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Indices of Body Build and Nutritional Status

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ABSTRACT In 1993, body mass index (BMI), subscapular-tricipital fatfold ratio (STFR) and waist-hip circumference ratio (WHI) were analysed in 1200 subjects from years of age 2-75 years old living in Progreso and Merida, Yucatan, Mexico. These data were compared with data for Mexican American (MA), Puerto Rican, Peru Indians, and Guatemala and Belize Maya children. In boys and girls before puberty changes of BMI are small. At ages 8-18 in boys and 7-16 in girls a moderate increase of BMI is observed in Peru, Guatemala and Belize (group A), but intensive occurs in Yucatecan, Mexican American (MA) and Puerto Rican (group B). The group A and B show separated areas of variance (developmental pathways) in late puberty period. In girls differences between 7 populations are smaller but BMI increase is more rapid in both groups, than in boys. After 18 years there are very small changes in BMI in Peruvians and very rapid ones in Yucatecans and MAs. In US Whites there is some increase, but on much lower rate, US Black are in between. In adults BMI is twice as large as before puberty. Until the age of 14 years changes of STFR are slow, than rapid in late puberty and in adolescence. At this age STFR is lower in children from Peru, higher in Guatemala, and Yucatan values are in between. Before puberty ratio is higher in girls than in boys, after in males than in females. In adult males a higher ratio is observed in Yucatecans and MAs, a medium one in US Whites and is lowest in Peru males; in females STFR is higher in Yucatecans, MAs and Peruvians than in Whites US. Both BMI and STFR increase with age. WHI generally decrease till puberty and then increase starting at age 15 in boys and 17 in girls. In age of 3-5 and of 45-65 years WHI is almost the same in males, and in age 4 and 65 in females. In adults, this ratio is highest in Yucatacans, medium in MAs and lowest in US Whites. Our analysis suggested that BMI must be related to ethnic differences in body build. Whereas STFR and WHI rather reflect nutritional status. A higher WHI is typical for populations from lower economic conditions, whereas a lower STFR is seen in both: in nutritional deprivation in poor populations, and is self restriction of nutrition in well-off social strata.

INTRODUCTION

Use of simple indices for evaluation of nutritional status is very important for both research and practical reasons. This is especially true for making epidemiological evaluations of individuals in developing countries and in personal control of nutritional status (Jeliffe, 1966; Wolanski, 1974). Several papers suggest relationships between such index as BMI and risk for some diseases, specifically the type II diabetes mellitus and gallbladder disease (Hartz et al., 1984; Haffner et al., 1986, 1989).

In 1963, I proposed a simple measure for undernutrition: arm circumference, which describes both the fat and muscle tissue nutritional deprivation. This "index" and my standards were popularized by Jeliffe (1966) in his WHO book. In studies of African tribes where ages of children were unknown, I originally suggested a relationship of arm circumference to stature instead of to age, if age was unknown. In the contemporary world, the problem of undernutrition still exists. Perhaps no less important is the problem of obesity. Half of the world populations is hungry, and the other half eats too much.

Standard values for body Mass Index are published (Cole, 1991; Rolland-Cachera et al., 1991; Prokopec and Bellisle, 1992). The original name of this index (BMI) is Kaup Index. It was created at the beginning of this Century (Martin and Saller, 1957). People continue to refer to it as the BMI = body mass index. The Kaup index is a ratio of body weight to height which is expressed as a square (this is mathematically incorrect, it should rather be expressed as a cube: relationship of mass to volume - see also Gasser et al., 1994 a, b). A high value for this index suggests a strong, plump body build and/or obesity. It is difficult to determine whether ratio of weight to height depends on genetic factors (a native population component), because of the so called living together effect (life style and environmental, mainly nutritional factors) and cultural nutritional habits.

In recent years, other indices have suggested an accumulation of fat tissue on the trunk (subscapular tricipital fatfold ratio - STFR, also called the centrality or centripetal index - Robson et al., 1971; Mueller and Kaplowitz, 1994), and waist-hip circumference index (WHI). At this time it is not clear what these indices really measure. The STF ratio is a proportion of a fat fold on the trunk and an upper extremity (subcutaneous fatfold on the arms above the triceps brachii). It measures the distribution of fat deposited on the body. The waist-hip circumference index is expressed as a ratio between accumulation of soft tissues, mainly fat, in the waist and hip areas (waist circumference expressed as a per cent of hip circumference).

Obesity and body fat distribution are independently associated with several metabolic properties of the organism (Stern and Haffner, 1986).

The purpose of this study is to present ontogenetic changes of the above mentioned indices and their levels in several different population and to suggest what they measure.

MATERIALS AND METHODS

Body mass (Kaup) index (BMI), subscapular-tricipital fatfold ratio (STFR) and waist-hip circumference index (WHI) were analysed in 1200 subjects aged 2-75 years from Progreso and Merida, Yucatan, Mexico (Table 1). In Poland, body mass index (BMI) and subscapular-tricipital fatfold ratio (STFR) were analysed in 3220 subjects aged 20-85 years.

Factor analysis was used for 23 somatic traits and indices related to body size, mass and shape on 324 males and 317 females 20 years and older from towns of Yucatan, in 444 males and 721 females living in Polish towns, and 951 males and 1104 females living in Polish villages.

RESULTS AND DISCUSSION

1. Age Changes and Sexual Dimorphism in Body Size, Mass and Fat Tissue Deposition

Body size was measured by body height and weight increases during a period of positive growth and decreases during periods of involution. Maximal values for stature are observed at about 20-30 years of age (decrease in stature was observed after age 40), and with respect to body weight for 35-45 year olds in Yucatan and 45-55 year olds in Polish populations. Because most data is based on cross-sectional studies, it is difficult to separate changes due to age from those due to secular trends (Trotter, 1951; Panek, 1978). In various populations, similar directions of changes but some differences in peak values with age, especially connected with body mass, are observed.

Although a fat tissue deposition change with age shows a more complicated pattern, this pattern is , however, similar among different populations (Wolanski, 1996). During the course of growth, we observed a preschool loss of adipose tissue, a prepubertal gain, followed by an adolescent loss in males. At about age 20 years females show some stabilization, then gain as attaining their peak value between ages 45-50, and finally a females exhibit a loss with age. This adult gain and loss of adipose tissue with age is much more evident in females. For some populations, adipose tissue changes in males after 30 are quite small.

In compared populations waist circumference increased similarly in both sexes until puberty, it was then larger in males, and continues to increase almost their whole life-span (Wolanski, 1994).

With respect to weight and fat deposits, correlations with the above traits were strong, they were a little weaker between weight and stature, but are very weak in Polish males and exist only between stature and fatfolds (Table 2). The correlation of body height to weight is greater in Polish and Yucatecan populations in males than in females, but correlation of weight and fatfolds is similar for the sexes. Waist circumferences are stronger correlated (Table 3) with body weight and subscapular fatfold, a little less strongly with triceps fatfolds, but do not correlated with stature.

The Mexican Americans were the tallest individuals in our study populations, the shortest, Peruvian Indians with Yucatecan in between and similar to Guatemalan and Belizean Maya. We

Table 1 : Mean values and standard deviation of Kaup Index (BMI), Waist-hip Index (WHI) and Subscapular-triceps-fatfold-ratio (STRF) in Yucatan population from Merida and Progreso

Age	Kaup (BMI) index				Waist-hip index				STFR ratio				Freqen.	
in	Male		Female		Male		Female		Male		Female		m	f
years	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	N	N
2	160.21	15.7	161.26	9.3	100.95	2.9	99.21	3.2	82.02	11.4	90.05	11.7	7	6
3	162.56	12.3	163.30	14.8	97.49	2.3	96.59	3.2	74.21	17.0	83.38	14.7	9	14
4	161.96	16.6	161.50	22.7	94.17	5.2	93.59	5.4	74.11	15.8	84.10	25.4	14	15
5	149.61	21.3	155.76	13.2	96.39	5.2	92.78	4.3	71.63	12.5	84.01	24.4	9	21
6	162.27	21.9	167.94	25.9	94.64	5.1	92.85	4.8	75.88	18.5	76.36	19.6	14	16
7	166.13	25.4	163.47	23.9	92.14	5.7	89.24	5.4	76.48	26.4	91.41	32.5	16	15
8	163.86	22.8	168.57	29.4	88.30	4.9	87.13	5.4	73.88	12.3	82.01	18.2	13	24
9	173.84	33.2	183.27	46.3	89.91	4.8	86.62	6.3	89.44	26.7	79.88	26.9	13	17
10	176.26	28.8	180.65	30.8	86.74	4.7	85.50	6.9	72.40	13.3	89.68	32.1	11	15
11	192.66	38.6	195.08	36.0	90.69	7.0	82.45	1.5	74.30	18.7	84.46	23.0	15	12
12	210.27	38.7	203.47	42.0	89.64	5.7	81.51	5.3	95.46	32.7	80.67	24.0	27	17
13	202.53	31.0	203.96	51.2	84.66	5.6	81.15	5.7	93.22	37.7	86.08	39.1	27	15
14	210.49	27.8	209.32	30.0	84.73	5.5	79.21	5.8	97.58	37.8	106.74	34.4	22	13
15	213.01	38.5	228.68	36.6	83.30	8.2	78.06	4.8	107.40	34.4	124.48	38.4	22	16
17	225.44	39.3	231.39	42.3	85.11	6.5	77.67	5.0	117.95	39.9	106.79	31.9	55	56
22	248.31	38.4	237.58	35.7	87.46	6.5	80.93	8.6	157.61	58.9	112.45	31.0	47	42
27	264.56	26.6	275.08	44.8	91.45	4.6	84.87	7.4	179.06	53.7	107.92	30.1	32	48
35	285.30	37.9	284.70	41.7	95.03	4.7	83.83	6.3	189.16	54.8	116.71	34.8	113	122
45	284.45	50.6	302.71	47.4	97.29	5.1	86.78	6.6	191.88	66.8	110.51	23.4	91	88
55	288.78	43.9	293.83	40.7	98.65	5.3	90.17	7.0	197.00	84.8	112.25	28.4	37	19
65	275.21	45.4	332.13	41.0	96.76	4.5	93.85	6.2	199.17	63.8	114.84	15.9	11	4
75	248.40		.	.	94.74		.	.	142.86		.	.	1	

observed the most abundant deposition of adipose tissue in Yucatecans. It was a little less in Mexican Americans, Puerto Ricans and Cubans, Smaller still in US Whites less in Poles with Peruvian Indians, showing the least (scanty).

Yucatecans, American Whites and Poles show similar patterns of subcutaneous fat thickness change with age-but different levels of fat accumulation.

Table 2: Correlation coefficients between body height, weight and subcutaneous fat tissue thickness (subscapular fatfold in Yucatan, sum of 10 fatfolds in Poland). Significant at * .001 and ** 01 level**

Population, group	Stature × weight	Stature × fat	Weight × fat
Yucatan males	.406***	-.014	.685***
-"- females	.372***	-.019	.558***
Poland town males	.477***	.092**	.728***
-"- -"- females	.306***	-.021	.749***
-"- village males	.513***	.127***	.809***
-"- -"- females	.309***	.033	.880***

Table 3 : Correlation coefficients between waist circumference and body weight, height and subcutaneous fat tissue thickness under scapula and at triceps in Yucatan populations. Significances as in table 2

Sex	Waist × weight	Waist × stat.	Waist × scap	Waist × tric
Males	.601***	.121	.742***	.419***
females	.800***	.047	.585***	.513***

2. *Indices of Body Build and Distribution of Fat Tissue: Age Changes and Sexual Differences*

The body mass index (also referees as Kaup index or relative body weight, BMI - Cole, 1991) have been suggested as a measure of nutritional status or physique differences. BMI is correlated with sitting height/stature ratio and Lean Body Mass, so is also "a measure of body build or body proportions" (Garn et al., 1986). The Kaup index (body mass expressed in grams as a percent of stature squared in cm) varies with a mean ranging from 140 to 340 and is 10 times higher than BMI (14-34).

Based on body builds (BMI) there appear to exist separate paths of ontogenetic changes for Yucatecans, Mexican Americans and Puerto Ricans. This path is somewhat different for Belizean (Crooks, 1994), Guatemalan (Bogin and MacVean, 1984) and Peruvian (Leatherman et al., 1995) Indians. For Poland and Czech populations the values was in a middle range.

Until about age 5 the BMI decreases. Then till about 45-55 years of age it increases (Table 1). The pre-pubertal ratio was higher for girls than for boys; the after-puberty value higher for males than for females.

Generally, BMI follows the same pattern (rhythm) orf ontogenetic changes, as (chapter 1) described above for fat tissue (Wolanski, 1998) : preschool loss, prepubertal gain, adolescent loss in males, and stabilization in females, then subsequent adulthood gain till peak value between ages 45-55, and finally loss with age of index values.

In Yucatan and MA girls BMI in age 10-19 it increased from 187 to 232. It was significantly higher than in American girls (Roche et al., 1990., Rycan et al., 1990, and others).

Changes of BMI in pre-pubertal boys were small. The slowest increase was observed in Peruvian, Guatemalan and Belizean boys and a more rapid one in Yucatecan, Mexican American (MA) and Puerto Rican boys.

For girls, differences between populations were less but BMI increase was a more rapid in girls than among boys.

After 18 years of age there were very small changes in BMI in Peruvian Indians and very great ones in Yucatecan and MA girls. In US Whites there was some increase, but to a much lower rate; US Blacks were between.

Maximal adult values varied in different populations from about 240 to 310. The highest BMI ratio is observed in Yucatecan and MA adults, a medium value was seen in US Whites and the lowest among Peruvian Indian males. BMI value was higher among Yucatecans, MA and Peruvians than among US White females. In our analysis, the greatest values were seen among females of Progreso and were smallest in US white females (Fig. 1-6). Variation between male groups was less.

US White adults and Peruvian Indians showed the lowest BMI. This is probably true for US Whites because of practices of weight control and for Peruvian Indians because of undernutrition.

Until age 14, in our populations changes of subscapular-triceps (centripetal) ratio (STFR) were slow. They were rapid in the late pubertal and adolescence periods (Table 1).

Subscapular-triceps (centripetal) ratio values for Yucatecan children were in a middle range. However for Guatemala Indians there was more fat accumulation on the trunk (Bogin and MacVean, 1984), it was lower for Peruvian Indians (Leatherman et al., 1995). Adult Yucatecans and Mexican Americans showed similar centripetal ratios, whereas for US Whites this ratio showed a proportionally much lower fat accumulation on the trunk (Fig. 7-8).

The waist-hip index generally decreased until puberty and increased starting at age 15 in boys and 17 in girls (Table 1). Between ages 3-5 and 45-65 years, this ratio was almost the same among males. Among females this occurs at age 4 and again at age 65. Adult values of this ratio were highest for Yucatecans, medium for MAs and lowest for US Whites. The waist to hip circumference measures was larger for males than for females, due to higher fat accumulation on the hips of women (Fig. 9).

3. *What BMI, STFR and WHI Measure (Results of Factor Analysis)*

As a result of factor analysis (FA) applied to 23 somatic traits and indices, 4 to 7 independent latent factors were found.

Because of relations between them, generally, as a rule in FA, we cannot directly join together measured traits and indices. However, one of the tasks in this paper was to analyse such connections.

In Poland, 10 fatfold measures were done, in Yucatan only two. In the final populations, we added circumferences of head, mid-arm, waist and hip, nose length and breadth, and frontal, shoulder and hip breadth measures. In a past program of field studies (see the list of factors in Tables 4-6) a different set of traits were used in the Yucatan and Polish populations. In

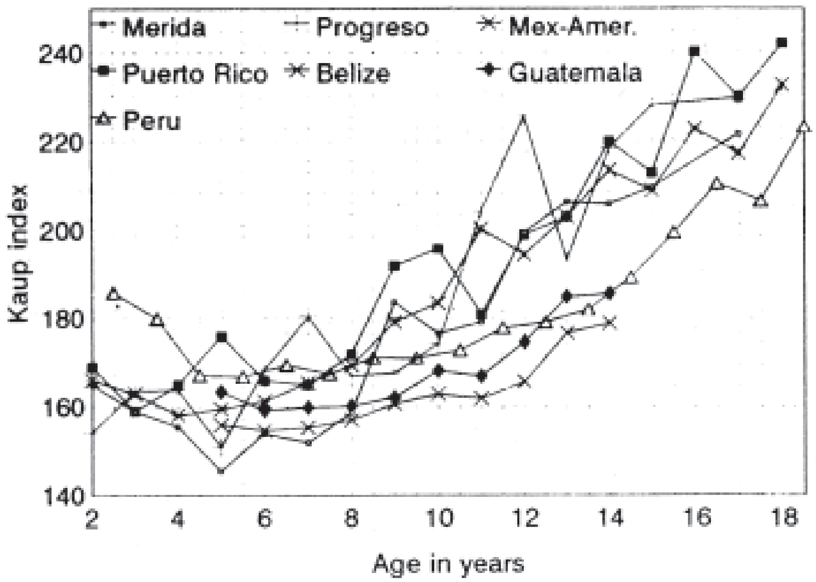

Fig. 1. Relative body weight (Kaup index) in 2-18 years old boys from Merida and Progreso in comparison with Mexican American, Puerto Rican, Belizean and Guatemalan Maya and Peruvian Indians (Data from Bogin and MacVean, 1984; Najjar and Rowland, 1987; Crooks, 1994 and Leatherman et al., 1995)

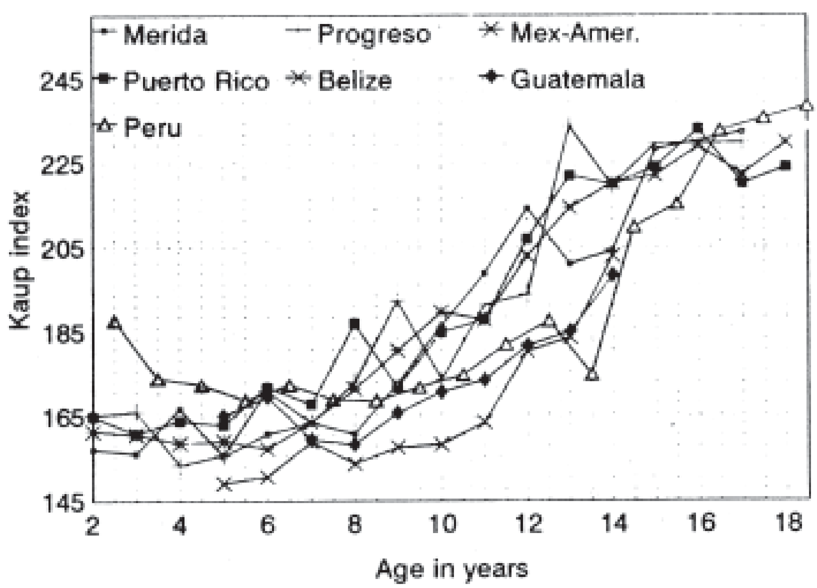

Fig. 2. Relative body weight (Kaup index) in 2-18 years old girls from Merida and Progreso in comparison with Mexican American, Puerto Rican, Belizean and Guatemalan Maya and Peruvian Indians (Data from Bogin and MacVean, 1984; Najjar and Rowland, 1987; Crooks, 1994 and Leatherman et al., 1995)

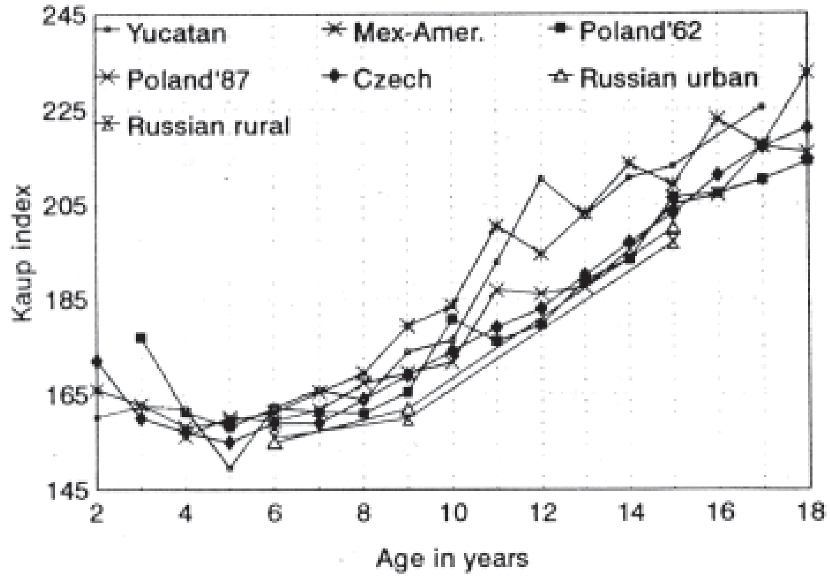

Fig. 3. Relative body weight (Kaup index) in Yucatan boys 2-18 years old in comparison with Mexican American, Poles, Czech and Russian (Data from Wolanski, 1962, 1987; Najjar and Rowland, 1987; Prokopec and Belliste, 1992 and Spurgeon et al., 1994)

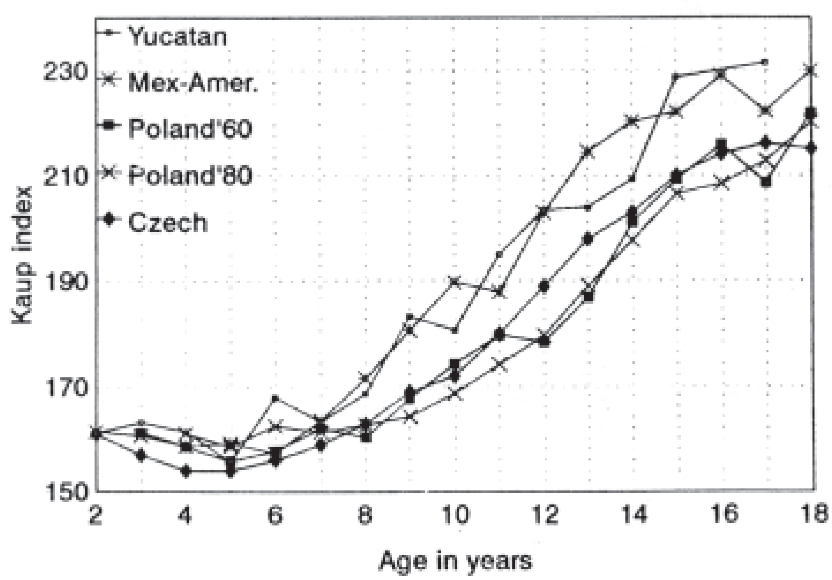

Fig. 4. Relative body weight (Kaup index) in Yucatan girls 2-18 years old in comparison with Mexican American, Poles and Czech (Data from Wolanski, 1962, 1987; Najjar and Rowland, 1987 and Prokopec and Belliste, 1992)

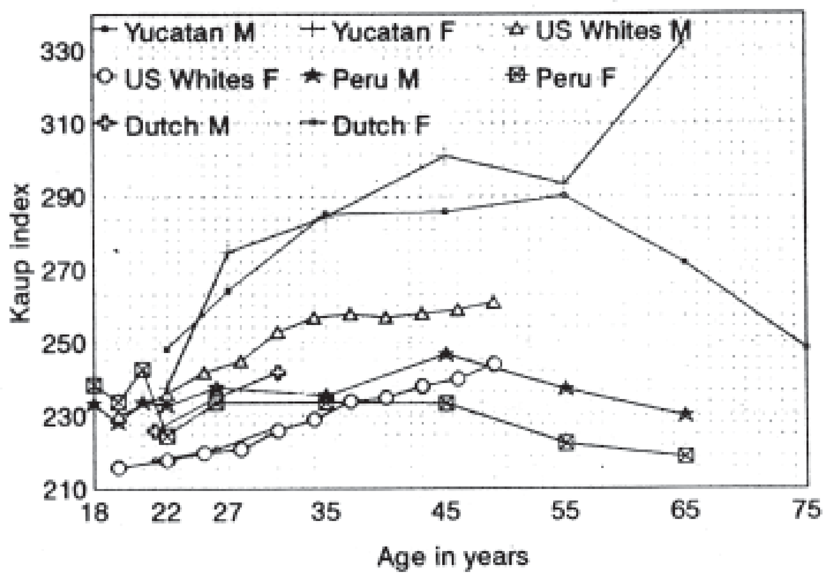

Fig. 5. Relative body weight (Kaup index) in Yucatecans 19-75 years old in comparison with US White, Peru Indian and Dutch (Data from Cronk and Roche, 1982; Roos, 1986; Najjar and Kuczmarski, 1989 and Leatherman et al., 1995)

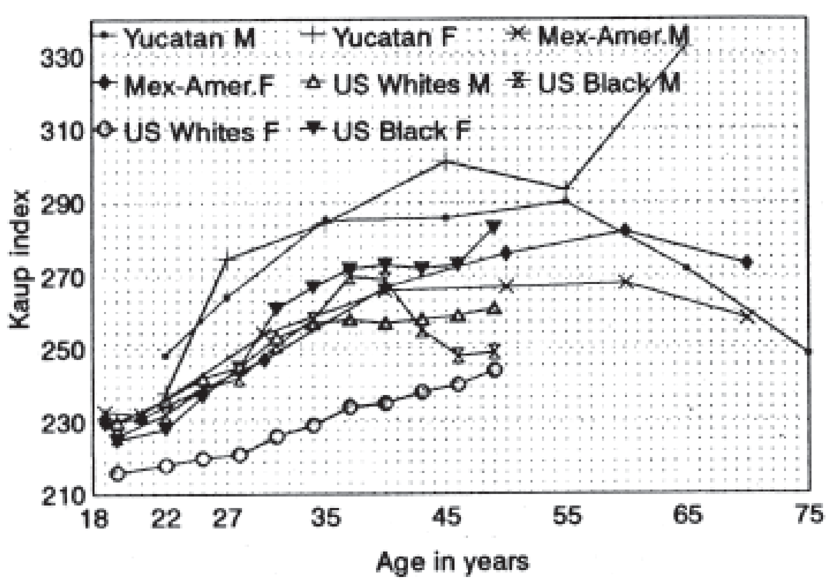

Fig. 6. Relative body weight (Kaup index) in Yucatecans 19-75 years old in comparison with Mexican American and US White and Black (Data from Cronk and Roche, 1982 and Najjar and Kuczmarski, 1989)

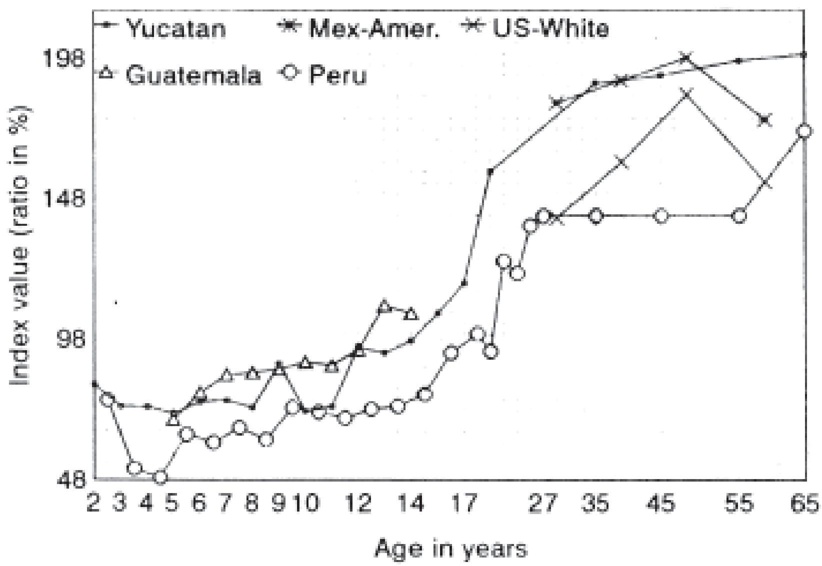

Fig. 7. Subscapular-triceps fatfold ratio in males from Yucatan, Guatemala, Peru Indian, Mexican Americans and US Non-Hispanic Whites (Data from Bogin and MacVean, 1984; Haffner et al., 1986, and Leatherman et al., 1995)

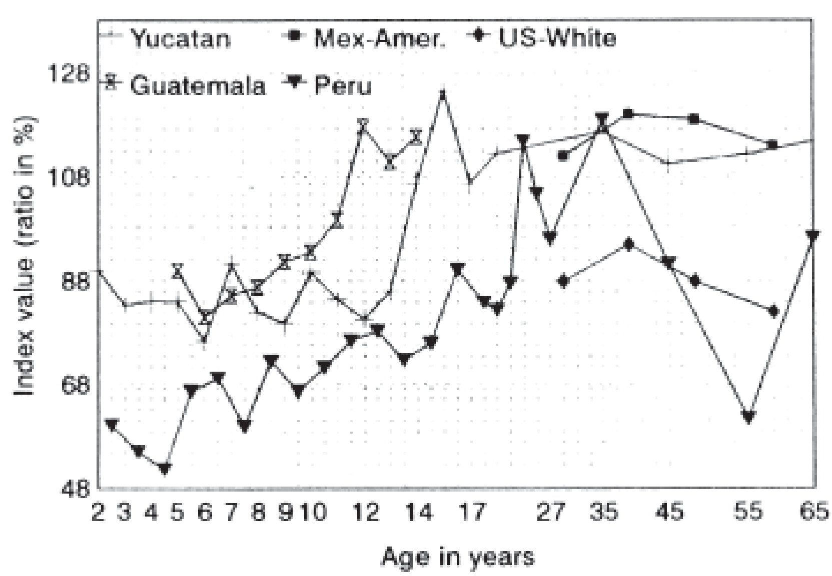

Fig. 8. Subscapular-triceps fatfold ratio in females from Yucatan, Guatemala, Peru Indian, Mexican Americans and US Non-Hispanic Whites (Data from Bogin and MacVean, 1984; Haffner et al., 1986 and Leatherman et al., 1995)

Poland, analysis of arterial blood pressure was included because of its association with some heart diseases.

In the Yucatan population, seven factors were identified, their names are the same for males and females but they include a slightly different components (measured traits; Table 7-8). BMI and Quetelet index (W/H) constituted factor one (F1). F1 which explained the highest per cent of variation was associated with body weight, and with most of the circumference and fatfold (and among males also with nose breadth) values.

Among females, centripetal ratio (STFR) was a fourth factor, associated with nose breadth. It was sixth in males, and was associated with tricipital fatfold.

1,98%) with chocolate drinks (Siniarska, 1995).

The last factor (F7) named waist-hip index only in females was independent. For males was associated with hip circumference.

In Poland samples, (Tables 9-12) five factors were found (four for village females). In all four cases, the first factor (F1) was associated with BMI and Quetelet index, fatfolds and chest circumference (for females living in villages and towns also with body weight). Centripetal ratio was not associated with any other traits, nor with their components. Except for body height in village-dwelling females, blood pressure was not associated with any trait nor indices under study.

It was interesting that a body size factor based on stature was associated with head

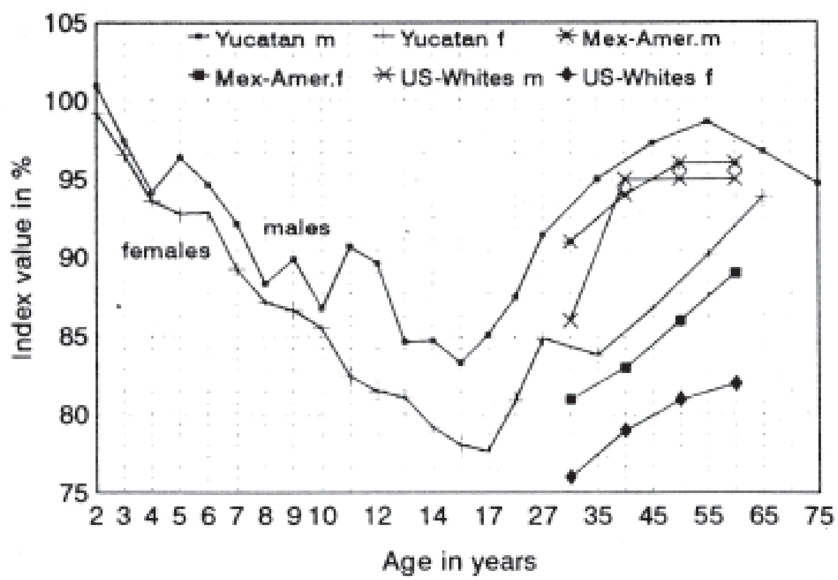

Fig. 9. Waist-hip index in Yucatecans, Mexican Americans and US Whites (Own data for Yucatan, other from Haffner et al., 1996)

For Yucatecan populations, variation of STFR is negatively correlated (depended in 1.66%) with a factor named consumption of carbohydrate. Variation of BMI is related positively (depended in 1.87%) with consumption of alcoholic drinks (beer mainly), and negatively (in

length or facial height, and that a head size factor based on face and head breadths was independent from body size.

Our analysis suggested that BMI was somewhat related to ethnic differences in body build (proportions), whereas STFR and WHI reflected

Table 4: Mean values and standard deviations of traits under study 324 males and 317 females over 20 years old from towns of Yucatan

Trait	*Males*		*Females*	
	Mean	*Std Dev*	*Mean*	*Std Dev*
Body weight W	71.39	11.876	62.56	11.291
Body height H	160.41	6.451	148.39	5.797
Shoulders breadth a-a	376.12	19.204	340.25	17.770
Hip breadth ic-ic	281.77	24.286	292.81	26.757
Head lenght g-op	186.50	6.184	175.59	5.879
Head breadth eu-eu	161.51	5.802	155.19	5.738
Frontal breadth ft-ft	109.47	5.715	106.11	6.135
Facial breadth zy-zy	146.95	5.425	141.48	5.783
Face height n-gn	117.46	6.042	111.53	6.082
Nose length n-sn	51.33	3.777	48.14	3.695
Nose breadth al-al	40.88	3.399	35.71	3.160
Head circumference	56.90	1.584	54.80	1.632
Mid-air circumference	30.95	2.842	29.50	3.512
Chest circumference	94.05	7.790	86.39	9.266
Waist circumference	93.47	10.812	87.25	11.724
Hip circumference	98.50	10.319	102.15	11.381
Fatfold subscapular	24.21	8.604	32.19	9.691
Fatfold thickn. arm	13.96	5.788	29.36	9.013
Kaup index (BMI) W/H2	277.24	42.352	283.91	47.358
Subscap-tricip. ratio STFR	186.09	63.774	113.09	30.411
Waist-hip index WHI	97.18	47.034	87.78	46.839
Quetelet index W/H	444.55	68.786	421.14	71.296
Shoulder-hip index	134.22	10.780	116.84	8.806

Table 5: Mean values and standard deviations of traits under study 721 females from towns and 1104 females from villages over 20 years old from Poland

Trait	*Towns*		*Villages*	
	Mean	*Std Dev*	*Mean*	*Std Dev*
Body height b-v	157.14	5.574	157.37	6.196
Body weight bw	65.25	11.588	64.19	12.822
Fatfold thickn. cheek	9.36	2.881	10.17	2.744
Fatfold thickn. chin	10.71	3.882	9.28	3.564
Fatfold thickn. axillary	11.38	6.486	8.62	5.646
Fatfold thickn. arm	18.32	7.242	16.96	7.875
Fatfold thickn. scapular	20.03	9.205	19.33	10.289
Fatfold thickn. abdomen	24.33	11.598	25.11	15.451
Fatfold thickn. 10 rib	17.95	8.525	16.15	9.421
Fatfold thickn. hip	18.71	10.182	18.08	12.424
Fatfold thickn. tigh	18.83	9.632	15.31	7.837
Fatfold thickn. shank	14.62	7.539	12.43	6.852
Chest circumference res	84.58	8.221	82.64	8.812
Head lenght g-op	177.83	5.918	180.29	6.494
Head breadth eu-eu	152.41	5.638	152.59	5.561
Total facial height n-g	107.59	7.239	110.10	7.038
Facial breadth zy-zy	132.31	7.882	135.22	5.667
Kaup index (BMI)	264.27	45.209	259.24	49.994
Systolic blood pressure	124.96	20.442	130.39	22.946
Diastolic blood pressure	76.81	12.597	79.67	11.885
Subscap-tricip. ratio STFR	112.71	40.069	118.83	50.987
Quetelet index	415.02	70.779	407.65	78.446
Sum of 10 fatfolds	248.86	68.994	234.14	75.410

Table 6 : Mean values and standard deviations of traits under study 444 males from towns and 951 males from villages over 20 years old from Poland

Trait	*Towns*		*Villages*	
	Mean	*Std Dev*	*Mean*	*Std Dev*
Body height b-v	169.71	6.261	169.18	6.669
Body weight bw	72.60	11.044	69.69	11.423
Fatfold thickn. cheek	8.56	2.946	8.69	2.612
Fatfold thickn. chin	7.96	3.457	7.25	2.962
Fatfold thickn. axillary	8.45	5.064	6.21	4.188
Fatfold thickn. arm	9.27	4.647	7.79	4.287
Fatfold thickn. scapular	12.93	6.092	11.24	6.312
Fatfold thickn. abdomen	15.65	9.904	14.88	10.674
Fatfold thickn. 10 rib	12.61	7.021	10.15	6.415
Fatfold thickn. hip	12.61	7.702	11.62	8.286
Fatfold thickn. tigh	9.60	5.612	8.29	4.024
Fatfold thickn. shank	7.88	4.696	6.80	4.181
Chest circumference rest	93.47	6.784	91.98	6.813
Head length g-op	186.94	6.764	189.33	7.458
Head breadth eu-eu	159.42	6.400	158.71	6.340
Total facial height n-gn	117.64	7.764	119.55	7.375
Facial breadth zy-zy	141.02	8.429	142.76	6.718
Kaup index	251.74	33.617	243.06	34.519
Systolic blood pressure	126.89	14.892	130.46	18.593
Diastolic blood pressure	77.29	10.560	80.25	11.147
Subscap-tricip.rat.STFR	149.92	53.816	153.95	66.274
Quetelet index	427.21	58.929	411.28	60.942
Sum of 10 fatfolds	199.05	52.613	184.95	50.604

Table 7: Factor analysis of selected somatic traits and indices in Yucatecan populations - 317 females over 20 years old from towns

Rotated Factor Matrix	*FAC 1*	*FAC 2*	*FAC 3*	*FAC 4*	*FAC 5*	*FAC 6*	*FAC 7*
Kaup index (BMI) W/H2	.949	.177	.071	.022	-.070	.054	-.002
Quetelet index W/H	.942	.241	.038	.048	.107	.021	-.030
Chest circumference	.913	.150	.145	.005	.078	.072	.020
Body weight W	.890	.289	.004	.069	.268	-.009	-.054
Waist circumference	.874	.105	.143	.046	.028	.119	.073
Mid-arm circumference	.861	.145	.075	.105	.041	-.092	.022
Hip circumference	.740	.152	.096	.065	.077	-.042	-.562
Fatfold thickn.arm	.640	.033	.380	.177	-.010	-.452	.031
Fatfold subscapular	.616	.036	.464	.187	.043	.224	.125
Head breadth eu-eu	.033	.831	.123	-.016	.054	.060	.029
Head circumference	.219	.813	.091	.235	.157	-.025	.020
Face breadth zy-zy	.284	.742	.066	-.040	.019	.004	.013
Head length g-op	.167	.638	-.050	.214	.203	-.046	.028
Frontal breadth ft-ft	.159	.548	-.496	-.039	-.045	.024	-.180
Shoulder-hip index	-.365	-.167	-.710	.089	.209	.062	.213
Hip breadth ic-ic	.571	.179	.660	-.022	.230	.049	-.149
Nose length n-sn	.011	.008	.076	.897	.061	.051	-.029
Face height n-gn	.213	.276	-.110	.789	.091	-.068	-.094
Body height H	.014	.316	-.141	.125	.771	-.134	-.115
Shoulders breadth a-a	.468	.089	.144	.079	.702	.168	.019
Subscap-tricip.ratio	-.020	-0.008	.075	-.001	.071	.914	.148
Nose breadth al-al	.369	.046	-.112	.043	-.290	.476	-.114
Waist-hip index WHI	.093	.072	-.070	-.089	-.052	.081	.926
% of common variation	38.6	11.6	7.3	6.3	5.2	4.9	4.8 =
						Total	78.6%
Identification of factor	body mass	face size	trunk build	nose size	body size	soft tiss	WHI

Table 8 : Factor analysis of selected somatic traits and indices in Yucatecan populations - 324 males over 20 years old from towns

Rotated Factor Matrix	*FAC 1*	*FAC 2*	*FAC 3*	*FAC 4*	*FAC 5*	*FAC 6*	*FAC 7*
Kaup index (BMI) W/H2	.931	.200	-.046	.092	.067	.044	-.031
Quetelet index W/H	.913	.245	.176	.113	.073	.040	-.031
Waist circumference	.896	.101	.029	.247	.133	.017	-.013
Chest circumference	.876	.156	.144	.168	.087	.107	-.014
Body weight W	.843	.271	.372	.125	.074	.033	-.029
Fatfold subscapular	.841	.116	-.096	.060	-.030	-.057	.034
Mid-arm circumference	.832	.151.	.097	.078	-.007	.015	-.002
Nose breadth al-al	.386	-.048	-.047	.013	.142	.363	-.058
Head breadth eu-eu	.166	.845	-.076	.006	.022	-.045	-.016
Head circumference	.248	.794	.298	.109	.177	.016	-.019
Facial breadth zy-z	.433	.718	.087	.063	.008	.008	-.000
Head length g-op	.028	.536	.381	.187	.228	.092	-.014
Frontal breadth ft-ft	.074	.496	.380	-.224	-.058	.115	.038
Body height H	-.025	.189	.875	.080	.024	-.029	-.000
Shoulders breadth a-a	.396	.139	.652	-.178	.200	-.055	.012
Shoulders-hip index	-.223	-.033	.163	-.938	-.009	-.024	.033
Hip breadth ic-ic	.464	.106	.227	.777	.114	-.007	-.024
Nose lenght n-sn	.054	.068	-.081	.085	.890	.050	.020
Face height n-gn	.128	.120	.313	-.013	.764	-.049	-.035
Subscap-tricip.ratio	.319	.105	-.035	.023	-.020	.850	.026
Fatfold thickn. arm	.495	.008	-.050	.017	.045	-.809	.001
Waist-hip index WHI	.110	.019	.059	.019	.008	-.009	.955
Hip circumference	.593	.078	.121	.159	.043	-.008	-.672
% of common variation	37.5	11.4	6.9	6.6	5.8	5.7 total	4.7 = 78.5%
Identification of factor	body mass	head size	body size	trunk build	face height	fat fold	WHI

nutritional status. A higher WHI value was typical for populations of lower economic strata whereas higher STFR value was seen in extreme situations: of nutritional deprivation in poor populations and of diet restriction in well-off populations.

CONCLUSIONS

Use of fatfold thickness, arm circumferences and Kaup index (BMI) measures of Yucatecan populations and of US Whites and Polish populations showed that inhabitants of Yucatan had abundant fat tissue, and even showed a tendency for obesity.

Kaup (BMI) index follows the same rhythm of ontogenetic changes which is typical for all studied populations of different ethnic groups and economic levels. Kaup index probably expressed constitutional factors (under genetic control) in its quality (rhythm of changes) and nutritional factors in its quantity (thickness of fat layers).

High WHI values were typical for populations in poorer economic conditions. High STFRs were typical for extreme conditions: nutritional deprivation in poor populations and restriction of diet in well-off social strata.

BMI was related to ethnic differences in body build, whereas the SFTR and WHI values reflected nutritional status.

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Table 9 : Factor analysis of selected somatic traits and indices in Polish populations - 721 females over 20 years old from towns

Rotated Factor Matrix	*FAC 1*	*FAC 2*	*FAC 3*	*FAC 4*	*FAC 5*
Sum of Fatfolds	.982	.084	.125	.046	.013
Fatfold thickn.hip	.870	-.008	.042	.200	-.030
Fatfold thickn. scapular	.858	.069	.068	.315	.000
Fatfold thickn.abdomen	.851	.086	.156	.092	-.077
Fatfold thickn.arm	.846	.138	.052	-.294	-.029
Fatfold thickn.10 rib	.834	.132	.008	.204	-.110
Kaup index (BMI) W/H2	.811	.382	.145	.239	-.078
Quetelet index W/H	.801	.438	.083	.246	.057
Fatfold thickn.chin	.790	-.031	.081	.028	.118
Body weight W	.758	.473	.020	.244	.186
Fatfold thickn. shank	.748	-.059	.138	-.316	.137
Fatfold thickn.axillary	.747	-.021	.172	-.006	.058
Fatfold thickn. tigh	.744	.005	.161	-.314	.017
Chest circumference rest	.665	.410	.094	.387	.062
Fatfold thickn.cheek	.586	-.193	.186	-.097	.257
Facial bready zy-zy	.086	.843	-.004	-.023	-.063
Total facial height n-gn	-.009	.649	-.099	.057	.129
Head breadth eu-eu	.107	.547	.039	-.188	.234
Systolic blood pressure	.187	.023	.892	.097	-.097
Diastolic blood pressure	.213	-.081	.887	-.021	.121
Subscap-tricip.rat.STFR	.138	-.083	.068	.861	.039
Head length g-op	.085	.079	.201	.027	.786
Body height H	-.052	.261	-.286	.026	.656
% of common variation	45.5	10.2	6.6	6.4 total	4.8= 73.5%
Identification of factor	body build	head size	blood pressure	centripetal	body size

Table 10 : Factor analysis of selected somatic traits and indices in Polish populations - 1104 females over 20 years old froms villages

Rotated Factor Matrix	*FAC 1*	*FAC 2*	*FAC 3*	*FAC 4*
Sum of 10 fatfolds	.975	.149	.103	.042
Fatfold thickn. 10 rib	.887	.090	.097	.146
Quetelet index W/H	.885	.312	.137	.072
Fatfold thickn.hip	.875	.154	.074	.187
Kaup index (BMI) W/H2	.874	.221	.232	.118
Fatfold thickn.scapular	.861	.093	.078	.363
Body weight W	.860	.388	.041	.025
Fatfold thickn.arm	.827	.154	.057	-.336
Fatfold thickn.abdomen	.809	.172	.158	.265
Chest circumference rest	.800	.282	.203	.167
Fatfold thickn.chin	.788	.097	.033	-.070
Fatfold thickn.tigh	.762	-.019	-.088	-.357
Fatfold thickn.shant	.732	.044	-.057	-.430
Fatfold thickn.axillary	.711	.155	.175	-.259
Fatfold thickn.cheek	.573	-.077	.151	.117
Facial breadth zy-zy	.185	.720	.117	.121
Head breadth eu-du	.090	.713	.019	.088
Head length g-op	.101	.590	.043	-.110
Total facial height n-gn	.133	.545	-.159	-.082
Systolic blood pressure	.208	.004	.888	-.032
Diastolic blood pressure	.219	.050	.861	-.019
Body height H	.038	.446	-.464	-.228
Subscap-tricip.rat. STFR	.197	-.048	.004	.872
% of common variation	48.5	9.3	7.3 total	6.3 = 71.4%
Identification of factor	body mass	head size	body s. b. pres.	centripetal

Table 11 : Factor analysis of selected somatic traits and indices in Polish populations - 444 males over 20 years old from towns

Rotated Factor Matrix	*FAC 1*	*FAC 2*	*FAC 3*	*FAC 4*	*FAC 5*
Sum of fatfolds	.972	.160	.037	.120	.067
Fatfold thickn.scapular	.860	.064	.056	.053	.312
Fatfold thickn. 10 rib	.859	.053	.044	.074	.217
Fatfold thickn. abdomen	.852	.131	.009	.060	.160
Fatfold thickn.axillary	.849	.029	.086	.136	-.079
Fatfold thickn. hip	.827	.097	-.067	.041	.098
Fatfold thickn. arm	.822	.166	.054	-.022	-.324
Fatfold thickn. chin	.803	.045	.124	.146	-.040
Fatfold thickn. shank	.792	.160	-.180	.155	-.186
Fatfold thickn.tigh	.780	.006	-.065	.165	-.221
Kaup index (BMI) W.H2	.716	.315	.243	.179	.361
Fatfold thickn.cheek	.689	.057	.087	.261	-.087
Quetelet index W/H	.689	.528	.233	.154	.294
Chest circumference rest	.592	.528	.232	.157	.324
Body height b-v	-.008	.812	-.022	-.057	-.200
Body weight bw	.623	.680	.207	.123	.217
Head lenght g-op	.089	.474	.314	.335	-.056
Facial breadth zy-zy	.073	.017	.852	-.023	.158
Total facial height n-gn	-.094	-.000	.737	.004	-.122
Head breadth eu-eu	.136	.330	.589	-.016	.038
Diastolic blood pressure	.298	.026	-.013	.846	.052
Systolic blood pressure	.131	.073	-.037	.843	.114
Subscap-tricip.rat. STFR	-.037	-.088	.002	.114	.869
% of common variation	46.7	10.3	7.0	5.9 total	4.9= 74.7%
Identification of factor	body build	body size	head size	blood pressure	centripetal

Table 12 :Factor analysis of selected somatic traits and indices in Polish populations - 951 males over 20 years old from villages

Rotated Factor Matrix	*FAC 1*	*FAC 2*	*FAC 3*	*FAC 4*	*FAC 5*
Sum of 10 fatfolds	.979	.099	.086	.065	.077
Fatfold thickn. scapular	.903	.053	-.212	.060	.011
Fatfold thickn.hip	.900	.053	-.009	.003	.087
Fatfold thickn. 10 rib	.894	-.013	.026	.075	.032
Fatfold thickn. adbomen	.886	.120	-.057	.039	.049
Kaup index (BMI) W/H2	.869	.250	-.092	.107	.101
Quetelet index W/H	.852	.254	-.069	.082	.313
Fatfold thickn. chin	.842	.110	.024	.078	-.024
Body weight W	.787	.242	-.044	.055	.479
Fatfold thickn. axillary	.771	.103	.339	.046	.064
Fatfold thickn.arm	.739	.051	.544	.027	.009
Chest circumference rest	.733	.298	-.193	.131	.299
Fatfold thickn. tigh	.691	-.010	.485	.035	.068
Fatfold thickn. shank	.683	.015	.514	-.004	.040
Fatfold thickn. cheek	.646	.002	-.138	.170	-.130
Facial breadth zy-zy	.162	.827	-.091	.061	.023
Head breadth eu-eu	.103	.791	-.000	-.108	.074
Head length g-op	.090	.549	.131	-.004	.294
Subscap-tricip.rat.STFR	.296	.008	-.853	.019	-.006
Systolic blood pressure	.124	-.049	.032	.915	.006
Diastolic blood pressure	.132	-.000	-.033	.903	-.033
Body height H	.060	.055	.066	-.088	.814
Total facila height n-gn	.067	.171	-.030	.046	.680
% of common variation	47.3	9.4	8.1	6.4 total	4.7= 75.9%
Identification of factor	body build	head size	centripetal r	blood pressure	body size

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