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Review Article

A CRITICAL APPRAISAL OF HUMAN GROWTH STUDIES IN IRAN

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ABSTRACT

Studies of human growth throughout Iran since 1966 have been surveyed critically. Only 32 papers and 15 research reports on this very crucial issue have been published or compiled so far, most of them on Tehran and Shiraz, which is negligible in comparison with American or European and even some African and Asian studies. Though measurements of height and weight naturally predominate, arm circumference, head circumference and skinfold thickness are also extensively documented. People are now heavier and taller than reported previously. Children in well-off homes everywhere grow faster than those in poor homes and urban children grow faster than rural children. The necessity for using local standards covering all age groups for clinical work in Iran is emphasised and a longitudinal growth study is suggested. A study of the pattern of growth and its related complex factors would serve as an invaluable asset in planning and evaluation of community health service and health promotion. The paper also provides a comprehensive bibliography of growth studies in Iran which would be helpful to the interested researchers in this field.

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INTRODUCTION

Human growth plays a main role in preventive as well as curative medicine. Growth charts are used in medical fields. Growth standards are extensively used in paediatrics and show the nutritional and general health status of a community. Reference standard assess the normality of a child's size at any point in time.

Growth monitoring is a key component of primary health care programmes aimed at bringing about a "Child Survival Revolution" in the coming years. It provides an excellent opportunity to give other primary health care services, such as immunisation, advice on nutrition, treatment of illness, birth spacing, etc., as well as to improve women participation in the care of their children and their interaction with health workers.

Human growth studies have a relatively long history in western countries and were well known to scientists in the nineteenth century.[1-8] Tanner has compiled a comprehensive detailed work on the history of human growth in Europe up until 1980.[9] A concise account of this work has been published separately.[10]

On the contrary, the earliest study on human growth in Iran dates back to 1966. This paper, therefore, aims at briefly reviewing these studies chronologically, which have fallen in three groups according to the age of subjects: a) Infants and preschool children, b) School children and c) Adults, and have never been systematically compiled so far. The paper also intends to evaluate them critically which highlights the needs of carrying out research of this sort and provokes the thoughts of interested investigators to embark on further studies.

Growth studies of infants and preschool children

The first study on the growth of infants in Iran was conducted in 1967. It is concerned with birth weight of infants in Shiraz in relation to their maternal, social and economic status.[11] Weight measurements of infants of both sexes in families with poor background were compared to their conterparts with well-off parents. It was found that boys' weight in both socio-economic groups were on average greater than that of girls and similarly well-off families produced heavier infants than the poor parents. Two other short papers[12-13] have been written on the growth and health status of selected groups of school children and infants in Tehran, but contribute little to the present discussion.

Another study was conducted on 2123 live births at three hospitals in Tehran (the capital), during the period of October 1969 to August 1970. The patients admitted to the hospitals were from various socio-economic levels of the community. Male infants were found to be heavier than females. A direct positive correlation between economic status and birth weight was found to be significant. There was a systematically increasing trend in the birth weight for the maternal age group up to 30 years, with a significant correlation. The birth weight increases according to the order of birth up to the third, and shows a significant correlation. Mean birth weight according to the level of education was significant when infants of illiterate parents were compared with those of parents with secondary education and those whose parents had only primary education were compared with children of parents with university level of education. A significant correlation between birth weight and the mother's intake level of eggs and milk was found. Maternal age at first delivery was significantly higher for those with a better economic status. The occurrence of complications of pregnancy was found to be higher in the lower income groups.[14]

The fifth study was carried out in a child clinic at a university hospital from the beginning of January 1969 to the end of January 1972. All newborns who appeared for week-baby check-up at the clinic were included in the study. Length, weight and head circumference were measured from birth to age two in 63 boys and 68 girls of a high income Iranian group living in Shiraz in economic and cultural conditions similar to high income groups in Western Europe and North America. The 10th, 50th and 90th centiles of the measurements were very similar to the London and Boston standards. Secondly, the high income Iranian group was compared with racially similar village and poor urban groups in Shiraz and the nearby countryside. The 50th centiles of these groups for lenght and weigth were at or below the 3rd centile of the high-income group from 3 to 24 months; head circumference 50th centile was at the 10th to 3rd centile. It was concluded that the growth potential of Iranian children is no less than that of West Europeans, though the majority of the population grow along a very much lower curve.[15]

Growth and development of 1-5 year old children of Majidieh in Tehran[16] and growth of 0-2 year old children of Tonokabon[17] areas have been surveyed by two graduate students.

In the other study, the growth in lenght, weight and head circumference of eighty three infants born in a village in Fars province (the principal province of southern Iran), was studied longitudinally from birth to 21 months. The weight and lenght of the infants was low compared to American standards difference became progressively more pronounced. The average weight and height was below the 10th centile of Boston children by six months in boys and three months in girls, and the 90th centile of the village group was below the Boston 10th by 18 months in both sexes. Developmental milestones were also delayed.[18]

Ghassemi and his colleagues[19] studied the state of nutrition in pre-school children in Tehran to determine calorie and protein intake. This study could be relevant to the growth of pre-school children to some extent, but indirectly.

Another study deals with mean birth weight of infants in Gondi Shapoor medical centre.[20] Birth weight and lenght of group of infants in a maternity hospital of Tehran[21], seasonal relationship of infants' weights in Roodsar areas[22] and growth pattern of children in Kheyrkhah institution health centres (Tehran)[23] were presented by three graduate students.

Weight, height and arm circumference of 400 Esfahan (one of the five principal cities in Iran) children aged 1-24 months attending the City Public Health Centre, were measured. It was found that 240 (60%) of children had a weight and 58 (14.5%) had a height for age less than Boston standards. Comparing the 80% weight for age as an upper limit for protein-calorie malnutrition (PCM) with the arm for age and the age constant arm standard, in the childen age 13-24 months classified as malnourished on arm circumference criteria was found to be similar to the total number in the first, second and third degree malnutrition groups by weight. Thus, arm circumference measurement could be used for detection of malnutrition in crisis situations. The values of correlation coefficient (r) between mid-upper arm circumference for age and weight, lenght, head and chest circumferences show that the correlation for mid-upper arm circumference for age is better with weight-for-age than other parameters.[24]

Froozani and her colleagues[25] have also compared their data for weight and height in Esfahan with that of

Boston standards, and the arm circumference with the Wolanski's standard in another paper. All three measurements, and especially arm-circumference, were lower than the standards.

Another paper concerns the growth pattern of live-born infants of Shiraz compared with western norms. A prospecive study was undertaken during a 33 month period, from April 1977 through February 1980 on 434 consecutive live-born infants from 24-44 weeks of gestation in Shiraz. A comparison between Iranian and western standards was presented. Intrauterine growth in terms of lenght, head and chest circumference was comparable to the standards given for United States and Canada. Small differences were noted in weight between Shiraz, Great Britain, and American norms.[26]
A relationship is established between infants' lenghts and weights with mothers' age among those who delivered their first, second, ... babies in Mashad.[27]
Birth weights of a group of infants in southern Tehran and its relationship with the health status of their mothers during pregnancy is also surveyed in another study.[28]

Height and weight of Esfahans' urban and rural 0-14 year old children were measured and compared with the international standards. The results indicate that on the average the urban dwellers have been taller and heavier than rural residents. Median height and weight of the 1-14 year old children correspond to the 10th percentile of the international standard. This difference is especially more pronounced in the 1-15 year group. The role of socio-economic conditions in determination of height and weight have been stressed against those of genetic background and nutritional status.[29]

A relatively recent study concerns the assessment of the nutritional status of pre-school children in Mahabad rural areas (North West of Iran). It is not directly concerned with growth of pre-school children. A total of 802 subjects, aged 0-60 months from 24 villages were surveyed. Body weight, lenght and midupper arm circumference were measured and compared with Harvard 50th percentile.[30]

Height, weight and skull circumference were studied in a sample of 701 infants (0-2year old) in Tehran cross-sectionally. The relationships with socio-economic and biological factors have been investigated and growth rate was compared to the standard (NCHS) data. Growth velocity decreases as age increases so that median growth velocity of weight was 900 gram per month at first month which was decreased to 140 gram per month at 24th month of age. Height velocity was reported to be 3.5 cm per month at first month and 1 cm per month at 12th month of age. In any case, boys were growing slightly faster than girls.[31] Birth weight and lenght and the determinants of some factors in infants low birth weight have been also investigated in other research projects.[32-33] A linear correlation between Ponderal Index, which is a combination of weight and height of infants and that of infants ages and the number of abortions which occurred before each case was elaborated.[32] Growth trend of 544 children of 2.6 years old was investigated in the same study and a correlation between weight reduction of the children and their mothers' weight was found.[34]

Mortality of low birth weight and normal infants at first and fourth week of life was compared and the relationships were discussed.[35] The relationship between birth weight and inter-pregnancy interval has been analyzed in a maternity hospital in Tehran. As a result of this study it is suggested that the minimum interval between two consectutive pregnancies must not be less than 18-21 months. A short inter-pregnancy interval may be a potential risk factor in low birth weight and birth weight and inter-pregnancy interval have shown potential positive correlation.[36]

A case-control study was carried out on the growth and development of one year old infants. 730 low birth weight (<2500 grams) infants were compared with 1460 normal infants in 17 hospitals in Tehran and their height, weight and head circumference were measured. Infants who were breast fed had a better growth velocity than those who were bottle fed.[37] An index for birth weight is determined and introduced in another study,[38] and claimed to be an efficient substitute index to the existing one.

Studies on growth of school children

The earliest study on children growth dates back to 1966. This study was conducted in September 1966 among schoolchildren of Marvedasht, a town of about 10,000 population in Southern Iran and covers both sexes. Most of the children attending these schools came from a number of villages in the vicinity of the town. Six hundred and twenty two school boys and girls between the ages of 12 and 17 in Iran were measured and examined clinically. Children weights and heights were the only anthropometric measurements studied. It was reported that out of the total number mentioned, 126 were 3 or more standard deviations below the Iowa mean standard growth curve. Evidence of malnutrition and sexual retardation was noted in a high percentage of the latter group.[39]

The same principal author published another paper concerning body height and chronic malnutrition in school-children of the same area. Only 414 out of 695 boys of ages between 12 and 17 years who possessed a properly issued birth certificate, establishing age with certainty were studied. Seventy five percent of these had village background. Height and weight of these

selected boys were the two most readily obtained measurements. The paper reports height, clinical symptoms of nutritional deficiency and laboratory parameters in a group of adolescent school children in Marvedasht. It is reported that growth retardation with heights below the third percentile or two standard deviations of the Iowa mean measures of chronic malnutrition in adolescents is associated with the increased incidence of lower haemoglobin, serum protein and albumin concentration. The authors claim this as evidence that subnormal stature is particularly significant as an indicator of malnutrition.[40] Skeletal maturation, skinfolds thickness and body fat of a group of children in Shiraz have also been reported elsewhere.[41-42]

The fifth study concerning the growth of school children was carried out in a rural area in Shahriar District (South-West Tehran). Observations made in this study were based on 2936 cases of school children, including 1316 girls and 1575 boys, 6-15 years of age, attending fourteen primary schools scattered over the area. The measurements taken were height, weight, arm circumference, head circumference and skin-fold thickness at triceps. Significant correlations were reported between weight and height, arm circumference with weight and head circumference with weight. The same result was noticed when the arm circumference with height and head circumference with height were correlated.[43]

Prevalence of high blood pressure in relation to body weight, height, age and sex of 1330 females and 1123 males over 15 years old in Roodsar city (Caspian area) was estimated using Ponderal Index. A mathematical model for systolic and diastolic pressure has been elaborated and an association between higher prevalence of blood pressure in women and a higher proportion of obese women was detected.[44-45]

Another study on the growth of school children was implemented during the years of 1975-1976. This study was carried out among school children aged 6-14 years old in Shiraz and four rural areas in the vicinity of Hamadan, West Azerbaijan (West Iran) and Varamin (a town in North-East of Iran). The sample size was 2317 and it is reported that the sample was taken from middle level school of Shiraz, but nothing was said on middle level norm and the criterion was not well defined. A comparison was made on the stature of Shirazi children with that of middle level Tehranis. Again, the middle level norms were not defined and the quality, precision and the period of the study were not clearly stated. Then comparison was made with Boston standards of growth (USA).[46]

Height and weight of Iranian children and youths are reported in two other papers.[47-48] Physical growth of a group of school children in Shiraz has also been studied and some comparisons made with that of American and European countries.[49]

The most recent study was carried out in the academic year 1988-1989 in the four educational districts of Shiraz. Since an adequate sampling frame of the population was unavailable, a multistage random sampling was applied.[50-51] A 10% sample of schools in each region was drawn. Within each selected school a 1 in 15 sample of children aged between 6 and 12 was selected, using tables of random numbers. Applying this procedure a total of 1207 subjects (642 boys and 565 girls) aged 6-12 years was selected in a cross-sectional study, representing a 1 in 150 sample of the school children in the city. Height, weight and arm circumference of the sampled healthy children were measured. The smooth centile values have been derived from the raw data by HRY nonparametric method[52] and the growth charts for the three measurements have been presented.[53] In addition, the relationship to the NCHS[54] standard has been explored in another paper. Median heights and weights of children in Shiraz lie approximately on the 25th centile of US children, but are above most groups of children from the developing world. The spread of the data is similar to that observed in US, and there is no evidence of widespread malnutrition. These observations suggest that local growth standard should be used in clinical work.[55] Also, the effects of socio-economic/cultural factors in the growth of school children were examined by using univariate and multivariate analysis (ANOVA & MANOVA). Districts of residence and fathers' level of education were identified as the factors affecting the growth of children after adjusting for the effects of family size and the parent sizes.[56]

Studies on adults' sizes

Population data on adult sizes are limited, even in the developed world. Population data on adult sizes are available from USA[57-59] and more recently for the United Kingdom[60-63] and some other developed countries.[64] Very little data are available for the Middle East.[64]

Until recently, the only available data on adult size of Iranians pertained to two selective studies carried out more than 20 years ago. One related to females aged 26-30 years in a small village in southern Iran[65] and the other was restricted to 120 females (>20 years) in a northern urban area.[66]

Height, weight and body mass index (BMI) of married adults aged 20-69 years with a school aged child in Shiraz has recently been studied[67] and factors affecting obesity of adults were examined. Shiraz adults are taller and heavier than most adults from developing

Table I. Summary results of mean weight (W) in Kg., lenght (L) in cm, and head circumference (H) in cm. of 0-24 month infants

Study	Sex	Measure	Birth	3	6	9	12	24
Hedayat, et.al., 1971.	M	W	3.31	-	-	-	-	-
	F	W	3.18	-	-	-	-	-
Amirhakimi, 1974.	M	W	3.37	6.00	8.00	9.20	10.15	12.60
	M	L	50.2	60.4	67.4	71.7	75.6	87.6
	M	H	35.2	40.2	43.2	45.0	46.2	-
	F	W	3.28	5.60	7.36	8.80	9.64	12.6
	F	L	49.8	59.4	65.7	70.6	74.4	87.4
	F	H	35.0	39.4	42.5	44.4	45.7	-

Table II. Summary results of mean heights and weights of adults

Study	Place	Age & Sample	Sex	Height(Cm.)	Weight(Kg).
Mahloudji, 1968	Village	20-30	M	164.4	59.4
		26-31	F	152.3	51.9
Wadsworth & Emami, 1970	Urban N=120	>20	F	152.3	50.8
Ayatollahi & Carpenter, 1992	Urban	25-64	M	169.8	68.0
		20-49	F	158.9	58.6
		N=1207			

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 BMI appropriate for clinical work in Iran. In another paper weight for age and weight for height centiles have been presented graphically.[68] The distribution BMI is broadly similar to that reported for UK adults but curves corresponding to BMI=constant, i.e., weight proportional to height square, cut across the centiles of weight for height. This paper argues that Garrow's definition of obesity[69] is not appropriate for Iranian adults and presents a suitable definition for Iranian data.

The same data were used to develop power-type obesity indices, $I_p=W/H^p$. Optimal value of p was 2.5 for children and I for their parents. The smoothed obesity index by age charts are presented using HRYnonparametric method, which are likely to provide normal ranges of fatness measures for clinical work in Iran. The familial pattern of parent-child obesity was investigated by a preliminary analysis of distribution of obesity using arbitrarily chosen cut-off points to define obese, normal and lean parents. The principal component analysis (PCA) was applied to analyze the data as continuous variables, which is found to be an efficient sophisticated technique in clarifying the structure of familial obesity. The analysis also shows no indication of clustering of super obese families. A structural analysis indicates a direct relationship between obesity of parents and children.[70]

Critical appraisal of growth of studies in Iran

During the past quarter century only 32 papers and 15 research reports (in the form of MS or MSPH theses) concerning the growth of Iranians have been published or compiled, i.e., almost two works per yer on the average, out of which 28 were on the growth of infants and pre-school children, 14 on children growth and the remaining five on the growth of adults. This number is nothing in comparison with research done in Europe and America and even in some Asian and African countries. On the other hand, most of these studies have been conducted in Tehran and Shiraz. Other rural and urban areas, even big cities have almost been ignored.

Most of these studies were not directly addressed to the issues of human growth; rather their main objectives were medically or nutritionally-oriented. They were carried out by nutritionists and physicians from a wide range of specialisations to evaluate health and nutrition status of the subjects. Of course, the real point of growth monitoring is to promote the health status of the subjects, but these studies had regarded the growth issues as a secondary objective of their investigations.

None of these studies, except the recent one[53] could be classified as survey reseaches on the subject of the growth. They were not aimed at a specific target population and sampling was far from random. The groups studied were taken from clinics, hospitals, groups of malnourished infants and children, etc. Sampling and research methodology were not clearly defined in most of them. Apart from the recent papers,[53,55-56,67-68,70] few attempts were made to obtain statistical advice. This is not surprising in view of the shortages of statisticians during the course of studies and even now in Iran.

The cited growth studies are likely to be out of date now as the recent paper shows.[53] Drastic changes have recently taken place in the country especially during the past decade, which have shaken the whole structure of life in the country. Changes include substantial migration from war zones, increase in the rate of urbanization, increase in literacy rate as a result of the literacy movement,[71] rapid population growth rate,[71-72] urban and rural development, health promotion and primary health care programmes in rural areas,[73] the mass production programme to increase the number of general physicians,[74] nationwide food rationing and expanding television coverage. All these are among the many factors that have absolutely changed the social pattern of Iranians at all levels in recent decades and will have affected the growth of children. These factors need to be taken into consideration in the analysis of growth studies.

Furthermore, data analysis of these order studies

were mostly trivial and the statistical inferences were not reliable. No attempt has previously been made to produce a reliable growth chart for Iranians. Rather the results could not be generalised to the whole or even a relatively large portion of the population. Many predictive and essential factors in relation to growth were ignored in the studies. Recent Shiraz study[53] has some advantages over the previous ones. First, an adequate random sample was selected and sample sizes in each sex-age group is statistically adequate and therefore the results can be generalised to the target population. Second, for the first time the growth charts of school children are presented and it is shown that local standards should be used for the study of growth in Iran. Third, it has used a robust sophisticated statistical methodology using GROSTAT software.[75] However, it has still one disadvantage that only special age group (6-12 years) was studied.

Almost all of them have compared their results to the American standards. One author went a step further and compared his results with British standards as well. The authors have accepted American standards especially Harvard standards as "normal" implicitly. They have never questioned this matter and the suitability of the Harvard norms in this part of the world. Other than the recent study,[53,54] their implicit assumption is that the American standards are ideal to be used world wide, a matter that is far from being generally accepted.[76-77] It is worth noting that the United States possess a huge amount of growth data on infants and children and perhaps it is the pioneer of growth charts production in the world, with a very long history dating back to the 1920s.[54] Using American standards, while quite plausible, is of limited value. The recent work[55] strongly suggests that it is necessary to produce local growth charts for Iranian children.

Finally, we should add that it is not the intention of this critical appraisal to belittle the efforts that had been made by the previous authors, nor does it ignore their attempts and contributions on such an important issue. Their contributions and efforts must be appreciated and their findings may be used as a basis for further survey researches on this area and motivated this study.

CONCLUSIONS

Critical review of growth studies in Iran leads us to conclude that:

1. Growth monitoring as an integrated system in primary health care (PHC) is necessary expecially in rural Iran in order to promote child health and nutrition. It must be a topic in medical schools curricula and medical students should gain practical experience of this issue.

2. Local standards should be used for clinical work in Iran because they are 'realistic' about the expected growth of Iranian children. The immediate need is for a survey of growth in Iran, covering all age ranges from birth to adulthood in which various parts of the country would be appropriately represented. These local growth standards will have to be updated periodically in order to take into account the changes that appear over time. A study of changes that have occurred in the pattern of growth of Iranian children in 10-15 years time would serve as an invaluable asset in the planning and evaluation of community health service and of health promotion.

3. A representative longitudinal study on infants and children born in Iran is suggested in order to determine growth velocity (growth rate) in relation to health promotion and intellectual development because the health of a population is reflected most accurately by the rate of growth of its infants and children. Such a study could be designed to investigate the complex inter-related pattern of factors affecting growth of infants and children and would throw much light on important public health problems.

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