastolic BP, FPG, HDL, TG, insulin, HbA1C and HOMA-IR were significantly higher in study subjects with MetS than without (P = 0.00). Sex, area of residence and LDL level showed no significant differences between subjects with MetS and without MetS (P>0.05).

Table 1. Prevalence of metabolic syndrome according to sex and age group

Age groups in years	N	No. of MetS (%)	Confidence interval (CI)
30-39	16	15.1	11.3-18.9
40-49	30	25.9	21.3-30.5
50-59	43	35.0	29.9-40.0
Total	89	25.8	21.2-30.4
Test Statistics		$\chi^2=10.5$; P=0.005	
	Men		
30-39	8	16.0	10.3-21.7
40-49	12	25.5	18.7-32.3
50-59	18	29.0	21.9-36.1
Total	38	23.9¹	17.3-30.5
Test Statistics		$\chi^2=2.9$; P=0.23	
	Women		
30-39	8	14.3	9.3-19.3
40-49	18	26.1	19.8-32.4
50-59	25	41.0	33.9-48.1
Total	51	27.4¹	20.9-33.8
Test Statistics		$\chi^2=9.2$; P=0.01	

($\chi^2=0.5$; **P=0.27**)¹

Table 2. Prevalence of each MetS component according to age and sex

Age	No. (%)								
	Central obesity	High TG	Low HDL	High BP	High FPG	High HbA1C	High insulin	Over weight	Obese
In years									
30-39	57 (53.8)	28 (26.4)	37 (34.9)	20 (18.9)	9 (8.5)	3 (3.6)	27 (25.7)	42 (39.6)	9 (8.5)
40-49	76 (65.5)	33 (28.4)	46 (39.7)	48 (41.4)	24 (20.7)	4 (4.2)	27 (23.7)	52 (44.8)	12 (10.3)
50-59	84 (68.3)	36 (29.3)	41 (33.3)	70 (56.9)	32 (26.0)	4 (4.0)	38 (30.9)	58 (47.2)	11 (8.9)
P values	$\chi^2=5.6$ P=0.06	$\chi^2=0.24$ P=0.89	$\chi^2=1.1$ P=0.56	$\chi^2=34.5$ P=0.000	$\chi^2=11.8$ P=0.003	$\chi^2=0.01$ P=0.6	$\chi^2=1.7$ P=0.4	$\chi^2=1.4$ P=0.5	$\chi^2=0.3$ P=0.9
Sex									
Male	73 (45.9)	59 (37.1)	41 (25.8)	65 (40.9)	43 (27.0)	5 (3.8)	40 (25.3)	58 (36.5)	7 (4.4)
Female	144 (77.4)	38 (20.4)	83 (44.6)	73 (39.3)	22 (11.8)	6 (4.0)	52 (28.3)	94 (50.5)	25 (13.4)
P values	$\chi^2=36.5$ P=0.000	$\chi^2=11.7$ P=0.000	$\chi^2=13.2$ P=0.000	$\chi^2=0.09$ P=0.4	$\chi^2=12.9$ P=0.000	$\chi^2=0.00$ P=0.6	$\chi^2=0.4$ P=0.3	$\chi^2=6.8$ P=0.006	$\chi^2=8.3$ P=0.003
Total	217 (62.9)	97 (28.1)	124 (35.9)	138 (40.0)	65 (18.8)	11 (3.9)	92 (26.9)	152 (44.1)	32 (9.3)
Male									
30-39	19 (38.0)	20 (40.0)	11 (22.0)	13 (26.0)	6 (12.0)	5 (3.2)	9 (18.0)	16 (32.0)	2 (4.0)
40-49	22 (46.8)	19 (40.4)	15 (31.9)	21 (44.7)	15 (31.9)	5 (3.2)	13 (28.3)	18 (38.3)	1 (2.1)
50-59	32 (51.6)	20 (32.3)	1 (24.2)	31 (50.0)	22 (35.5)	1 (1.9)	18 (29.0)	24 (38.7)	4 (6.5)
Test statistics	$\chi^2=2.1$ P=0.35	$\chi^2=1.0$ P=0.59	$\chi^2=1.4$ P=0.5	$\chi^2=6.9$ P=0.03	$\chi^2=8.5$ P=0.01	$\chi^2=0.04$ P=0.9	$\chi^2=2.1$ P=0.4	$\chi^2=0.6$ P=0.7	$\chi^2=1.2$ P=0.5
Female									
30-39	38 (67.9)	8 (14.3)	26 (46.4)	7 (12.5)	3 (5.4)	1 (2.2)	18 (32.7)	26 (46.4)	7 (12.5)
40-49	54 (78.3)	14 (20.3)	31 (44.9)	27 (39.1)	9 (13.0)	2 (3.5)	14 (20.6)	34 (49.3)	11 (15.9)
50-59	52 (85.2)	15 (26.2)	26 (42.6)	39 (63.9)	10 (16.4)	3 (6.4)	20 (32.8)	34 (55.7)	7 (11.5)
Test statistics	$\chi^2=5.1$; P=0.08	$\chi^2=2.6$; P=0.28	$\chi^2=1.8$; P=0.9	$\chi^2=32.4$; P=0.000	$\chi^2=3.6$; P=0.2	$\chi^2=1.1$; P=0.58	$\chi^2=3.1$; P=0.2	$\chi^2=1.2$ P=0.5	$\chi^2=0.6$ P=0.7

(Overweight = BMI \geq 25.0 and Obesity = BMI \geq 30.0)

Table 3. Prevalence of metabolic syndrome components and insulin resistance in studied population

No. of components	No.	%	Confidence interval (CI)
No any component	105	30.4	25.6-35.3
1 component	104	30.1	25.3-34.9
2 components	62	18.0	14.0-22.1
3 components	22	6.4	3.8-8.9
4 components	10	2.9	1.1-4.7
5 components	42	12.3	8.8-15.8
Insulin resistance (HOMA-IR)	342	22.3	19.8-28.9
Total	345	100.0	

Table 4. Relationship of MetS with associated factors

Associated factors	No. (%) with MetS		Total	P value
	Yes	No		
Age groups in years				
30-39	16 (18.0)	90 (35.2)	106	$\chi^2=11.7$; P=0.003
40-49	30 (33.7)	86 (33.6)	116	
50-59	43 (48.3)	80 (31.3)	123	
Sex				
Male	38 (42.7)	121 (47.3)	159	$\chi^2=0.5$; P=0.27
Female	51 (57.3)	135 (52.7)	186	
Area of residence				
Urban	41 (46.1)	135 (52.7)	176	$\chi^2=1.8$; P=0.17
Rural	48 (53.9)	121 (47.3)	169	
BMI (kg/m²)				
<18.5	1 (1.1)	21 (8.2)	22	$\chi^2=23.1$; P=0.000
18.5-24.9	30 (33.7)	140 (54.7)	170	
25.0-29.9	44 (49.4)	76 (29.7)	120	
≥30.0	14 (15.7)	19 (7.4)	33	
BMI Asian cut-off values (kg/m²)				
<18.5	1 (1.1)	21 (8.2)	22	$\chi^2=23.2$; P=0.000
18.5-22.9	16 (18.0)	84 (33.8)	100	
23.0-24.9	14 (15.7)	56 (21.9)	70	
≥25.0	58 (65.2)	95 (37.1)	153	
Total	89 (25.8)	256 (74.2)	345	
Mean (SD)				
BMI (kg/m ²)	26.4 (3.9)	23.9 (4.0)	24.6 (4.1)	F=; P=0.000
Waist circumference (cm)	94.2 (7.9)	85.3 (10.2)	87.6 (10.4)	F=; P=0.000
FPG (mg/l)	102.6 (28.7)	91.7 (22.9)	94.5 (24.9)	F=; P=0.000
TG (mg/l) 170.4 (73.6)	110.1 (61.5)	125.6 (69.9)	F=; P=0.000	
HDL (mg/l)	44.5 (10.0)	50.3 (10.1)	48.8 (10.3)	F=; P=0.000
LDL (mg/l)	153.5 (37.9)	144.6 (35.9)	146.9 (36.5)	F=; P=0.05
Systolic BP (mmHg)	136.8 (14.6)	121.8 (15.9)	125.7 (16.9)	F=; P=0.000
Diastolic BP (mmHg)	81.1 (11.0)	72.1 (11.0)	74.4 (11.7)	F=; P=0.000
HbA1C level (%) (n=279)	4.3 (1.4)	3.9 (1.2)	4.0 (1.2)	F=; P=0.01
Plasma insulin level (μIU/mL)	10.7 (10.5)	6.9 (4.4)	7.9 (6.7)	F=; P=0.000
HOMA-IR (n=342)	2.72 (2.8)	1.65 (1.9)	1.93 (2.2)	F=; P=0.000

Table 5 shows that prevalence of hyperinsulinaemia was 26.9% and no significant difference between men and women (25.3% in men and 28.3% in women). The highest prevalence of hyperinsulinaemia was seen in age group 50-59 years (30.9%). The prevalence of hyperinsulinaemia was significantly higher in study subjects living in rural sector (33.1% vs 21%; $P=0.01$), having metabolic syndrome (46.6% vs 20.1%; $P=0.000$), central obesity (33% vs 16.5%; $P=0.001$), high BP (26.2% vs 20.6%; $P=0.001$), low HDL (34.7% vs 22.6%; $P=0.01$) and high TG (34.4% vs 24%; $P=0.04$). The highest

prevalence of hyperinsulinaemia was seen in obese subjects according to both WHO and Asian classification (42.4% and 36.8% respectively).

Prevalence of insulin resistance was 22.3% and significantly higher in study subjects with metabolic syndrome (44.3% vs 14.6%; $P=0.000$), obesity (33.3% vs 31.1% and 16.1%; $P=0.002$), central obesity (26.5% vs 15.1%; $P=0.009$), high BP (30.7% vs 16.7%; $P=0.002$) and high TG (33.3% vs 18%; $P=0.002$) as shown in Table 5.

Table 5. Prevalence of hyperinsulinaemia and insulin resistance in MetS associated factors

Associated factors	Total	Hyperinsulinaemia		P value	HOMA-LR	
		No. (%)	95% CI		No. (%)	P value
Age groups in years						
30-39	105	27 (25.7)	21.7-30.3	$\chi^2=1.7$; $P=0.43$	19 (18.1)	$\chi^2=2.1$ $P=0.3$
40-49	114	27 (23.7)	19.2-28.2		25 (21.9)	
50-59	123	38 (30.9)	26.0-35.8		32 (26.2)	
Sex						
Male	158	40 (25.3)	20.7-29.9	$\chi^2=0.38$; $P=0.3$	35 (22.3)	$\chi^2=0.0$ $P=0.5$
Female	184	52 (28.3)	23.5-33.1		41 (22.3)	
Area of residence						
Urban	176	37 (21.0)	16.7-25.3	$\chi^2=6.4$; $P=0.008$	31 (17.7)	$\chi^2=4.3$ $P=0.03$
Rural	166	55 (33.1)	28.1-38.1		45 (27.1)	
Metabolic syndrome						
Yes	88	41 (46.6)	41.3-51.9	$\chi^2=23.4$; $P=0.000$	39 (44.3)	$\chi^2=33.2$ $P=0.000$
No	254	51 (20.1)	15.9-24.4		37 (14.6)	
BMI (kg/m²)						
<18.5	21	1 (4.8)	2.5-7.1	$\chi^2=17.7$; $P=0.001$	1 (4.8)	$\chi^2=15.1$ $P=0.002$
18.5-24.9	169	35 (20.7)	16.4-24.9		27 (16.1)	
25.0-29.9	119	42 (35.3)	30.2-40.4		37 (31.1)	
≥ 30.0	33	14 (42.4)	37.2-47.6		11 (33.3)	
BMI Asian cut-off						
<18.5	21	1 (4.8)	2.5-7.1	$\chi^2=17.7$; $P=0.001$	1 (4.8)	$\chi^2=16.1$ $P=0.001$
18.5-22.9	99	17 (17.2)	13.2-21.2		13 (13.3)	
23.0-24.9	70	18 (25.7)	21.1-30.3		14 (20.0)	
≥ 25.0	152	56 (36.8)	31.7-41.9		48 (31.6)	
Central obesity						
Yes	215	71 (33.0)	28.0-37.9	$\chi^2=11.0$; $P=0.001$	57 (26.5)	$\chi^2=5.9$ $P=0.009$
No	127	21 (16.5)	12.6-20.4		19 (15.1)	
High BP						
Yes	138	50 (26.2)	31.1-41.3	$\chi^2=17.7$; $P=0.001$	42 (30.7)	$\chi^2=9.2$ $P=0.002$
No	204	42 (20.6)	16.3-24.9		34 (16.7)	
Low HDL						
Yes	121	42 (34.7)	29.7-39.7	$\chi^2=17.7$; $P=0.01$	32 (26.7)	$\chi^2=2.1$ $P=0.09$
No	221	50 (22.6)	18.2-27.0		44 (19.9)	
High TG						
Yes	96	33 (34.4)	29.4-39.4	$\chi^2=3.8$; $P=0.04$	32 (33.3)	$\chi^2=9.4$ $P=0.002$
No	246	59 (24.0)	19.5-28.5		44 (18.0)	
Total	342	92 (26.9)	22.2-31.6		76 (22.3)	

Discussion

With the metabolic syndrome driving the twin global epidemics of type 2 diabetes and CVD there is an overwhelming moral, medical and economic imperative to identify those individuals with metabolic syndrome early, so that lifestyle interventions and treatment may prevent the development of diabetes and or CVDs (5). The results of this study showed that the prevalence of metabolic syndrome is high in studied population and it increases with increment of age and BMI significantly. The prevalence of MetS was 25.8% in this study which is lower than previous studies in Sri Lanka (27.1%) (12). This may be due to methodological and sampling differences between these studies. In DECODE study that was conducted in 9 European countries, MetS was detected in 32% of men and 28.5% of women (21). The prevalence of MetS has been reported in other parts of the world with different diagnostic criteria made the comparison difficult.

Prevalence of high BP (40%), high FPG (18.8%), overweight (44.1%) and obesity (9.3%) was higher in our sample than the prevalence estimated by the WHO in 2008 (39.2%, 8.8%, 21.9% and 5.1%) (14). However, high BP was lower (40%) in this study than the previous national study in 2006 (81.1%) (12). Prevalence of high TG in our study was 28.1%; 37.1% in men and 20.4% in women but in previous study it was 55.1% (12), in Sri Lanka. It may be due to different criteria used to define the components of MetS in these studies.

Relationship between associated factors and MetS showed very useful information for future actions. Our study identified that age, BMI, central obesity, FPG, TG, HDL, LDL, systolic BP, diastolic BP, HbA1C, plasma insulin, HOMA-I had significant relationship with MetS, but not with the area of residence. It was identified in some studies that many factors including: age, ethnicity, weight, menopause in women, smoking, low income economies, high carbohydrate intake, and low physical activity play a role in metabolic syndrome (22).

In most studies (23,24) increasing age was the key factor affecting the prevalence of metabolic syndrome and it was also shown in our study. Increasing in BMI was correlated with increasing prevalence of MetS, hyperinsulinaemia and insulin resistance in this study. This is in agreement with other studies (9). In this study, prevalence of metabolic syndrome was significantly higher in women than men as shown in other studies (12,23). This may be due to reduction of physical activity in Sri Lankan women which may cause higher rate of central obesity and low HDL. Strengths of our study was that it is a community based study including both urban and rural population of Sri Lanka. However, there was no difference of prevalence of MetS between urban and rural populations but rural subjects had significantly high level

of insulin resistance. One limitation was that, this study was cross sectional that does not allow us to draw any causal interference which indicates the need of a longitudinal study.

Nearly one third of our sample did not have any component of MetS which is lower than the previously reported figure (51%) (13). Presence of two or more components were noted in 27.3% of our sample compared to the previous study (25% between 20-40 years) (13). This information is very useful to make decision on appropriate population screening to prevent MetS in the future.

Prevalence of hyperinsulinaemia in our study was 26.9%, 25.3% in men and 28.3% in women and insulin resistance was 22.3%. Living in rural area, presence of metabolic syndrome, obesity, central obesity, high BP and high TG were strongly associated with both hyperinsulinaemia and insulin resistance.

Studies in the general population revealed that hyperinsulinemia is an early feature, of the cardiovascular clusters of MetS. It a surrogate marker to predict future development of MetS, but also the increased risk for future CVD as well (25). Therefore the results of our study strongly emphasise the urgent need of implementing lifestyle modifications for this population which help in reversing hyperinsulinaemia and insulin resistance to prevent MetS and CVD in the future.

Conclusions

Metabolic syndrome has high prevalence in our population and its prevalence increases with increasing age and BMI. Women are at higher risk for MetS than men. Metabolic syndrome was strongly associated with hyperinsulinaemia and insulin resistance. Strategies to reverse hyperinsulinaemia to reduce the risk in developing type-2 diabetes and cardiovascular diseases need to be identified.

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