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A STUDY OF ADULT HEIGHT, WEIGHT, AND OBESITY IN SHIRAZ, IRAN, 1988-1989.

S.M.TAGHI AYATOLLAHI, Ph.D. AND R.G.CARPENTER, Ph.D.

From the Department of Biostatistics, Shiraz University of Medical Sciences, Shiraz, Islamic Republic of Iran, and the Medical Statistics Unit, London School of Hygiene and Tropical Medicine, London WC1E 7HT, England.

ABSTRACT

Height, weight and body mass index (BMI) of married adults aged 20-69 years with a school-aged child in Shiraz (Iran) are reported. Smoothed centile values have been derived from the raw data by Healy's nonparametric method. Factors affecting obesity of adults are examined. Shiraz adults are taller and heavier than most adults from developing areas of the world, but are shorter and lighter than most European countries. They are substantially bigger than previously reported. The results provide normal ranges of height, weight and body mass index (BMI) appropriate for clinical work in Iran.

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INTRODUCTION

The data on adult sizes and growth are extremely limited, even in the developed world. The only available data on adult size of Iranians pertain to two selective studies carried out more than 20 years ago. One relates to females aged 26-31 and males 20-30 years in a small village in southern Iran,[8] and the other is restricted to 120 females (>20 years) in a northern urban area.[15]

This paper examines the heights, weights, obesity and factors affecting obesity of adults aged 20-69 years, living in Shiraz, a major city in the south of Iran.

METHODS AND MATERIALS

The data relate to the parents of a random sample of children of Shiraz aged 6-12 years who were measured in the academic year 1988-89. The sample of 1207 children. including absentees when the main survey was conducted, was drawn from the population of school children in the four educational districts of the city using a multistage design.[1]

Data on the parents were obtained by questionnaire. Each questionnaire had two parts. The first part provided information relevant to the child growth and the second asked for data on the parents. The questionnaire was completed with the co-operation of the relevant teachers and principals of the schools who were familiar with childrens' families. If the parents had no special problem such as addiction or divorce and had at least nine years schooling they completed the questionnaires themselves. If these parents were uncertain about a measurement, they were advised to leave it blank. In the event of any difficulty, they had access to their childrens' school authorities for help. Parents who did not fulfill the above criteria were invited to come to the school by an appointment. The questionnaire was then filled out in a face to face interview with a member of the survey staff and their heights and weights were measured as follows:

Standing height was measured using a rule installed on the wall and a set square (goniometer), with the adult standing in stocking feet with feet together and

Table I. Correlation of height, weight and body mass index with number of children for mothers and fathers after adjusting for age.

	Mothers	Fathers
Height	−0.098**	−.0.02
Weight	−0.000	−0.03
BMI	+0.075	+0.01

** P<0.01

Table II. Distribution of height(cm.) by age

All	Age groups									
	ages	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69
male											
Mean	169.8	—	174.3	171.5	170.4	169.1	168.7	169.5	168.1	164.4	166.7
SD	7.2	—	8.9	8.9	8.2	8.5	9.9	9.7	9.7	10.6	14.4
SE	0.3	—	2.1	0.7	0.6	0.9	1.2	1.5	2.2	2.2	4.8
SK	−0.2	—	−0.0	−0.0	−0.1	−0.4	−0.3	0.1	0.4	−0.6	−0.8
KR	0.8	—	−1.0	−0.8	0.7	1.6	0.8	0.3	−0.0	0.0	0.1
N	907	—	19	173	249	189	127	63	42	23	9
Female											
Mean	158.9	159.8	159.2	158.5	159.0	158.9	158.1	158.0	155.0	—	—
SD	8.6	7.2	8.5	8.6	8.7	8.7	9.5	9.7	10.0	—	—
SE	0.3	1.3	0.6	0.5	0.6	0.9	1.4	1.4	3.4	—	—
SK	0.2	−0.2	0.3	−0.1	0.2	0.2	1.0*	1.6*	2.0*	—	—
KR	0.2	1.0	0.3	−0.5	0.6	0.3	2.0	3.2	4.0*	—	—
N	939	30	225	314	211	91	45	8	4	—	—

* P<0.01

N.B. In all tables:

1. SD (standard deviation), SE (standard error), SK (Skewness), KR (kurtosis) 2. Insufficient or complete absence of data in a table cell has been represented by a dash (-) and non-zero percentages of less than 0.5% have been shown as 0.

back and heels against the upright wall. Weights measured by the survey team were taken without shoes or heavy outer clothing and using a bathroom scale. This type of scale is placed on the ground and adults stand on the weighing platform.[11]

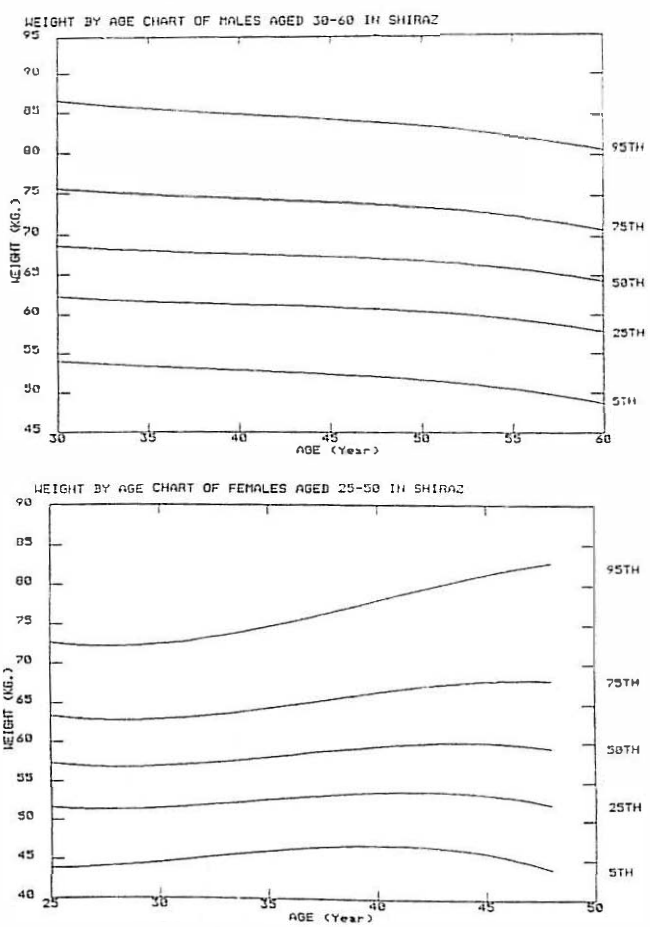
Standardized examination clothing with approximate weights between 300 to 500 grams were used. Instruments were calibrated before each measurement session.

In Iran, adequately educated parents are generally well aware of their heights and weights, and our impression is that those who were not measured but reported them did so conscientiously and accurately.

Height is an important determinant of weight, and a study of obesity requires an index of weight that takes account of height. We have adopted Quetelets' Index, otherwise known as the body mass index, BMI, which is defined as Weight/Height^2; in metric units, kg/m^2. This is easy to calculate,[3] and is widely used in epidemiological research, e.g., in study of severe obesity and coronary heart disease in civil servants by Jarret et.al.[7]

Any definition of obesity in terms of BMI is arbitrary, but for comparative purposes we tabulated our data using three thresholds which are commonly used: underweight, BMI=20.0 or less; normal weight, 20<BMI≤30; obese, BMI over 30.0.[13]

The statistical package for the Social Sciences[14] and MINITAB[10] were used for basic calculations and general statistics purposes. Healy's distribution free method[6] was applied to calculate smooth centiles. The method has been implemented for WHO in the GROSTAT PC computer package.[5] Generalised linear modelling was applied using GLIM software[4] to examine the effects of social class and age on adult sizes.



Figs.1a (Top) and 1b (Bottom)

Table III. Distribution of weight (kg.) by age

All	Age groups								
Weight	**ages**	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**50-54**	**55-59**	**60-64**
Males:										
Mean	68.0	—	66.6	68.9	68.6	68.5	66.4	68.1	66.5	62.2
SD	10.0	—	12.2	10.4	8.9	10.4	9.6	10.1	9.7	9.1
SE	0.3	—	2.8	0.8	0.6	0.7	0.9	1.2	1.5	1.8
SK	0.3	—	0.5	0.4	0.2	0.2	0.3	0.7	−0.1	−0.2
KR	0.3	—	1.7	−0.0	0.7	0.2	0.2	−0.2	1.4	−0.2
N	954	—	19	189	265	208	125	69	43	26
Females:										
Mean	58.6	56.9	57.6	58.3	58.9	60.6	61.3	—	—	—
SD	9.3	7.7	8.9	8.8	9.3	10.1	11.4	—	—	—
SE	0.3	1.3	0.6	0.5	0.6	1.0	1.7	—	—	—
SK	0.8*	1.2*	0.7*	0.2	0.4	1.0*	0.9*	—	—	—
KR	1.0	3.8	0.7	−0.2	1.0	1.0	1.3	—	—	—
N	1014	36	246	334	232	101	48	—	—	—

* $P<0.01$

RESULTS

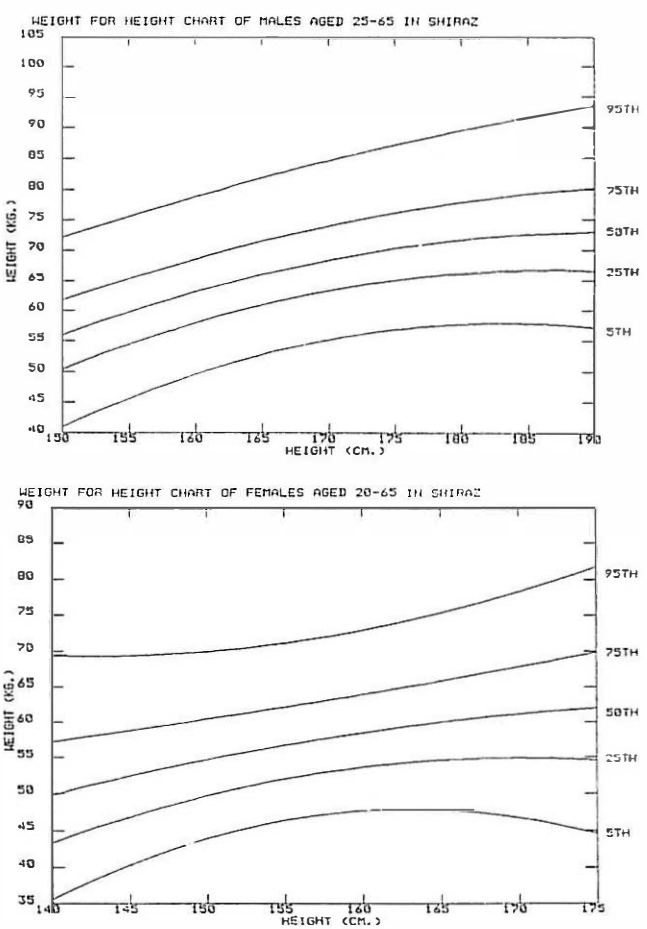
Effect of Sampling Method

The method of sampling resulted in 80% of the females being in the age range 25 to 40 years. The age range of the males was slightly larger with 82% being between 30 and 50 years. Unmarried people and parents without children in this age group were not included in the study. Parents with several children in the age group are more likely to be included than those with only one child between six and 12, but in the absence of any detailed information on family structure, either in this survey or in published census data, it is impossible to say how the sample should be weighted to take account of the differential sampling rates. All the data are therefore given equal weight.

Results are unlikely to be affected by doing so, because with one exception discussed below, height, weight and body mass index of both fathers and mothers are not significantly correlated with family size (Table I). The one significant relationship is between mothers' height and size, ($r=0.09, P<0.05$), so that the association explains less than 1% of the variation in mothers' height and weighting data for the number of children in the family has negligible effect. One advantage of our sampling method is that the data are comparatively sensitive for detecting effects of factors related to growth, e.g. social class, which are associated with large families.

Data Completeness

Only 42 parents did not complete the questionnaire or failed to turn up for the appointment. So, data relate to 98% of all eligible households. One thousand and eleven (43%) of adults completed the questionnaire themselves, and the remaining 1317 (57%) were measured directly. Average heights and weights of those measured were less than the corresponding averages for self-reported measurements. However, after ad-



Figs.2a (Top) and 2b (Bottom)

justing for age and area of residence the differences were all non-significant (P>0.18) and in the case of weights the direction of the differences were reversed. It was therefore concluded that the self-reported measurements were as accurate as those recorded by the survey team.

Height

Table II presents distribution and statistics of heights by ages for both sexes. It is well known that the distribution of heights in adults is approximately Gaussian (there is a slight excess of very tall people), and thus uniquely determined by the mean and standard deviation (SD). No significant skewness or kurtosis was found in any group of males. Significant skewness or kurtosis was found in some of the small age groups of females, which appears due to the small size of the groups in question.

The average height of males aged 25-69 was 169.8 cm and of females aged 20-59, 158.9 cm with standard errors (SE) of 0.30 and 0.28 cm respectively. Thus, males are one average 11 cm taller than females. In both sexes height tends to decrease as age increases, the decrease being greater in males than females. The only substantial exception is in age group 50-54 among males which is a chance deviation, (P>0.5). For both sexes the average height was greatest in the youngest age group for which there are data; 25-29 for males and 20-24 for females.

For all age groups, males' height are significantly more spread than females (P<0.05). For both sexes the dispersion increases with age, and from age group 35 and upward the dispersion for the two sexes are very similar. The reason for the overall dispersion being greater in males than females is because of the smaller dispersion of the females in the younger age groups and because height changes less with age in women than in men.

Weight

Unusually, the distribution of male weight was not significantly skewed, nor did the tails of the distribution appear to be significantly long or short compared with a Normal distribution. However, female weight data are skewed.

The distribution of weights by age are summarized for both sexes in Table III. Smoothed percentiles of weight by age and sex are presented in Figs. 1a and 1b. These were computed by fitting cubic polynomials for age together with quadratic polynomials in a standard normal deviate, Z, to the raw weight for age data using the GROSTAT package. Inspection of these smoothed centiles reveal a gradual reduction in all the male centiles as age increases with little change in spread. The female centiles are much more constant except for the 95th centile which rises at nearly 0.25kg per year after the age of 30 corresponding to the tendency for skewness of the distribution of weight to increase with age.

Table IV. Smoothed percentile of weight (kgs) for height (cm) of adults aged 30-60 years

Sex and Height (cm.)	Smoothed percentile 5th	25th	50th	75th	95th
Male		**Weight in kilograms**			
150	40.95	50.31	55.93	61.75	72.17
155	45.63	54.45	59.77	65.37	75.59
160	49.56	57.98	63.12	68.61	78.79
165	52.72	60.92	65.99	71.48	81.78
170	55.13	63.26	68.36	73.96	84.55
175	56.77	65.00	70.25	76.07	87.10
180	57.66	66.13	71.65	77.80	89.43
185	57.78	66.67	72.56	79.16	91.55
190	57.15	66.61	72.99	80.14	93.45
Female					
140	35.54	43.30	49.79	57.18	69.38
145	40.32	46.85	52.39	58.76	69.38
150	43.93	49.75	54.71	60.43	69.97
155	46.38	52.00	56.74	62.16	71.15
160	47.66	53.61	58.49	63.97	72.93
165	47.78	54.57	59.94	65.85	75.29
170	46.74	54.89	61.12	67.81	78.25
175	44.54	54.56	62.00	69.84	81.80

Weight by Height

The smoothed percentiles of weight for height of males aged 30-60 and females aged 25-50 years are given in Table IV. For both males and females the centiles were constructed by fitting quadratic polynomials in age and Z, which account for age trends and changes in skewness with age. Inspection of Table IV and Figures 2a and 2b show that for any given height, males are heavier than females.

Body Mass Index (BMI)

Figures 3a and 3b show the smoothed percentiles of BMI by age for males and females calculated by fitting cubic polynomials to the raw data. For males these change little whith age except for a small reduction in the oldest age groups. For females the smoothed 5th to 75th centile values first rise with age and then fall, but the 95th centile increases with age. This corresponds to the increasing proportion of overweight women in the older age groups.

Factors affecting BMI

By fitting linear models with the GLIM computer programme the relationship of BMI to the following social/cultural factors were examined: area of residence, social class, adults' level of education and family

Table V. BMI of Females by Family Income

Income	BMI	Under weight	Normal	Over weight	Obese	Total N	Total %
Low	N	29	62	21	11	123	13.4
	%	23.6	50.4	17.1	8.9	100	
Fair	N	97	220	102	13	432	47.1
	%	22.5	50.9	23.6	3.0	100	
Good	N	28	83	35	8	154	16.8
	%	18.2	53.9	22.7	5.2	100	
High	N	12	80	28	7	127	13.8
	%	9.4	63.0	22.0	5.5	100	
Very High	N	19	36	18	8	81	8.8
	%	23.5	44.4	22.2	9.9	100	
Total	N	185	481	204	47	917	
	%	20.2	52.5	22.2	5.1	100	

Chi-Squared=26.6 P=.009
Degrees of Freedom=12 Contingency Coefficient=0.17

Table VI. Association between males' BMI and their education

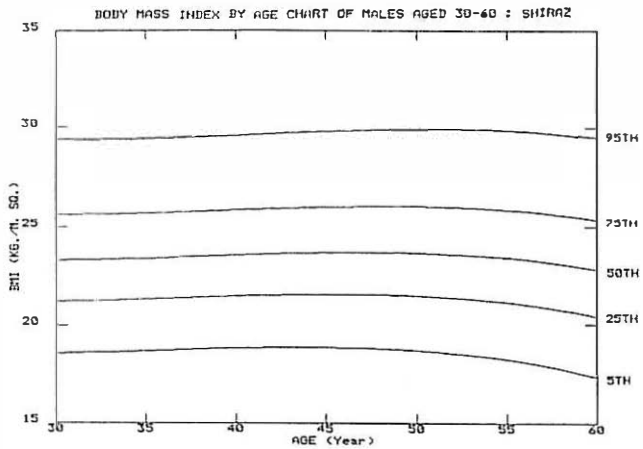
Education	BMI	Under weight	Normal	Over weight	Obese	Total N	Total %
Illiterate	N	26	58	21	8	113	12.9
	%	23.0	51.3	18.6	7.1	100	
Elementary School	N	46	179	89	22	336	38.6
	%	13.7	53.3	26.5	6.5	100	
High School	N	38	173	78	9	298	33.9
	%	12.8	58.1	26.2	3.0	100	
Higher Education	N	13	84	32	2	131	14.9
	%	9.9	64.1	24.4	1.5	100	
Total	N	123	494	220	41	878	
	%	14.0	56.3	25.1	4.7	100	

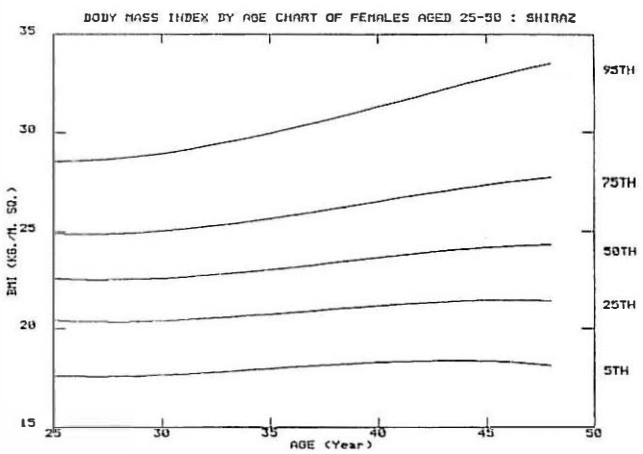
Chi-Squared=21.9 Degrees of Freedom=9
P=0.009 Contingency Coefficient=0.16

income.

Social class has not been formally defined in Iran, as in England where code books published by the office of Population Censuses and Surveys categorize every occupation into seven social classes. For the present purpose, the reported occupation of fathers have been allocated to seven categories (jobless, unskilled manual, semi-skilled manual, skilled manual, clerical, managerial and professional), which for present purpose have banded into upper, middle and lower socio-economic groups comprising 14.7%, 53.3%, 31.7% of the population respectively. For both sexes, BMI did not differ significantly between these groups. This conclusion was not altered by adjusting for any possible differences in age, nor was there any suggestion of any social class effect in any age group.

Family income was banded into five groups ranging from low to very high. Male obesity was not associated with income, P>0.05, but some interesting associations between obesity and income were found for





Figs.3a (Top) and 3b (Bottom)

women which are summarized in Table V. This shows a diminishing proportion of women who were underweight as income increases from low to high, but increases to 23.5% again in the very high income group. The same group has the highest proportion of obese women and lower proportion 44.4% of women with a normal level of obesity.

In contrast, the BMI of fathers is strongly associated (P<0.01) with their level of education. The results of the GLIM analysis are summarised in Table VI. The illiterates include the largest proportion of underweight, 23.0%, the highest proportion of obese 7.1%, and the lowest proportion normal. Fathers who have had higher education have the lowest proportion underweight (9.9%) or obese (1.5%) and the highest proportion of normals (64.1%).

In contrast, the GLIM analysis showed that obesity was not associated (P>0.05) with education in women although the proportion of obese diminishes as the level of education increases.

Further analysis showed that the distribution of obesity varied in different educational regions of the city, in general agreement with the findings in relation to income and education, so that there are a greater

population of underweight parents in the poorer regions and a greater proportion of overweight in the more well to do regions, ($P<0.01$) for both sexes.

DISCUSSION

Worldwide variation in growth has been summarised by Eveleth and Tanner.[2] Comparison of our results with their data show that Shiraz adults are taller and heavier than most adults from developing areas of the world, including the Indo-Mediterranean adults, but are shorter and lighter than most European countries.

Comparison of our data with the distribution of obesity in the U.K.[12] shows that a greater proportion of both men and women in Iran are underweight by their standards (BMI<20 kg./m^2) but that a similar proportion (5%) are obese by their counters.

Comparison with studies from the developing world should be treated with caution, because many of the studies are based on selected groups of adults with a restricted age range and conditions in developing countries can change rapidly. Thus comparison of our findings with previous data from Iran[8,15] suggest that adults are now substantially bigger than they were some twenty years ago. It is, however, impossible to quantify the changes because the earlier data were based on very small samples and/or limited age ranges, who are unlikely to form a representative population sample.

Differences between the distributions of heights, weights and obesity of Iranians and western values show that normal ranges derived for western adults are not appropriate in Iran.

The smallness of correlations of height and weight with the number of children in the family (Table I) implies that normal ranges tabulated from our data will be generally applicable to married adults with children in Shiraz, and probably to other urban areas of Iran.

Adult height diminishes with age, the effect being greater in males than females. The reduction of height with age closely parallels that reported for British adults of both sexes[12] so that males in England are consistently 4 cm taller than Iranian males at all ages and English females 2 cm taller than Iranian women at all ages. The similarity of the changes with age in these two very different communities suggests that the reduction in height is mostly due to aging rather than a tendency for succeeding generations to be taller. Because heights are accurately normally distributed, normal centiles can be readily calculated in Table II.

In contrast, weights have a skew distribution especially among older women. Table IV presents the smoothed centiles of weight by height. These smoothed centiles provide local norms for clinical work in Iran.

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