DYNAMICS OF SUBCUTANEOUS ADIPOSE TISSUE CHANGES IN RELATION TO AGE AND SEXUAL MATURATION IN GIRLS AGED 12-15 IN SARAJEVO DURING WAR

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Abstract

During war time in Sarajevo, on a sample of 180 schoolgirls, aged 12-14, divided into three groups of 12, 13 and 14 years old, 17 anthropometric variables in the transversal study have been determined including height, body mass, 15 skinfolds, fat weight and percentage of body fat. Chronological and gynaecological age were also recorded and secondary sex characteristics were estimated. There were distinct differences in skinfold values among girls related to their chronological age, axillary hair, onset of menarche, but fewer differences related to the development of pubic hair and breasts. According to results of multiple linear regression analysis the gynaecological age was more influential than chronological age on all investigated variables entering the equation, except metacarpal skinfold value. In addition, gynaecological age correlated only with skinfold values of the trunk and proximal extremity parts. Evident influences of both chronological age and gynaecological age on body fat content in the period of sexual maturation thus reflect, even in the circumstances of besieged Sarajevo, a continuation the positive secular trend in size and fatness reported before war.

Keywords: *anthropometry, body fat, sexual maturation, adolescent girls, Sarajevo*

Zusammenfassung

DYNAMIK DER VERÄNDERUNG VOM SUBKUTANEN FETT IM BEZUG AUF DAS ALTER UND DIE GESCHLECHTSREIFE BEI MÄDCHEN IM ALTER VON 12-15 JAHREN IN SARAJEVO WÄHREND DES KRIEGES

Auf dem Muster von 180 Schülerinnen im Alter von 12 bis 14 Jahren aus Sarajevo, die in drei Altersgruppen eingeteilt wurden, und zwar: die Gruppen der 12, 13 und 14jährigen Schülerinnen, wurden 17 anthropometrischen Variablen gemessen, und zwar die Höhe, das Gewicht und die Menge, bzw. das Prozent des Fettgewebes, usw. Es wurden sowohl die Daten über das Alter und das Alter in dem die Menarche erscheint als auch die sekundären Geschlechtscharakteristiken notiert. Wir haben klare Unterschiede bezüglich der Hautfaltengröße, Achselhöhlenbehaartheit und Ausbruch der Menarche zwischen den Altersgruppen festgestellt. Die kleineren Unterschiede wurden in der Brustentwicklung und Schambehaartheit festgestellt. Die Regressionsanalyse hat gezeigt, daß, außer Faustfalten bei allen Variablen, die in die Equatation gekommen sind, das Menarchenalter einen größeren Einfluß als das chronologische Alter hat. Dazu korreliert das Menarchenalter nur mit den Werten der Oberkörperhautfalten und mit den Werten der proximalen Glieder. Daraus können wir schließen, daß der Einfluß des chronologischen Alters und des Menarchenalters auf die Erhöhung des subkutanen Fetts im Zeitraum der Geschlechtsreife in den Umständen des belagerten Sarajevo eine noch vor dem Krieg notierte positive Tendenz reflektiert.

Schlüsselwörter: *Anthropometrie, Körperfett, Geschlechtsreife, Adoleszentinnen, Sarajevo*

Introduction

A series of quantitative and qualitative changes of body composition is commonly recognised in girls aged 12-15. The greatest changes in this life period are the adolescent growth spurt and large increase in body fat (Frisch, 1985). During growth and maturation of the reproductive system the proportion of body water declines rapidly while fat weight increases (Frisch, 1988). However, while some authors have argued that a certain minimum of body fat is necessary for normal maturation (Frisch, 1978, 1985, 1988 i Frisch, Mc Arthur, 1974), the others find no consistent relationship between body fat and menstrual irregularities, and show that biological maturation, as measured for instance by skeletal age, is a better predictor of gynaecological age than fat or body composition (Drinkwater, et al. 1984; Sanborn et al. 1987; Sharma et al. 1988).

The purpose of this transversal study is to describe the dynamics of adipose tissue changes in relation to the chronological age, gynaecological age and onset of menarche, and the development of secondary sex characteristics in the besieged city of Sarajevo, lacking food during the time of war (1992-1994). A longitudinal study would be undoubtedly more appropriate in this field of investigation as the transversal approach is more suitable for phenomena description than for their cause-effect interpretation (Mužić, 1982). In addition, the war time in Sarajevo and uncontrollable dissipation of the sample precluded any other approach but the transversal one.

Table 3. Mean values and standard deviations of anthropometric variables, body fat amount and fat percentage in relation to chronological age

AGE	12 - 13 ys (N= 60)		13 - 14 ys (N= 60)		14 - 15 ys (N= 60)	
VARIABLE	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
CHAGE	12,55 ys	0,30 ys	13,48 ys	0,29 ys	14,68 ys	0,28 ys
HEIGHT	155,63cm	6,88cm	162,17cm	7,16cm	163,55cm	5,72cm
WEIGHT	43,45 kg	8,49 kg	49,73 kg	7,64 kg	53,36 kg	7,05 kg
AXILLS	6,18mm	1,97mm	5,45mm	1,59mm	6,50mm	1,65mm
SUBSCS	8,70mm	3,87mm	8,78mm	2,36mm	10,56mm	2,82mm
ABDOMS	9,08mm	4,45mm	9,44mm	2,88mm	12,01mm	4,65mm
MPUPAS	10,92mm	4,34mm	10,56mm	2,89mm	11,83mm	3,51mm
CALFS	15,66mm	5,40mm	16,13mm	5,39mm	17,63mm	5,12mm
INFORS	5,81mm	2,08mm	5,98mm	1,41mm	6,49mm	1,72mm
METACS	3,14mm	1,84mm	2,58mm	0,53mm	3,58mm	2,82mm
THIGHS	16,05mm	5,84mm	14,89mm	4,02mm	18,78mm	5,02mm
LASLLS	12,37mm	4,85mm	11,51mm	3,41mm	12,99mm	4,02mm
TRICES	11,60mm	5,13mm	11,99mm	3,49mm	14,62mm	3,99mm
UTSUAS	7,98mm	4,31mm	7,20mm	2,75mm	9,19mm	2,36mm
ILIACS	7,03mm	5,20mm	6,01mm	1,71mm	7,20mm	3,10mm
BICEEPS	6,30mm	3,01mm	6,03mm	2,31mm	7,20mm	2,38mm
QUADRS	18,89mm	7,41mm	19,03mm	6,34mm	22,17mm	6,02mm
COSTAS	8,45mm	3,75mm	8,71mm	2,66mm	9,97mm	3,66mm
FATWEI	9,22kg	4,33 kg	9,59 kg	2,85 kg	11,91 kg	3,01 kg
% FAT	20,58%	6,13 %	18,97%	3,46%	22,19%	4,04%

Methods

180 girls without apparent acute or chronic diseases and psychic or physique alterations, pupils of two schools located in the centre of Sarajevo were grouped into three age groups, i.e. of 12, 13 and 14 years of age. With regard to ethnicity, 80% of them were Muslims, 12.2% Croats, 6.7% Serbs, 1.1% Albanians and 2.2% didn't declare themselves. The investigation was performed during the April of 1994 and anthropometric measurements were done in accordance to the International Biological Program (IBP) and authors instructions [9,10,11], using Marthin's anthropometer and Harpenden's calliper. The development of secondary sex characteristics was estimated according to IBP [9] and girls were asked about the age and onset of menarche.

The data about chronological age (CHAGE), gynaecological age (AGEMEN), secondary sex characteristics (pubic hair, axillary hair, breast development) were collected.

The following morphological variables were assessed: height (HEIGHT)[9], weight (WEIGHT)[9], skin folds - axillary (AXILLS), IBP variation (in the left elbow flexion with the arm held horizontally, the fold being estimated in the middle axillary line [12], subscapular (SUBSCS)[9], abdominal (ABDOMS)[9], middle of the posterior side of the upper arm (MPUPAS) [9], upper third of the supine upper arm (UTSUAS)[11], upper third of triceps (TRICES)[11], biceps (BICEPS)[10], inner side of forearm (INFORS)[11], distal end of metacarpals (METACS)[11], proximal lateral side of thigh (THIGHS)[11], quadriceps (QUADRS)[10], calf (CALFS)(9), lateral side of lower leg (LASLLS)[11], supra iliac (ILIACS)[11], costal margin (COSTAS)[10], as well as body composition indicators: fat weight (FATWEI) and percentage of body fat (%FAT) by Matiegke's method [11].

Descriptive statistics, discriminant analysis and multiple linear regression analysis were applied with independent variables: chronological age and gynaecological age for the sexually mature subgroup.

Results

The mean height and weight (± standard deviation) of girls were 155,63 ± 6,88 cm and 43,45 ± 8,49 kg for the

(9) (Weiner, Lourie, 1969)

(10) (Montagu, 1960)

(11) (Martirosov, 1982)

(12) (Stojanović et al., 1975)

Table 2. Discriminant analysis of skin folds in relation to chronological age (3 groups by 12, 13 and 14 years)

VARIABLE	FUNCTION 1	FUNCTION 2
	CORRELATION	
ABDOMS	,45*	,17
TRICES	,45*	,17
SUBSCS	,39*	,20
QUADRS	,32*	,16
COSTAS	,28*	,08
INFORS	,24*	,03
CALFS	,23*	,04
AXILLS	,17	,53*
THIGHS	,38	,46*
UTSUAS	,27	,40*
METACS	,18	,40*
ILIACS	,07	,33*
LASLLS	,12	,29*
BICEPS	,24	,24*
MPUPAS	,17	,20*
EIGENVALUE	,484	,181
PERCENT OF VARIANCE	72,76%	27,24%
CANONICAL CORRELATION	,57	,39

after function				
function	Wilks lambda	chi-square	degree of freedom	significance
0	,57	95,41	30	,00
1	,85	28,31	14	,01

Table 3. Mean values and standard deviations of anthropometric variables, fat weight and percentage of body fat in relation to onset of menarche

	Without menarche (N= 54)		With menarche (N= 126)	
VARIABLE	Mean	Standard deviation	Mean	Standard deviation
CHAGE	13,01 ys	0,83 ys	13,79 ys	0,82 ys
HEIGHT	154,03cm	5,99cm	163,20cm	6,21cm
WEIGHT	41,11 kg	7,02 kg	52,16 kg	7,16 kg
AXILLS	5,37mm	1,63mm	6,33mm	1,78mm
SUBSCS	7,39mm	2,15mm	10,19mm	3,19mm
ABDOMS	7,14mm	2,22mm	11,48mm	4,26mm
MPUPAS	9,03mm	2,61mm	11,99mm	3,68mm
CALFS	13,85mm	3,92mm	17,60mm	5,49mm
INFORS	5,25mm	1,50mm	6,45mm	1,76mm
METACS	3,02mm	1,95mm	3,13mm	2,03mm
THIGHS	13,91mm	4,13mm	17,71mm	5,28mm
LASLLS	10,78mm	3,08mm	12,94mm	4,39mm
TRICES	10,43mm	3,97mm	13,72mm	4,28mm
UTSUAS	7,32mm	3,39mm	8,47mm	3,27mm
ILIACS	5,19mm	2,05mm	7,42mm	3,97mm
BICEEPS	5,04mm	1,48mm	7,14mm	2,75mm
QUADRS	14,88mm	4,82mm	22,23mm	6,26mm
COSTAS	6,77mm	1,98mm	10,02mm	3,47mm
FATWEI	7,57kg	2,14kg	11,38 kg	3,56 kg
% FAT	18,37%	4,01%	21,53%	4,87%

Table 4. Mean values and standard deviations of anthropometric variables, fat weight and percentage of body fat in relation to pubic hair

PUBIC HAIR										
stage	I stage N= 12		II stage N= 20		III stage N= 62		IV stage N= 70		V stage N= 16	
VARIABLE	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
CHAGE	12,90 ys	0,82 ys	13,12 ys	1,18 ys	13,35 ys	0,77 ys	13,79 ys	0,81 ys	14,36 ys	0,50 ys
HEIGHT	151,82cm	7,77cm	152,10cm	6,58 cm	159,59cm	5,20cm	164,14cm	6,03cm	164,58cm	6,82cm
WEIGHT	38,87kg	10,50kg	39,80kg	7,71kg	47,73kg	6,91kg	52,43kg	5,97kg	56,31kg	9,04kg
AXILLS	4,75mm	1,42mm	5,55mm	1,48mm	6,18mm	1,82mm	6,35mm	1,77mm	5,76mm	1,93
SUBSCS	6,22mm	1,94mm	7,97mm	2,25mm	9,11mm	3,56mm	10,19mm	2,36mm	10,66mm	4,33mm
ABDOMS	6,45mm	2,94mm	8,95mm	4,47mm	9,05mm	3,38mm	11,90mm	4,12mm	11,34mm	5,10mm
MPUPAS	8,85mm	3,52mm	9,59mm	3,11mm	10,70mm	3,53mm	12,31mm	3,63mm	10,98mm	4,00mm
CALFS	12,70mm	1,63mm	13,93mm	5,39mm	16,11mm	4,90mm	18,08mm	5,82mm	17,10mm	3,98mm
INFORS	4,87mm	1,41mm	5,62mm	2,07mm	6,07mm	2,13mm	6,55mm	1,22mm	5,70mm	1,62mm
METACS	2,78mm	0,60mm	2,70mm	0.64mm	3,45mm	2,47mm	2,75mm	0,54mm	4,01mm	4,34mm
THIGHS	11,97mm	3,04mm	14,69mm	3,01mm	15,48mm	4,92mm	18,19mm	5,15mm	19,51mm	6,48mm
LASLLS	10,00mm	3,16mm	10,08mm	2,10mm	12,14mm	4,57mm	13,29mm	4,19mm	12,99mm	3,40mm
TRICES	10,45mm	3,18mm	11,19mm	4,37mm	12,09mm	4,24mm	13,92mm	4,41mm	13,69mm	4,95mm
UTSUAS	6,20mm	3,77mm	7,58mm	2,37mm	8,24mm	3,69mm	8,76mm	3,14mm	6,98mm	2,80mm
ILIACS	4,77mm	2,67mm	6,58mm	3,40mm	2,58mm	5,95mm	7,66mm	4,26mm	7,59mm	4,25mm
BICEEPS	5,07mm	1,99mm	5,23mm	1,60mm	6,40mm	3,01mm	6,93mm	1,87mm	7,79mm	4,02mm
QUADRS	14,23mm	4,35mm	15,94mm	3,81mm	19,52mm	6,26mm	21,93mm	6,78mm	23,10mm	8,00mm
COSTAS	5,87mm	2,64mm	8,74mm	4,12mm	8,54mm	3,35mm	9,90mm	3,01mm	10,05mm	3,64mm
FATWEI	6,85 kg	3,06 kg	8,04 kg	2,95 kg	9,53 kg	3,34 kg	11,74 kg	3,15 kg	11,71 kg	4,35 kg
% FAT	17,13%	3,50%	19,93%	3,80%	19,66%	4,83%	22,17%	4,66%	20,55%	5,70%

Table 5. Mean values and standard deviations of anthropometric variables, fat weight and percentage of body fat in relation to axillary hair

AXILLARY HAIR						
stage	I stage N= 42		II stage N= 10		III stage N= 36	
VARIABLE	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
CHAGE	12,88 ys	0,76 ys	13,59 ys	0,83 ys	14,25 ys	0,68 ys
HEIGHT	154,14cm	7,81cm	161,49cm	6,40cm	164,87cm	4,71cm
WEIGHT	41,08kg	8,69kg	49,83kg	6,72kg	55,12kg	7,44kg
AXILLS	5,12mm	1,28mm	6,43mm	1,85mm	6,03mm	1,77mm
SUBSCS	7,03mm	1,66mm	9,64mm	3,03mm	11,22mm	3,44mm
ABDOMS	7,27mm	2,37mm	10,47mm	3,96mm	12,82mm	4,76mm
MPUPAS	9,03mm	2,70mm	11,42mm	3,46mm	12,63mm	4,15mm
CALFS	13,55mm	3,37mm	16,82mm	5,62mm	18,90mm	4,98mm
INFORS	4,81mm	0,97mm	6,43mm	1,88mm	6,62mm	1,46mm
METACS	2,67mm	0,40mm	3,15mm	2,00mm	3,45mm	2,90mm
THIGHS	13,00mm	3,54mm	16,93mm	4,69mm	19,73mm	6,07mm
LASLLS	10,90mm	2,73mm	12,20mm	4,47mm	14,16mm	3,99mm
TRICES	9,85mm	3,14mm	13,34mm	4,38mm	14,38mm	4,50mm
UTSUAS	6,17mm	2,49mm	8,65mm	3,40mm	8,92mm	3,20mm
ILIACS	5,44mm	2,31mm	6,82mm	4,09mm	8,08mm	3,13mm
BICEEPS	4,90mm	1,54mm	6,77mm	2,61mm	7,65mm	2,82mm
QUADRS	16,39mm	6,06mm	19,95mm	6,03mm	24,49mm	7,00mm
COSTAS	7,03mm	2,48mm	9,32mm	3,36mm	10,63mm	3,62mm
FATWEI	7,29 kg	2,20 kg	10,58 kg	3,31 kg	12,71 kg	3,68 kg
% FAT	17,66%	3,21%	21,03%	4,98%	22,70%	4,57%

Table 6. Mean values and standard deviations of anthropometric variables, fat weight and percent of body fat in relation to breast development

BREAST DEVELOPMENT										
stage	I stage N= 14		II stage N= 24		III stage N= 54		IV stage N= 78		V stage N= 10	
VARIABLE	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
CHAGE	12,57 ys	0,56 ys	12,73 ys	0,51 ys	13,64 ys	0,92 ys	13,83 ys	0,79 ys	14,32 ys	0,29 ys
HEIGHT	146,00 cm	2,64 cm	157,98 cm	5,49 cm	160,46 cm	6,45 cm	163,42 cm	5,96 cm	163,38 cm	6,06 cm
WEIGHT	33,00 kg	2,06 kg	44,58 kg	6,90 kg	48,35 kg	7,72 kg	52,16 kg	6,88 kg	58,10 kg	1,17 kg
AXILLS	4,26 mm	0,70 mm	6,07 mm	2,06 mm	6,55 mm	1,78 mm	5,91 mm	1,67 mm	6,80 mm	1,54 mm
SUBSCS	5,73 mm	0,98 mm	8,36 mm	4,22 mm	9,03 mm	2,46 mm	9,95 mm	2,76 mm	13,86 mm	2,09 mm
ABDOMS	6,29 mm	2,38 mm	8,55 mm	4,05 mm	9,83 mm	3,86 mm	10,64 mm	3,64 mm	17,78 mm	3,31 mm
MPUPAS	8,94 mm	1,86 mm	9,23 mm	3,86 mm	11,05 mm	3,38 mm	11,50 mm	3,60 mm	15,82 mm	0,89mm
CALFS	12,60 mm	1,32 mm	16,03 mm	5,81 mm	16,29 mm	5,28 mm	16,94 mm	5,43 mm	20,32 mm	4,39 mm
INFORS	4,89 mm	1,17 mm	5,42 mm	2,68 mm	6,03 mm	1,58 mm	6,43 mm	1,58 mm	7,08 mm	0,63 mm
METACS	2,51 mm	0,34 mm	2,57 mm	0,56 mm	3,15 mm	1,92 mm	3,37 mm	2,52 mm	2,78 mm	0,63 mm
THIGHS	12,50 mm	3,26 mm	14,14 mm	5,53 mm	16,20 mm	5,57 mm	17,43 mm	4,21 mm	23,38 mm	4,43 mm
LASLLS	9,74 mm	1,88 mm	11,75 mm	5,32 mm	12,66 mm	4,06 mm	12,27 mm	4,09 mm	15,38 mm	1,93 mm
TRICES	9,77 mm	1,40 mm	9,79 mm	3,77 mm	13,69 mm	5,65 mm	13.03 mm	3,45 mm	16,52 mm	2,27 mm
UTSUAS	6,64 mm	3,68 mm	6,66 mm	4,11 mm	8,66 mm	2,79 mm	8,26 mm	3,27 mm	9,76 mm	2,65 mm
ILIACS	4,87 mm	2,89 mm	6,34 mm	3,62 mm	7,14 mm	4,98 mm	6,55 mm	2,39 mm	9,80 mm	2,61 mm
BICEEPS	4,97mm	1,75 mm	5,49 mm	3,64 mm	6,07 mm	1,83 mm	7,09 mm	2,65 mm	8,96 mm	1,03 mm
QUADRS	13,51 mm	3,46 mm	16,59 mm	5,76 mm	20,30 mm	6,55 mm	21,03 mm	6,38 mm	28,10 mm	5,06 mm
COSTAS	6,19 mm	3,05 mm	7,92 mm	3,31 mm	8,78 mm	3,08 mm	9,62 mm	3,33 mm	12,70 mm	2,97 mm
FATWEI	6,05 kg	1,35 kg	8,46 kg	4,44 kg	10,37 kg	3,58 kg	10,84 kg	2,88 kg	14,92 kg	1,06 kg
% FAT	18,31%	3,88%	18,25%	5,95%	21,20%	5,42%	20,61%	3,79%	25,71%	2,18%

age 12 - 13; 162,17 ± 7,16 cm and 49,73 ± 7,64 kg for the age 13 - 14; 163,55 ± 5,72 cm and 53,36 ± 7,05 kg for the age 14 - 15 respectively and these values are of normal distribution according to Smirnov-Colmogorov test (13). The mean age at menarche (± standard deviation) for 126 girls was 12.43 ± 0.79, which is similar to the age at menarche in general population, while 54 girls, with the mean age of 13.01 ± 0.83 years were without menarche.

The mean values of variables (± standard deviation) were calculated (Table 1). The relationship of some skin folds manifest variables and chronological age representing latent morphological structure of subcutaneous adipose tissue is given in Figure 1. and discriminant analysis of chronological age applied to the variable of subcutaneous adipose tissue in Table 2.

Discriminant analysis resulted in two canonical functions, the first of 72.76% and the second of 27.24% of variability. Both were statistically significant. The first function correlated closely with abdominal, triceps, subscapular, costal margin, quadriceps, forearm and calf skin folds, and the second with axillary, thigh, upper third of supine upper arm, distal end of metacarpals, supra iliac, lateral side of lower leg, biceps, and the middle of the prone upper arm skin folds.

In the same way, the variability among groups with regard to the occurrence of menarche and development of secondary sex characteristics was investigated. These

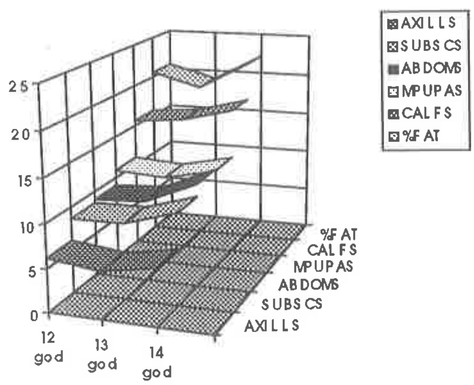

Figure 1. Values of some skin folds and percentage of body fat in relation to chronological age

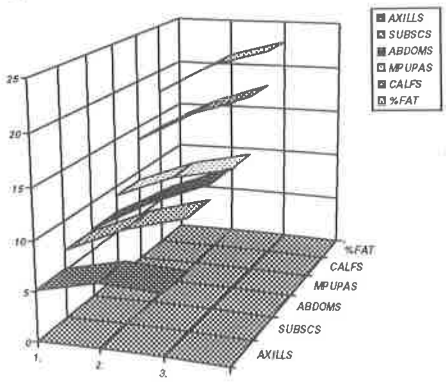

Figure 1. Values of some skin folds and percentage of body fat in relation to the level of axillary hair

Table 7. Discriminant analysis of skin folds in relation to onset of menarche (2 groups N1=54, N2=126)

VARIABLE	FUNCTION 1
	CORRELATION
QUADRS	,72
ABDOMS	,66
COSTAS	,60
SUBSCS	,55
MPUPAS	,50
BICEPS	,49
TRICES	,45
THIGHS	,44
CALFS	,42
INFORS	,41
ILIACS	,36
AXILLS	,32
LATLLS	,30
UTSUAS	,20
METACS	,03
EIGENVALUE	,65
PERCENT OF VARIANCE	100%
CANONICAL CORRELATION	62,81

after function				
function	Wilks lambda	chi-square	degree of freedom	significance
0	,61	85,55	15	,00

results are presented in Tables 3-6. The selected skin folds variables are given in Figure 2. The greater regularity in the increase of fat weight and its percentage in relation to the onset of menarche and stage of axillary hair development than to the chronological age can be observed (Table 1, 3-6 and Figures 1-4). The mean values of all the variables were greater in the sexually mature subgroup. Pubic hair and breast development were of somewhat less regularity in relation to the increase of skin folds thickness compared to the axillary hair and onset of menarche, but there was undoubtful increase of fat weight and its percentage in relation to the biological age. Body height and weight were also influenced both by the chronological and biological age with the exception of body height in relation to breast development. Discriminant analysis showed significant differences between groups formed according to the occurrence of menarche (p 0.01) and axillary hair (p 0.01), while in the case of pubic hair and breast development, two out of four and three out of four canonical after functions, respectively, showed significant differences (p) (Table 7-10). The eigen value and canonical correlation between breast stage and menarche was the highest of all those reported from the discriminant analysis. Nevertheless, it was also obvious that the chronological age as well as the age of the onset of menarche undoubtedly influenced the increase of subcutaneous adipose tissue. Multiple regression analysis done in the subgroup of 126 sexually mature girls validated them separately (Table 11). This can show that, with regard to the variability of skin folds, fat weight and percent of body fat, the gynaecological age and chronological age influence the follow-

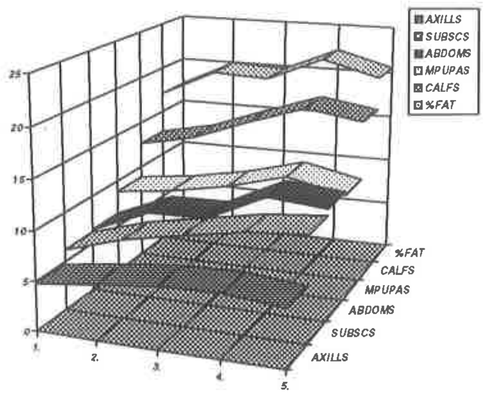

Figure 3. Values of some skin folds and percentage of body fat inb relation to the level of pubic hair

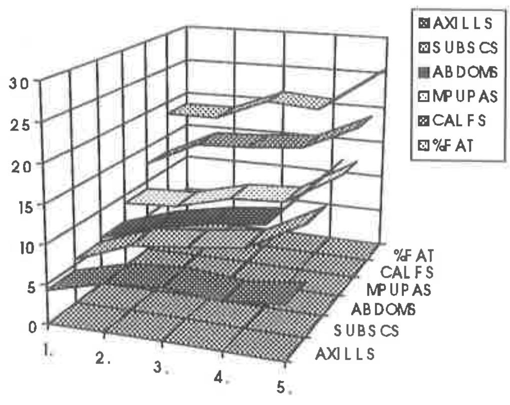

Figure 4. Values of some skin folds and percentage of body fat ini relation to the level of breasts development

Table 8. Discriminant analysis of skin folds in relation to pubic hair (5 groups N1=12, N2=20, N3=62, N4=70, N5=16)

VARIABLE	FUNCTION 1	FUNCTION 2	FUNCTION 3	FUNCTION 4
	CORRELATION			
THIGHS	,53*	,40	,19	,25
QUADRS	,50*	,30	,48	,08
SUBSCS	,45*	,34	,43	,32
BICEPS	,46*	,10	,31	,03
ABDOMS	,45	,60*	,17	,12
MPUPAS	,26	,45*	,37	-,16
ILIACS	,27	,38*	-,04	,17
METACS	,14	-,34*	,21	,30
TRICES	,32	,33*	,20	-,08
AXILLS	,10	,28	,51*	,20
CALFS	,32	,37	,44*	-,04
INFORS	,12	,41	,43*	,06
LASLLS	,31	,25	,43*	-,14
UTSUAS	,01	,35	,40*	,09
COSTAS	,33	,41	,16	,49*
EIGENVALUE	,43	,25	,14	,06
PERCENT OF VARIANCE	48,75	28,64	15,71	6,89
CANONICAL CORRELATION	,55	,45	,35	,24

after function				
function	Wilks lambda	chi-square	degree of freedom	significance
0	0,46	130,89	60	0,00
1	0,66	70,23	42	0,00
2	0,83	32,03	26	0,19
3	0,94	10,01	12	0,61

ng skin folds: subscapular, abdominal, thigh, triceps, biceps, quadriceps as well as the fat weight and percentage of body fat. The variable - gynaecological age - had greater "beta" value, i.e. partial influence. The gynaecological age influenced the upper third of the supine upper arm skin fold and costal margin skin fold, while concerning these two variables chronological age didn't enter the equation. Skin folds of lower leg, middle of prone upper arm, forearm, and axillary and suprailiac skin folds were correlated neither to chronological nor to gynaecological age. Skin fold of distal end of metacarpals correlated only chronological age, while the gynaecological age had more influence on other skin folds as well as on fat weight and percent of body fat. Variables: AXILLS, MPUPAS, INFORS, LASLLS, ILIACS didn't enter the equation.

Discussion

As indicated by numerous studies (Frisch, 1974, 1978, 1985, 1988, La Velle, 1994; Laska-Mierzejewska, 1993), both the growth and maturation are influenced by cultural, economic and geographical environment. Lack of food in Germany during the Second World War caused a 3-cm diminution of stature relative to immediate prewar statistics. However, this was a delay rather than a permanent limitation of development and the children concerned showed rapid growth as adequate amounts of food became available (Shephard, 1987). Although children in besieged Sarajevo during this war were also deprived of food, and under permanent stress, this study didn't find significant differences in the onset of menarche compared to the general population. Moreover, our girls aged 13 weighed more and were taller compared to those in an earlier study of girls in the former Yugoslavia (Kurelić et al., 1975). In addition, three out of four skin folds values, determined in that study, were higher in our sample (Kurelić et al., 1975). Increase in subcutaneous adipose tissue as well as in height and weight were observed along both the chronological and biological age.

As it can be seen from descriptive data (Tables 3-6) and Figures 1-4 showing the representative values of skin folds thickness and adipose tissue percentage, the greater regularity in the increase of skin folds thickness and adipose tissue percentage is observed in relation to the biological than in relation to chronological age. Therefore, it can be concluded that the biological age is a better predictor of the increase of fat weight and its percentage than chronological age.

Discriminant analysis pointed to significant differences among subgroups formed according to chronological age, onset of menarche and secondary sex characteristics development. The subgroups formed according

Table 9. Discriminant analysis of skin folds in relation to axillary hair (3 groups N1=42, N2=102, N3=36)

VARIABLE	FUNCTION 1	FUNCTION 2
	CORRELATION	
SUBSCS	,67*	-,12
ABDOMS	,65*	-,18
THIGHS	,63*	-,17
INFORS	,58*	,21
TRICES	,54*	,07
QUADRS	,54*	-,34
BICEPS	,53*	-,03
COSTAS	,51*	-,08
MPUPAS	,49*	-,04
CALFS	,48*	-,10
UTSUAS	,45*	,17
LASLLS	,33*	-,24
ILIACS	,32*	-,13
METACS	,18*	-,03
AXILLS	,34	,38*
EIGENVALUE	,55	,23
PERCENT OF VARIANCE	70,72%	29,28%
CANONICAL CORRELATION	,60	

after function				
function	Wilks lambda	chi-square	degree of freedom	significance
0	,53	109,42	30	,00
1	,81	34,89	14	,00

to biological age expressed greater differences among themselves than subgroups formed according to chronological age as canonical correlation values and discriminant functions structure suggested (Tables 2, 7, 8, 9 and 10) as well as mean values and appropriate figures. Furthermore, with regard to onset of menarche, first four places belonged to skin folds variables of central and proximal body parts and the last one to metacarpal skin fold. Regarding the axillary hair the first three variables in connection with discriminant function were of central body part, and the last one was a metacarpal skin fold value. The first discriminant function reaching 63.93% of variability correlated only with central body and extremity proximal part skin fold values. It was similar in the case of pubic hair characteristic. The results of regression analysis pointed that the gynaecological age strongly and significantly correlated with skin fold values of the trunk and proximal extremity parts. As adipose tissue distribution is under the influence of variety of factors, hormones being among the strongest, the observed pattern of greater centripetal or centralised fatness in our study could be oestrogen contribution to moulding the body contours in a manner not entirely understood (Ganong, 1985).

Rather surprisingly according to this study, the girls seemed to show no effect of the war time siege of Sarajevo and continued positive secular trend in size and fatness that was reported before the war. Food intake in the city was low in general, and food was poor in nutritional composition. Considering the energy expenditure for activities and state of growth, it is hard to believe that the energy balance was possible. However, two years every day danger of shelling and snipers shooting imposed the sedentary way of life, especially to children. Thus, their energy requirement may have been lower than predicted by RDA and the deficit may not have been as large as it seemed at first glance. There have also been reports of a more long-term auto-regulatory positive interaction between metabolism and food supply; starved laboratory animals have reduced their resting energy output by 10-15% (Shephard, 1987).

Undoubtedly, the interactions between reduced food intake, weight loss and endocrine changes are very complex. Menstrual irregularities and amenorrhea have been shown to appear more often in case of low food intake associated with weight loss in sedentary females (Vigersky et al., 1977). However, approximately 50% of anorectic women exhibit amenorrhea before weight loss (Vigersky et al., 1977). With these data in mind it is easier to accept the previously mentioned results as 70% of the schoolgirls in this survey exhibited normal sexual maturation, estimated by onset of menarche. Furthermore, this given it seems that maturation indicators, and breast development, for instance, are better indicators of menarche than fatness.

Yet, we don't know the long term nutritional implications of dietary change associated with war conditions in Sarajevo. The low reported intakes of most of nutrients cannot be discounted simply because of the absence of clinical symptoms of undernutrition, and further exploration is certainly warranted.

Table 10. Discriminant analysis of skin folds in relation to breast development (5 groups N1=14, N2=24, N3=54, N4=78, N5=10)

VARIABLE	FUNCTION 1	FUNCTION 2	FUNCTION 3	FUNCTION 4
	CORRELATION			
ABDOM	,57*	,38	,05	-,02
SUBSCS	,52*	,35	,10	,35
THIGHS	,45*	,19	,20	,08
QUADRS	,43*	,31	,36	,16
MPUPAS	,41*	,18	,23	-,11
COSTAS	,38*	,20	,14	,23
BICEPS	,36*	,01	,12	,19
AXILLS	,11	,60	,24	,26
ILIACS	,19	,35*	,07	-,09
LASLLS	,20	,32*	,11	,04
TRICES	,30	,27	,58*	-,10
UTSUAS	,17	,17	,39*	-,05
METACS	,06	-,06	,28*	,24
INFORS	,27	,07	,27	,29*
CALFS	,24	,24	,03	,25*
EIGENVALUE	1,03	,27	,18	,13
PERCENT OF VARIANCE	63,93	16,66	11,42	7,99
CANONICAL CORRELATION	,71	,46	,39	,34

		after function		
function	Wilks lambda	chi-square	degree of freedom	significance
0	0,29	208,96	60	0,00
1	0,59	89,24	42	0,00
2	0,75	49,02	26	0,00
3	0,86	20,47	12	0,06

Conclusion

On a sample of 180 schoolgirls from two schools in Sarajevo, aged 12-14, distinct differences were found in skin fold values compared to chronological age, axillary hair, onset of menarche, and fewer differences concerning breast development and pubic hair. The gynaecological age was more influential than chronological age on all investigated variables of skin folds, fat weight and percentage of body fat, with the exception of metacarpal skin fold value. In addition, gynaecological age only correlated with skin fold values of the trunk and proximal extremity parts. Evident influences of both chronological and gynaecological age on total body fat, percentage of body fat and skin folds in the period of sexual maturation thus reflect, even in the war time siege of Sarajevo, a continuation of the positive secular trend in size and fatness reported before the war.

Table 11. Multiple regression analysis of skinfolds, fat weight and percentage of body fat as dependent variables and chronological and gynaecological age as independent variables

SUBSCS	Variables in the Equation					
Variable Multiple	R	B	SE B	Beta	T	Sig T
AGEMEN	.28221	1.58950	.33519	.54397	4.742	.0000
CHAGE	.39316	-1.46672	.44422	-.37875	-3.302	.0013
ABDOMS	Variables in the Equation					
Variable Multiple	R	B	SE B	Beta	T	Sig T
AGEMEN	37745	2.26693	.43825	.58150	5.173	.0000
CHAGE	.43360	-1.52537	.58081	-.29524	-2.626	.0097
METACS	Variables in the Equation					
Variable Multiple	R	B	SE B	Beta	T	Sig T
CHAGE	.24164	.59534	.21470	.24164	2.773	.0064
THIGS	Variables in the Equation					
Variable Multiple	R	B	SE B	Beta	T	Sig T
AGEMEN	.21757	1.86221	.57874	.38542	3.218	.0017
CHAGE	.27955	-1.55520	.76699	-.24288	-2.028	.0448
TRICES	Variables in the Equation					
Variable Multiple	R	B	SE B	Beta	T	Sig T
AGEMEN	.31711	2.21870	.44569	.56632	4.978	.0000
CHAGE	.41046	-1.87222	.59066	-.36059	-3.170	.0019
UTSUAS	Variables in the Equation					
Variable Multiple	R	B	SE B	Beta	T	Sig T
AGEMEN	.18832	.56368	.26399	.18832	2.135	.0347
BICEEPS	Variables in the Equation					
Variable Multiple	R	B	SE B	Beta	T	Sig T
AGEMEN	.22771	1.22889	.29339	.48846	4.189	.0001
CHAGE	.35526	-1.25796	.38883	-.37729	-3.235	.0016
QUADRS	Variables in the Equation					
Variable Multiple	R	B	SE B	Beta	T	Sig T
AGEMEN	.22731	3.03121	.65858	.52901	4.603	.0000
CHAGE	.38887	-3.31498	.87281	-.43654	-3.798	.0002
COSTAS	Variables in the Equation					
Variable Multiple	R	B	SE B	Beta	T	Sig T
AGEMEN	.20512	.65244	.27957	.20512	2.334	.0212
FATWEI	Variables in the Equation					
Variable Multiple	R	B	SE B	Beta	T	Sig T
AGEMEN	.31205	1.73183	.37526	.53089	4.615	.0000
CHAGE	.38697	-1.36896	.49733	-.31665	-2.753	.0068
% FAT	Variables in the Equation					
Variable Multiple	R	B	SE B	Beta	T	Sig T
AGEMEN	.23059	2.21770	.51934	.49672	4.270	.0000
CHAGE	.36143	-2.27846	.68827	-.38508	-3.310	.0012
N = 126						

AXILLS, MPUPAS,INFORS, LASLLS, ILIACS didn't enter the equation.

Legend: Multiple R - The correlation coefficient; B - the partial regression coefficient; SE B - standard error of B; Beta - Beta coefficient; T - T test; Sig T - significance of T.

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