Original Article

Body fat distribution and lipids profile of elderly in southern Jakarta

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A cross-sectional study on 222 elderly subjects was carried out at Health Centers in 10 subdistricts in south Jakarta, Indonesia. The anthropometric data (body mass index (BMI), body fat distribution), fasting blood glucose, serum total cholesterol, low density lipoprotein (LDL) cholesterol and triglycerides were assessed. There was a positive correlation between body fat distribution and serum lipid concentration (total cholesterol, LDL cholesterol and triglycerides). Body fat distribution appears to be a stronger determinant of serum lipids than BMI.

Key words: BMI, body fat distribution, elderly, Jakarta, Indonesia, LDL cholesterol, serum total cholesterol, triglycerides.

Introduction

Morbidity and mortality from cardiovascular disease (CVD) in developing countries is increasing rapidly. According to the Indonesian Household Health Survey 1992, mortality from CVD is the highest (16.4%) among all diseases causing death in total population and its occurrence is also the highest (33.2%) in the elderly group.[1] The Indonesian mortality pattern is similar in characteristics where its occurrence is common in industrialized society and CVD is the leading cause of death.[2] Dyslipidemia is one of many major risk factors of CVD that can be determined by the nutrition implication to body fatness.[2,3]

Intra-abdominal or central obesity has been known as the initiating factor to the occurrence of disorders of carbohydrate and lipid metabolism. This type of fatness induces insulin resistance and glucose intolerance, leading to reduced lipoprotein lipase (LPL) activity, increased concentration of serum triglycerides and other lipid fractions, such as low-density lipoprotein (LDL) cholesterol, total cholesterol and decreased level of high-density lipoprotein (HDL) cholesterol. Insulin resistance may also lead to increase the sodium absorption in the gastrointestinal tract, causing plasma volume expansion and eventually hypertension. These factors, namely abdominal obesity, insulin resistance, glucose intolerance, dislipidemia and hypertension are known as syndrome X, which constitutes a major risk factor for coronary heart disease.[4–7]

A number of studies have shown that intra-abdominal or visceral fatness has a close correlation with the abdominal to hip circumference ratio (AHR).[7,8] Therefore, the AHR can be used to estimate regional fat distribution.[9,10] Besides AHR, the ratio of sum of truncal skinfold (subscapular and suprailiac skinfold-SSiSF) to extremity skinfold (triceps and biceps-TBSF; SSiSF–TBSF ratio) can be used to estimate body fat distribution.[11] Thus, fat distribution indexes indicate the accumulation of fat in the body whether it tends to accrete centrally or peripherally.

Method

The population of this study included elderly persons 60 years old and over, who were registered as members of ‘elderly health program’ conducted by Health Centers in south Jakarta, Indonesia. This region was used based on the presumption that the socioeconomic state of the population was more proportionally composed and the register was better compared to other municipalities in Jakarta. More than 50% of elderly in this area, irrespective of their state of health, participated in this program. The program activities included weekly physical exercise and health screening. Simple random sampling was used to select the subjects of the study. Independent variables were sociodemography and anthropometry, while dependent variables included fasting blood glucose and serum lipid. The anthropometric assessments were measured twice, the mean values were used in analyses. Bodyweight (BW) was measured in kilograms to the nearest 0.1 kg, with light clothes on, using an electro-digital scale ‘Seca’ (alpha Hamburg, Germany). Height (Ht) was measured in centimetres to the nearest 0.1 cm, in

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standing position with socks and shoes removed, using a microtois (staturemeter). Abdominal, hip and mid upper arm circumference were measured in centimetres to the nearest 0.1 cm, using a flexible non-elastic tape (Butterfly, Jakarta, Indonesia). Abdominal circumference was measured at the midway region between the lowest rib margin and the iliac crest, in standing position with abdomen relaxed, feet together and weight equally devided over both legs. Hip circumference was measured at the point yielding the maximum circumference over the buttocks, in standing position with abdomen relaxed, feet together and weight equally divided over both legs. Mid upper arm circumference was measured at the midway region between the acromion process and the tip of the olecranon of the left arm, in standing position with the arm relaxed. Skin-fold: subscapular (SSF), suprailiac (SiSF), triceps (TSF) and biceps (BSF) were measured in millimetres to the nearest 0.2 mm, using a Harpenden caliper (John Bull British Indicator, St. Albans-Hert, England).[12–14] Body composition indexes were estimated from anthropometric data using equations as described in Table 1.[9–15] The adiposity of the body site was divided into three categories. (1) General adiposity is estimated by body mass index (BMI) and total fat mass (FM); (2) peripheral adiposity by hip circumference, TSF, BSF and mid upper arm fat area (MUAFA); and (3) central or abdominal adiposity by abdominal circumference, SSF and SiSF. Fat distribution was estimated using AHR and sum of SSF and SiSF to sum of TSF and BSF ratio (SSiSF-TBSF ratio). Central obesity was defined if the AHR value was 0.95 and 0.85 or above, in men and women, respectively.[9,11]

Fasting blood glucose (FBG) was measured by using the glucose oxidase method supplied by Boehringer, serum total cholesterol (TC) was measured using the cholesterol oxidase method supplied by Boehringer, LDL cholesterol (LDLC) was measured using the precipitation polyvinyl sulfate (PPS) method and serum triglycerides were measured using an enzymatic test. Glucose tolerance was defined as follows: normal if FBG is in the range of 70–115 mg/dL; impaired glucose tolerance (IGT) if FBG is 116–139 mg/dL; and diabetes mellitus type II if FBG ≥ 140 mg/dL.[15] Serum lipid concentration classification follows the recommendations of PERKENI (Indonesian Endocrinology Association; Table 2).[16] Some atherogenic indexes (TC/HDLC, TG/HDLC and LDLC/HDLC) were calculated from serum lipid concentration.[17]

Statistical analyses were done using χ^2 test, ANOVA or Student's *t*-test, Pearson partial correlation and multiple linear regression, using SPSS for Windows Version 6.0 computer software program. The period of study was from July 1996 to June 1997.

Table 1. Body composition indexes estimated by anthropometric data

Indexes	Equation
BMI (kg/m^2)[11,12]	$\frac{BW (kg)}{\{Ht (m)\}^2}$
AHR[8,9]	$\frac{\text{Abdominal circumference (cm)}}{\text{Hip circumference (cm)}}$
SSiSF–TBSF ratio[10]	$\frac{(SSF + SiSF)(mm)}{(TSF + BSF)(mm)}$
MUAMA (cm^2)[11,12]	$\frac{\{MUAC(cm) - \pi TSF(mm)\}^2}{4\pi}$
MUAFA (cm^2)[11,12]	$\frac{\{MUAC(cm)\}^2}{4\pi - MUAMA(cm^2)}$
BD men[13,14]	1.1715–0.0779 log sfSF
BD women[13,14]	1.1339–0.0645 log sfSF
FM (%)[13,14]	$\{(4.9/BD) - 4.5\} \times 100$
FM (kg)[13,14]	$BW(kg) \times FM(\%)/100$
FFM(kg)[13,14]	BW(kg) – FM(kg)

MUAMA, Mid upper arm muscle area; MUAFA, Mid upper arm fat area; BD, Body density; FM, Fat mass; FFM, Fat free mass; sfSF, Sum of four (subscapular, suprailliac, triceps and biceps) skinfold; BMI, body mass index; AHR, abdominal to hip circumference ratio.

Results

Two hundred and twenty-two elderly subjects (80 men and 142 women) were selected randomly in this study. Mean age of subjects was 66.4 years (67.8 years for men and 65.6 years for women). The subjects' education levels were as follows: low level of education less than 7 years were 44.2% (21.3% in men and 57.0% in women), middle- 7–12 years were 37.8% (40.0% in men and 36.6% in women) and other high education- more than 12 years were 18% (38.8% in men and 6.3% in women; Table 3).

The AHR index revealed that most of the subjects (53.6%) were classified as having abdominal (central) fatness. However, according to BMI categories formulated by Department of Health Republic of Indonesia (1995), 5.9% of them were classified as being underweight (BMI < 18.5 kg/m^2), 55.0% being ideal weight (BMI 18.5–24.9 kg/m^2), 32.9% being overweight (BMI 25.0–29.9 kg/m^2) and 6.3% being obese (BMI ≥ 30 kg/m^2). These categories have been modified from Food and Agricultural Organization/World Health Organization (FAO/WHO). The modification was based on clinical experiences and results of research in several developing countries.[18] The mean AHR was 0.93 and 0.86 and the mean BMI was 23.8 kg/m^2 and 24.0 kg/m^2 for men and women, respectively (Table 4).

Serum lipid levels revealed that the mean concentration of serum total cholesterol was 232.6 mg/dL, triglycerides 133.1 mg/dL, LDLC 124.1 mg/dL, HDLC 60.0 mg/dL and FBG 90.2 mg/dL of total subjects (Table 5).

The risk factors for coronary heart disease are shown in Table 6. There was a higher prevalence of smoking in elderly men (47.5%) than in elderly women (5.6%) ($P < 0.001$), while the prevalence of hypercholesterolemia (> 240 mg/dL) was higher in women than in men (50.0% *vs* 32.2%) ($P = 0.036$). The prevalence of syndrome X (abdominal obesity, glucose intolerance and dislipidemia) was higher in

Table 2. Classification of serum lipids[15]

Serum lipids	Desirable	Moderate	High
Total cholesterol (mg/dL)	< 200	200–239	≥ 240
LDL cholesterol (mg/dL)	< 130	130–159	≥ 160
HDL cholesterol (mg/dL)	> 45	35–45	< 35
Triglycerides (mg/dL)	< 200	200–399	≥ 400

LDL, low-density lipoprotein; HDL, high-density lipoprotein.

women than in men (6.3% *vs* 5.0%) (P = 0.017). The prevalence of other risk factors such as body composition (overweight, obesity and abdominal fatness), glucose intolerance, dislipidemia and hypertension were not significantly different among the elderly men and women.

Table 7 compares serum lipids and fasting blood glucose with the level of BMI. Using ANOVA, the differences of serum lipids and fasting blood glucose concentration in terms of BMI levels were not significant, except among elderly men, where there was definitely a higher atherogenic index (TC/HDLC and TG/HDLC; $P < 0.05$) in higher levels of BMI. However, Table 8 reveals that serum lipid levels in total subjects including total cholesterol, LDLC, triglycerides and FBG concentration were definitely higher ($P < 0.05$) in high

Table 3. The sociodemographic background of the subjects

Characters	Total (n = 222)	Men (n = 80)	Women (n = 142)
Age (year)†	66.38 ± 0.34	67.76 ± 0.56	65.58 ± 0.42
60–69*	159 (71.6)	50 (62.5)	109 (76.8)
70–79 *	58 (35.0)	28 (35.0)	30 (21.1)
≥ 80*	5 (2.2)	2 (2.5)	3 (2.1)
Marital status*			
Single	4 (1.8)	3 (3.8)	1 (0.7)
Married	135 (60.8)	63 (78.8)	72 (50.7)
Widow/Widower	83 (37.4)	14 (17.5)	69 (48.6)
Level of education*			
Low (< 7 years)	98 (44.2)	17 (21.3)	81 (57.0)
Middle (7–12 years)	84 (37.8)	32 (40.0)	52 (36.6)
High (> 12 years)	40 (18.0)	31 (38.8)	9 (6.3)
Employment status*			
Self-employed	24 (10.8)	10 (12.5)	14 (9.9)
In full-time paid employment	2 (0.9)	1 (1.3)	1 (0.7)
In part-time paid employment	18 (8.1)	6 (7.50	12 (8.5)
Not employed	178 (80.2)	63 (78.8)	115 (81.0)
Income(Rupiah)†	239 942 ± 19 315	321 565 ± 32 396	195 107 ± 23 296
Low* (< 132 422)	88 (40.0)	15 (19.2)	73 (51.4)
Middle*(132 422–636 187)	130 (59.1)	62 (79.5)	68 (47.9)
High* (> 1 636 187)	2 (0.9)	1 (1.3)	1 (0.7)
Live with‡			
Spouse*	134 (60.4)	64 (80.0)	70 (49.3)
Child/grandchild*	188 (84.7)	72 (90.0)	116 (81.7)
Brother/sister*	18 (8.1)	4 (5.0)	14 (9.9)
Other relative*	30 (13.5)	13 (16.3)	17 (12.0)

*Presented in n (%). † Mean ± Standard Error (SE). ‡ Living with: may be more than one category.

Table 4. Body composition and anthropometric data of the subjects by gender

Parameters	Total (n = 222)	Men (n = 80)	Women (n = 142)	P*
Weight (kg)	57.20 ± 0.70	62.63 ± 9.85	54.14 ± 10.63	< 0.001
Height (cm)	153.92 ± 0.55	161.94 ± 6.11	149.40 ± 5.30	< 0.001
BMI (kg/m^2)	24.06 ± 0.26	23.84 ± 3.27	24.17 ± 4.18	*NS*
TSF (mm)	11.73 ± 0.27	11.48 ± 3.12	11.88 ± 4.49	*NS*
BSF (mm)	6.35 ± 0.19	6.20 ± 2.11	6.44 ± 3.18	*NS*
SSF(mm)	14.50 ± 0.33	14.68 ± 4.05	14.40 ± 5.29	*NS*
SiSF(mm)	21.35 ± 0.50	28.88 ± 7.16	21.62 ± 7.66	*NS*
SSiSF–TBSF ratio	2.08 ± 0.04	2.05 ± 0.46	2.09 ± 0.67	*NS*
MUAFA(cm^2)	14.82 ± 0.45	14.43 ± 5.02	15.03 ± 7.39	*NS*
MUAMA (cm^2)	47.68 ± 0.75	48.27 ± 9.77	47.34 ± 11.97	*NS*
Fat mass (kg)	18.07 ± 0.38	17.10 ± 5.07	18.61 ± 5.83	0.050
Fat mass (%)	31.16 ± 0.38	26.76 ± 4.47	33.64 ± 4.55	< 0.001
Fat free mass (kg)	39.13 ± 0.48	45.52 ± 5.29	35.52 ± 5.14	< 0.001
Abdominal circumference (cm)	82.26 ± 0.70	85.88 ± 9.48	80.23 ± 10.40	< 0.001
Hip circumference (cm)	92.83 ± 0.56	91.70 ± 6.71	93.33 ± 9.11	*NS*
AHR	0.89 ± 0.00	0.934 ± 0.06	0.859 ± 0.07	< 0.001
(deviation from cut-off point)†	—	(–0.016 ± 0.007)	(0.009 ± 0.011)	*NS*

Presented in mean ± SD. *Tested using Student's t-test. †AHR cut-off point; Men 0.95, Women 0.85. BMI, body mass index; TSF, triceps skinfold; BSF, biceps skinfold; SSF, subscapular skinfold; SiSF, suprailiac skinfold; MUAFA, mid upper arm fat area; MUAMA, mid upper arm muscle area; AHR, abdominal to hip circumference ratio.

AHR subjects than in desirable AHR subjects, but when it was adjusted to BMI there were no significant stastical differences (Fig. 1).

Using Pearson partial correlation (Table 9), it was found that in total subjects there was no correlation between peripheral adiposity indexes (MUAFA and TBSF) and serum lipids or FBG level. General adiposity indexes (FM(%), FM(kg), BMI) had a positive correlation with serum total cholesterol concentration ($P < 0.05$). Central adiposity index (SSiSF) had a positive correlation with serum total cholesterol concentration ($P < 0.05$). Finally, fat distribution index (SSiSF–TBSF ratio) had a positive correlation with either LDLC or triglycerides ($P < 0.05$).

Among the elderly men, only SSiSF and SSiSF–TBSF ratios were shown to have a positive correlation with serum lipids. The SSiSF ratio had a positive correlation with serum total cholesterol concentration ($r = 0.1662$, $P < 0.05$), and SSiSF–TBSF ratio had a positive correlation with serum

Table 5. Serum lipids, fasting blood glucose concentration and blood pressure of the subjects

Parameters	Total (*n* = 222)	Men (*n* = 80)	Women (*n* = 142)	*P*
Fasting blood glucose (mg/dL)†	90.2 (79.6–107.2)	87.2 (78.3–100.6)	91.8 (80.6–105.2)	*NS*
Total cholesterol (TC; mg/dL)*	232.62 ± 50.47	223.20 ± 45.24	237.76 ± 52.48	0.038
Triglycerides (TG; mg/dL)*	133.13 ± 69.09	132,44 ± 62.13	133.02 ± 63.89	*NS*
LDLC (mg/dL)*	124.14 ± 40.66	118.88 ± 38.36	127.21 ± 41.68	*NS*
HDLC (mg/dL)†	62.00 (50.0–84.4)	60.55 (49.5–84.1)	65.30 (50.5–88.2)	*NS*
TC/HDLC*	3.70 ± 0.56	3.74 ± 0.19	3.67 ± 0.12	*NS*
LDLC/HDLC*	2.08 ± 0.27	2.06 ± 0.14	2.09 ± 0.11	*NS*
TG/HDLC*	2.12 ± 0.37	2.21 ± 0.19	2.06 ± 0.11	*NS*
Blood pressure (mmHg)*				
Systolic	138.77 ± 31.77	139.21 ± 32.94	138.31 ± 31.18	*NS*
Dyastolic	79.31 ± 16.91	80.19 ± 18.28	78.75 ± 16.19	*NS*
MAP‡	100.06 ± 20.83	102.42 ± 15.59	100.01 ± 16.28	*NS*

* Presented in mean ± SD, tested using Student's *t*-test; † Presented in median (P25-P75), tested using Mann–Whitney U-test; ‡ MAP, mean arterial pressure; LDLC, low-density lipoprotein cholesterol; HDLC, high-density lipoprotein cholesterol.

Table 6. Distribution of coronary heart disease risk factors of the subjects

Variables	Total (222) *n* (%)	Men (80) *n* (%)	Women (142) *n* (%)	*P*
Smoking	46 (20.7)	38 (47.5)	8 (5.6)	< 0.001
Body composition:				
Overweight (BMI ≥ 25 kg/m^2)	73 (32.9)	28 (35.0)	45 (31.7)	*NS*
Obese (BMI ≥ 30 kg/m^2)	14 (6.3)	3 (3.8)	11 (7.7)	*NS*
Abdominal obesity	119 (53.6)	40 (50.0)	79 (55.6)	*NS*
Glucose intolerance:	31 (13.9)	11 (13.8)	20 (14.0)	*NS*
IGT (FBG 116–140 mg/dL)	15 (6.8)	6 (7.5)	9 (6.3)	*NS*
NIDDM (FBG > 140 mg/dL)	16 (7.2)	5 (6.3)	11 (7.7)	*NS*
Dyslipidemia:	178 (80.2)	62 (77.5)	116 (81.7)	*NS*
Total cholesterol 200–240 mg/dL	57 (25.7)	26 (32.5)	31 (21.8)	0.036
Total cholesterol > 240 mg/dL.	98 (44.1)	26 (32.5)	71 (50.0)	
LDL cholesterol ≥ 160 mg/dL	50 (22.5)	12 (15.0)	38 (26.8)	*NS*
HDL cholesterol < 35 mg/dL	9 (4.0)	3 (3.8)	6 (4.2)	*NS*
Triglycerides ≥ 200 mg/dL	31 (14.0)	12 (15.0)	19 (13.4)	*NS*
Hypertension:	62 (27.2)	26 (32.5)	36 (25.4)	*NS*
Systolic ≥ 160 mmHg	42 (18.90	15 (18.8)	27 (19.0)	*NS*
Diastolic ≥ 95 mmHg	33 (14.7)	15 (18.8)	18 (12.7)	*NS*
MAP (≥ P75/111.1 mg Hg)	55 (24.8)	24 (30.0)	31 (21.8)	*NS*
Syndrome X:				
AO + GI	18 (8.1)	6 (7.5)	12 (8.5)	0.027
AO + GI + DL	13 (5.9)	4 (5.0)	9 (6.3)	0.017
AO + GI + DL + HT	3 (1.4)	2 (2.5)	1 (0.7)	*NS*
GI + DL	27 (12.2)	9 (11.3)	18 (12.7)	*NS*
GI + DL + HT.	7 (3.2)	3 (3.8)	4 (2.8)	*NS*

Abdominal obesity: AHR men ≥ 0.95; women ≥ 0.85; IGT, impaired glucose tolerance; NIDDM, non-insulin-dependent diabetes mellitus; FBG, fasting blood glucose; MAP, mean arterial pressure; $P \geq 75$, Percentile ≥ 75; Dyslipidemia, the abnormality of one or more serum lipid concentrations; Hypertension, Systolic ≥ 165 mmHg or diastolic ≥ 95 mmHg. Syndrome X: AO, abdominal obesity; GI, glucose intolerance; DL, dyslipidemia; HT, hypertension.

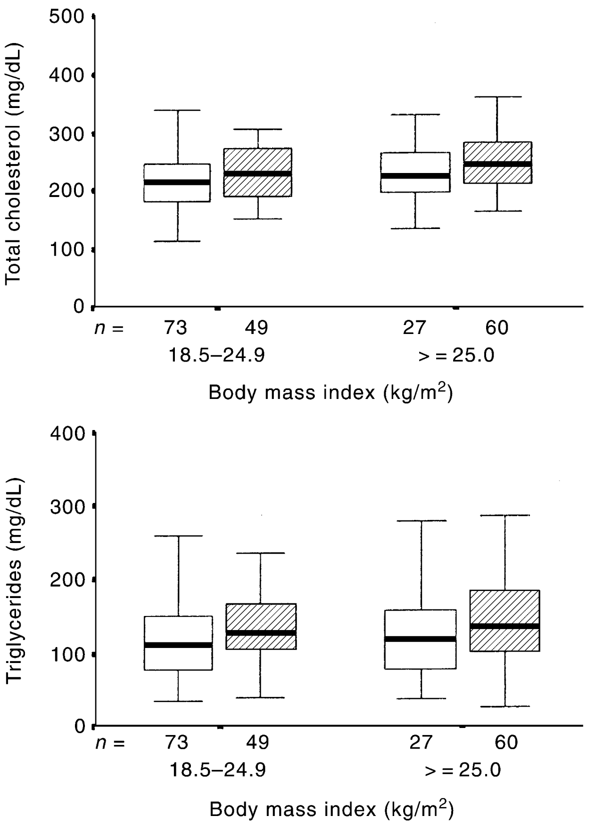

Figure 1. Serum total cholesterol and serum triglycerides concentration by body mass index (BMI) and abdominal to hip circumference ratio (AHR). (▨), high; (□), desirable.

LDLC concentration (r = 0.2663, P < 0.05) and SSiSF–TBSF ratio had a positive correlation with serum LDLC concentration (r = 0.2663, P < 0.05).

In elderly women, there was a negative correlation between TBSF and serum triglycerides concentration (r = –0.1804, P < 0.05). Body fat distribution index: SSiSF–TBSF ratio has a positive correlation with triglycerides (r = 0.2003, P < 0.05), and AHR has a positive correlation with serum total cholesterol (r = 0.1763, P < 0.05).

Using multiple linear regression model (Table 10), in total subjects there was a positive correlation between serum total cholesterol and SSiSF (P = 0.017), gender (P = 0.041); triglycerides and SSiSF–TBSF ratio (P = 0.033); and LDLC and SSiSF–TBSF ratio (P = 0.013). There were sex differences with respect to fat distribution as a determinant of serum lipids. In elderly men, SSiSF–TBSF ratio was strongly correlated with serum LDLC (P = 0.018), but in women AHR was strongly correlated with serum total cholesterol (P = 0.043). The BMI did not correlate with any of serum lipids in the multiple linear regression model, indicating that fat distribution indexes (SSiSF–TBSF ratio, AHR) represent a better or stronger determinant of serum lipids than the BMI.

Discussion

If the results of this study are compared with other studies, there is a wide variation in nutritional status among urban and non-urban areas in Indonesia. The proportion of body fat mass of the elderly were higher in urban than in suburban areas. The mean value of BMI subjects in this study

Table 7. Serum lipids and fasting blood glucose concentration by body mass index

	Body Mass Index (kg/m²)			
Lipid (mg/dL)	< 18.5	18.5–24.9	25.0–29.9	≥ 30
Total (222)	13	122	73	14
TC*	232.14 ± 13.79	225.85 ± 4.42‡	241.53 ± 5.93‡	252.46 ± 14.37
HDLC†	61.4 (49.9–114.2)	61.7 (49.9–86.4)	65.0 (50.6–88.7)	64.5 (47.1–85.3)
LDLC*.	118.79 ± 9.66	122.18 ± 3.72	129.50 ± 4.73	119.27 ± 11.39
TG*	117.36 ± 11.09	131.79 ± 6.02	136.72 ± 7.32	135.55 ± 14.86
FBG†	81.5 (79.4–102.2)	87.1 (77.1–103.0)	91.7 (83.6–106.5)	94.6 (86.6–110.4)
TC/HDLC*	3.18 ± 0.26	3.76 ± 0.16	3.64 ± 0.13	3.95 ± 0.36
LDLC/HDLC *	1.76 ± 0.23	2.17 ± 0.13	2.01 ± 0.11	1.93 ± 0.29
TG/HDLC*	1.65 ± 0.22	2.21 ± 0.14	2.03 ± 0.12	2.21 ± 0.40
Men (80)	4	45	28	3
TC*	213.40 ± 23.07	221.47 ± 6.83	224.29 ± 8.79	251.86 ± 14.76
HDLC†	60.0 (54.6–84.1)	63.7 (51.2–87.1)	55.1 (48.8–75.9)	45.1 (40.3–49.9)
LDLC*	110.52 ± 21.86	118.38 ± 5.98	118.96 ± 6.43	136.73 ± 34.39
TG*	100.55 ± 19.71	132.81 ± 9.53	131.99 ± 11.58	173.53 ± 40.47
FBG†	106.6 (98.5–129.0)	84.0 (74.1–101.6)	86.3 (79.6–93.2)	111.7 (86.5–135.3)
TC/HDLC*	3.27 ± 0.25‡	3.71 ± 0.29	3.70 ± 0.23‡	5.59 ± 0.75‡
LDLC/HDLC*	1.65 ± 0.7	2.09 ± 0.22	1.98 ± 0.17	3.04 ± 0.91
TG/HDLC*	1.54 ± 0.29‡	2.23 ± 0.27	2.11 ± 0.18‡	3.88 ± 1.12‡
Women (142)	9	77	45	11
TC*	240.47 ± 17.18	226.83 ± 5.79‡	252.26 ± 7.56‡	252.62 ± 18.17
HDLC†	78.2 (44.8–134.5)	61.1 (48.7–86.0)	70.2 (53.7–94.6)	72.9 (58.8–86.1)
LDLC*.	122.46 ± 10.82	124.41 ± 4.76	136.06 ± 6.42	114.50 ± 11.82
TG*	124.84 ± 13.38	131.20 ± 7.79	139.67 ± 9.51	125.20 ± 15.04
FBG†	81.0 (75.3–92.3)	88.6 (78.8–103.1)	99.3 (85.6–111.9)‡	94.3 (86.5–105.2)
TC/HDLC*	3.15 ± 0.38	3.78 ± 0.19	3.62 ± 0.17	3.50 ± 0.30
LDLC/HDLC*	1.80 ± 0.33	2.22 ± 0.17	2.02 ± 0.15	1.62 ± 0.22
TG/HDLC*	1.70 ± 0.30	2.19 ± 0.17	1.98 ± 0.16	1.76 ± 0.32

* Presented in Mean ± Standard Error (SE), tested by ANOVA; † Presented in Median (P25-P75), tested by Kruskal–Wallis H; ‡ P < 0.05; TC, total cholesterol; HDLC, high-density lipoprotein cholesterol; LDLC, low-density lipoprotein cholesterol; TG, triglycerides; FBG, fasting blood glucose.

(23.8 kg/m^2 in elderly men and 24.0 kg/m^2 in elderly women) and the result of 2nd MONICA study (ages 55–64 years) in Jakarta (22.9 kg/m^2 in men and 24.2 kg/m^2 in women)[19] were higher than in suburban studies such as in West Java (20.3 kg/m^2 in elderly men and 22.0 kg/m^2 in elderly women)[20] and in West Sumatra (18.2 kg/m^2 in elderly men and 18.2 kg/m^2 in elderly women), respectively.[21]

Occurrences of metabolic disorders such as diabetes mellitus type II and dyslipidemia increase in older age of subjects. Prevalence of type II diabetes in this study (7.2%) were higher than its occurrence among all ages (1.4–1.6%) in Indonesia,[21] and than the 2nd Monica Study in Jakarta in subjects 40–64 years old (3.6%).[23] Mean concentration of total cholesterol in this study (223.2 and 237.8 mg/dL in men and women, respectively) was higher than the result of the 2nd MONICA study Jakarta 1993 (204.8 mg/dL in men and 213.0 mg/dL in women, respectively).[23] According to the Framingham study, an increasing concentration of total cholesterol in the adult population is important to follow up, because an increase of 1% in total cholesterol concentration in a population survey, will be followed by an increase of 2.7% risk for CVD. Prevalence of hypercholesterolemia (≥ 200 mg/dL) in this study was also higher (65.0% in men and 51.8% women) than in the MONICA study 1993 in subjects 55–64 years (51.5% in men and 48.9% in women).[23] Fortunately, increasing concentration of total cholesterol (as a risk factor of CVD) in this study was followed by increasing concentration of HDLC (as a protective for CVD), ratio of them 3.7 (less than 4.5) indicating the low risk of CVD.[17] Moreover, Kirby reviewed that in elderly subjects HDLC was a better predictor, but total cholesterol was a poor predictor for CVD compared with their younger counterparts.[24] Unfortunately, treatment of hyperlipidemia using hypolipidemic drugs is not appropriate for most elderly women,[25] whereas in this study their cholesterol concentration was higher than elderly men. In those cases, nutritional intervention is only one choice for lowering and maintaining concentration of serum lipids.

Many studies have reported that there are generally close relationships between body fat mass with lipid serum as major risk factors of CVD. In terms of the risk of CVD caused by metabolic disorders due to body fatness, Després classified obesity into three categories: (1) gluteal-femoral (2) abdominal and (3) visceral fatness.[26] Gluteal-femoral fatness is associated with the lowest risk of CVD, abdominal shows greater association than gluteal-femoral fatness, and the visceral represents the highest.[26] Whereas the risk of CVD correlates with different levels of insulin resistance, the latter is influenced by the type of obesity.

Several studies reported elsewhere conclude that the AHR has a positive correlation with any form of serum lipid such as total cholesterol, triglycerides, LDLC and of blood insulin

Table 8. Comparison serum lipids and fasting blood glucose concentration by AHR

Lipid	AHR Desirable	AHR High	*P*
	< 0.95/< 0.85	≥ 0.95/ ≥ 0.85	
Total (*n* = 222)	(112)	(110)	
Total cholesterol (mg/dL)*	223.84 ± 5.03	240.01 ± 4.46	< 0.05
HDL cholesterol (mg/dL)†	59.3(50.5–84.70	69.4(50.2–93.60	*NS*
LDL cholesterol (mg/dL) *	117.44 ± 3.80	130.06 ± 3.80	< 0.05
Triglycerides (mg/dL) *	116.48 ± 5.65	136.53 ± 6.12	< 0.05
Fasting blood glucose (mg/dL)†	86.4(78.3–102.5)	92.1(81.4–105.1)	< 0.05
Total/HDL cholesterol*	3.69 ± 0.15	3.69 ± 0.14	*NS*
LDL/HDL cholesterol*	2.05 ± 0.12	2.10 ± 0.12	*NS*
Triglycerides/HDL cholesterol*	2.09 ± 0.14	2.14 ± 0.0,12	*NS*
Men (*n* = 80)	< 0.95	≥ 0.95	
	(49)	(31)	
Total cholesterol (mg/dL) *	211.72 ± 10.88	226.77 ± 5.67	*NS*
HDL cholesterol (mg/dL)†	58.2(50.1–82.0)	72.8(49.0–92.4)	*NS*
LDL cholesterol (mg/dL) *	109.77 ± 9.45	122.03 ± 4.76	*NS*
Triglycerides (mg/dL) *	115.13 ± 10.04	137.83 ± 8.47	*NS*
Fasting blood glucose (mg/dL)†	84.2(74.3–100.4)	90.0(81.1–105.0)	*NS*
Total/HDL cholesterol*	3.94 ± 0.28	3.43 ± 0.22	*NS*
LDL/HDL cholesterol*	2.17 ± 0.20	1.89 ± 0.17	*NS*
Triglycerides/HDL cholesterol*	2.32 ± 0.26	2.05 ± 0.16	*NS*
Women (*n* = 142)	< 0.85	≥ 0.85	
	(63)	(79)	
Total cholesterol (mg/dL) *	225.50 ± 6.80	247.53 ± 5.54	< 0.05
HDL cholesterol (mg/dL)†	61.9(50.5–86.1)	66.9(50.5–95.6)	*NS*
LDL cholesterol (mg/dL) *	117.68 ± 6.82	129.05 ± 3.94	*NS*
Triglycerides (mg/dL) *	117.54 ± 10.78	136.01 ± 6.02	*NS*
Fasting blood glucose (mg/dL)†	86.8(79.5–106.6)	96.5(81.4–105.2)	*NS*
Total/HDL cholesterol*	3.51 ± 0.17	3.80 ± 0.18	*NS*
LDL/HDL cholesterol*	1.96 ± 0.14	2.18 ± 0.16	*NS*
Triglycerides/HDL cholesterol*	1.92 ± 0.15	2.18 ± 0.15	*NS*

* Presented in Mean ± SE, analysed by Student's *t*-test; † Presented in Median (*P*.25-*P*.75), tested by Mann–Whitney U; *NS*, not significant; HDL, high-density lipoprotein; LDL, low-density lipoprotein.

concentration, of fibrinogen concentration and smoking. According to other studies, visceral (intra-abdominal) fat has a definite correlation with AHR. Therefore AHR might be used as an index of body fat distribution.[8] Epidemiological studies revealed that AHR is not only associated with blood glucose and serum lipid, but also with social class, morbidity of some diseases, incidence of peptic ulcer and depression (especially in women). On the contrary, there is not any association between BMI and the four statements above.[26,27]

Table 9. The correlation of body fat index with any of serum lipid and fasting blood glucose concentration

Body fat	Fasting blood glucose and serum lipids				
	FBG	LDLC	HDLC	TC	TG
Total (*n* = 222)					
MUAFA	0.0967	–0.0642	–0.0560	0.0818	–0.0416
FM (%)	0.0566	0.0314	0.0199	0.1783*	0.0825
FM (kg)	0.0526	0.0343	–0.0274	0.1461*	0.0616
TBSF	0.0888	–0.0920	–0.0119	0.0346	–0.1081
SSiSF	0.0143	0.0427	–0.0290	0.1401*	0.0635
SSiSF–TBSF ratio	–0.0607	0.1742*	0.0959	0.1306	0.1557*
BMI	0.0895	0.0728	– 0.0257	0.1396*	0.0878
AHR	0.0017	0.0909	– 0.0089	0.0580	0.1216
Men (*n* = 80)					
MUAFA	0.1363	–0.0108	–0.0715	0.1591	0.0376
FM (%)	0.0041	0.0856	–0.0107	0.1516	0.0912
FM (kg)	0.0209	0.1293	–0.0590	0.1650	0.1035
TBSF	0.1682	–0.0888	–0.0598	0.0886	0.0281
SSiSF	–0.0365	0.1610	0.0094	0.1999*	0.1662
SSiSF–TBSF ratio	–0.1788	0.2663*	0.0614	0.1080	0.1084
BMI	0.0048	0.1698	–0.0731	0.1386	0.1410
AHR	0.0663	0.1130	0.0955	0.1092	0.1526
Women (*n* = 142)					
MUAFA	0.0555	–0.0852	–0.0990	0.0180	–0.1664
FM (%)	0.0802	–0.0169	–0.1356	0.0717	–0.0417
FM (kg)	0.1192	–0.0008	–0.1065	0.0856	–0.0676
TBSF	0.0543	–0.1152	–0.1286	–0.0019	–0.1804*
SSiSF	0.0382	–0.0092	–0.0301	0.1079	0.0138
SSiSF–TBSF ratio	–0.0205	0.1649	0.1056	0.1411	0.2003*
BMI	0.1502	0.0527	–0.0542	0.1244	0.0030
AHR	0.0187	0.1578	0.0244	0.1763*	0.1637

* $P < 0.05$, analysed by Pearson partial correlation controlled by physical activity, income per capita, age, drugs; FBG, fasting blood glucose; LDLC, low-density lipoprotein; HDLC, high-density lipoprotein; TC, total cholesterol; TG, triglycerides; MUAFA, mid upper arm fat area; FM, fat mass; TBSF, triceps-biceps skinfold; SSiF, suprailiac skinfold; BMI, body mass index; AHR, abdominal to hip circumference ratio.

Table 10. Multiple linear regression between serum lipids and body fat index

Subjects	Variable	Regression coefficient		r^2	*P*
		Parameter estimate	SE		
Total	Total cholesterol				
(*n* = 222)	SSiSF	0.6899	0.2869	0.0260	0.0170
	Sex	14.2481	6.9181	0.0441	0.0406
	Variation of total cholesterol value determined by the model 7.01% (100 × 0.0701)				
	Triglycerides				
	SSiSF/TBSF	14.9890	6.9851	0.0205	0.0330
	Variation of triglycerides value determined by the model 2.05% (100 × 0.0205)				
	LDLC				
	SSiSF/TBSF	11.2585	4.4741	0.0280	0.0126
	Variation of LDLC value determined by the model 2.8% (100 × 0.0280)				
Men	LDLC				
(*n* = 80)	SSiSF/TBSF	22.1221	9.1143	0.0713	0.0175
	Variation of LDLC deterimined by the model 7.13% (100 × 0.0713)				
Women	Total cholesterol				
(*n* = 142)	AHR	135.6537	66.4816	0.0288	0.0432
	Variation of total cholesterol value determined by the model 2.88% (100 × 0.0288)				

Analysed by multiple linear regression *stepwise*, PIN 0.05 and POUT 0.10. Independent variables; all body fat index [FM(%), FM(kg), BMI, AHR, SSiSFi, SSiSF–TBSF ratio], with *r* (coefficient correlation) $P < 0.05$. Sex (1 = men, 2 = women). SE, Standard Error; FM. fat mass; BMI, body mass index; AHR, abdominal to hip circumference ratio; SSiSF/TBSF, suprailiac skinfold-tricep/bicep skinfold; LDLC, low-density lipoprotein cholesterol.

The results of this study demonstrate a positive correlation between body fat indexes such as AHR and SSiSF–TBSF ratio and BMI with serum lipid concentration. In these elderly subjects, body fat distribution indexes (AHR and SSiSF–TBSF ratio) are stronger determinants of serum lipids than BMI.

In conclusion, to predict the concentration of serum lipids, more attention should be given to fat distribution, rather than to other body composition indexes such as BMI, total FM and other measures.

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