The Growth Pattern of Saudi Arabian Pre-School Children in Riyadh Compared to NCHS/CDC Reference Population

Abdulrahman S Al Frayh, MD
Professor of Paediatrics and Consultant Paediatrician, Department of Paediatrics (39), College of Medicine, King Saud University, P O Box 2925, Riyadh 11461, Saudi Arabia

Elijah A Bamgboye, PhD (Lond)
Associate Professor and Consultant Medical Statistician, Department of Family and Community Medicine, College of Medicine, King Saud University, P O Box 2925, Riyadh 11461, Saudi Arabia

ABSTRACT

This study compares the growth patterns of Saudi Arabian pre-school children aged 0-5 years to a reference population of American children documented by the National Center for Health Statistics/Centers for Disease Control (NCHS/CDC). The anthropometric data of weight, height and age were collected in a cross-sectional study of Saudi Arabian children in Riyadh, the capital of Saudi Arabia. The sample selection was accomplished by a 3-stage stratified random procedure, basing the stratification on location and a socio-economic index. A total of 3,795 children comprising 55.2% males and 44.8% females had complete basic anthropometric measurements among other variables. Analyses were effected by using the WorHealth Organization/Centers for Disease Control (WHO/CDC) standard software programme for calculating nutritional indicators. A combination of height for age (as an indicator of stunting) and weight for height (as an indicator of wasting) showed that a sizeable proportion (78.1%) have normal or slightly above normal nutritional status. A small proportion of the children (1.4%) were below -2.0 SD scores of the reference population for weight for height and for age. Overall, Saudi Arabian children are slightly shorter and thinner than their American counterparts. An important finding in weight for height was that nearly 20% of the children were below -2 SD scores of the reference population median. However, due to the very high per capita income, and the fact that food and other essential items are subsidised by the government, the deficits from this reference population may be attributed to inadequate health education nutrition programmes, genetic and other social factors including reproductive behaviour, rather than malnutrition.

INTRODUCTION

The analysis of basic anthropometric measurements of age, weight and height has been found to provide good indicators for the nutritional status of children (WHO, 1986). The report of the World Health Organization (WHO) working group on the use and interpretation of anthropometric indicators of nutritional status firmly recommended the use of weight for height, and height for age, as important indicators, particularly for children 5 years and below (WHO, 1986). In order to facilitate inter-country comparisons, the WHO also recommended a standard approach to the analysis and presentation of results (WHO, 1986; Waterlow et al, 1977). The use of a reference population defined by the US National Center for Health Statistics/Centers for Disease Control (NCHS/CDC) has also been suggested for relating anthropometric measurements (NCHS, 1976).

There is a dearth of information on the nutritional status of Saudi Arabian children (Serenius and Hofvander, 1988; Al-Frayh et al, 1990). The present study was guided by the various recommendations of the WHO/UNICEF/FAO experts on surveillance of the nutritional status of children (USFNB, 1974). The results therefore compare the weight for height, weight for age and height for age of Saudi children 0-5 years, with the reference population collected in a cross-sectional survey. Saudi Arabia is a wealthy population, and the distribution of wealth is such as to make the average Saudi above the poverty line. However, in another paper, the influence of various socio-economic and educational status on the indicators is examined.

MATERIALS AND METHODS

Target Population

A cross-sectional survey of auxological variance and growth standards of Saudi pre-school children was carried out in the city of Riyadh, capital of Saudi Arabia in 1984-1986 but the anthropometric data on pre-school children were collected in 1986 (Al-Frayh et al, 1990). According to the Central Department of Statistics, Ministry of Finance and National Economy of the Kingdom of Saudi Arabia, 20% of the nearly one million population of Riyadh (approximately 200,000) at the time of study was aged 0-5 years. Hence it was decided to take a sample size of about 3% of the target population to ensure the minimum number of 200 healthy children in each age and sex group as recommended by Waterlow et al (Waterlow et al, 1977).

Sampling Design

A 3-stage stratified sampling technique was used in the selection of the children. In the first stage, the sampling frame was the 93 administrative areas of Riyadh easily identified by the roads. These areas were subdivided into 6 socio-economic homogenous strata based on socio-economic interpretation from the Central Department of Statistics. Each stratum has a different number of areas and 20% of areas in each of the stratum was selected by simple random method. A total of 17 areas were selected in this first stage.

In the second stage, the roads in each of the selected 17 areas were listed to form the sampling frame. There were a total of 1,376 roads and one in every 6 roads was selected by simple random sampling among the roads in each selected area. This gave a total of 224 roads.

In the third stage of sampling, the houses in each selected road, were grouped into blocks of nearly equal numbers of houses. A random sample of blocks was chosen and a systematic sample of one in every 2 houses in each selected block were the final sampling units.

Data Collection

The anthropometry of all pre-school children in each of these sampling units (households) were measured and their parents interviewed for other socio-demographic information. Age was ascertained by examining the birth certificates and recorded to the nearest 1 month for ease of coding.

The methods of measuring heights and weights as recommended by the committee on advisory to CDC were followed (USFNB, 1974). During the study, the interview team included a paediatrician, field supervisor, and an anthropometrician. The field supervisor examined the daily records for any uncompleted item and ensured the required quota sample in each age and sex group was interviewed.

Statistical Analysis

The 'Anthro' software version 1.01 of December 1990 for the calculation of paediatric anthropometric indices developed by the CDC/WHO were used on a micro-computer for the statistical analysis of this data (Sullivan, 1990). The reference population to which comparisons were made was the NCHS/CDC data as recommended by the WHO Nutrition Unit (WHO, 1983). The centile distribution of weight for height, weight for age and height for age of the children in relation to the reference population and their Z-score distributions expressed in standard deviation (SD) of the reference population were constructed. The cut-off points of the Z-scores were ± 2 SD and individuals with values outside the range -6 and +6 SD in height for age and weight for age and -4 and +6 SD in weight for height were excluded (Sullivan, 1990). The significance of the linear trend in the proportion deficit in weight for age or weight for height was examined by the chi-squared test (WHO, 1983). The interpretation of the results was based on the recommendations of the WHO (Armitage and Berry, 1987).

RESULTS

The number of children in each sex group and the mean weight and height at each age-group are presented in Table 1. Apart from girls under 6 months of age, the number in each age category was more than 200 and the age frequency distribution is fairly uniform. In the first year of life, the girls appear slightly taller than the boys. This observation is reversed at one year, and the boys remained consistently taller. However, the pattern of weights in the boys appear similar to those of the girls at each age. Boys have heights between 62.1 cms and 107.1 cms while the range for girls is between 62.5 cms and 106.3 cms. The range for weight is 5.3 kgs to 16.7 kgs for boys and 5.1 kgs to 16.4 kgs for girls.

SD Scores: Weight for Height

The distribution of weight for height at each age of Saudi Arabian children expressed as multiples of the standard deviation of the NCHS/CDC reference population median for males, females and both sexes are presented in Tables 2, 3 and 4. In both males and females, the distribution shifted to the left of the normal distribution of the reference population. Nearly 20% of the male children were below -2 SD of the reference population median, an indicator of a high proportion of wasted children. However, after 36 months of age, the proportion of male children considered wasted compared to the NCHS/CDC reference population decreased from as high as 30.2% at age 12 months to an all time low of 14.5% by age 60 months. On the average about 5% were below -3 SD of the reference population median, an indication of severe acute malnutrition.

There was generally a lower proportion of female children below -2 SD scores of the reference population compared to the male children. At 48 months the lowest percentage of weight for height (11.5%) was recorded in the female children. The proportion considered obese, having weight for height above +2 SD of the reference population median is higher in the females than males. An inspection of the distribution of low weight for height SD scores revealed a clustering around the scores -2.01 and -2.4 which accounted for nearly 50% of children below -2 SD scores.

SD Scores: Height for Age

Tables 5-7 shows the percentage of height for age of female and male children in SD scores of the reference population respectively. The percentage less than -2 SD scores, an indicator of stunted growth is about 11% for each sex group. The deficits in height for age compared to the NCHS/CDC standard did not show any significant linear trend with age ($P > 0.05$). For both sexes, 3.9% were below -3 SD scores of the reference population median, a cut off point for severe stunted growth. This percentage is slightly lower in females than in males. 5% of the children were taller for their age, above +2 SD scores.

SD Scores: Weight for Age

The percentages less than -3 SD, -2 SD and above 2 SD of the

TABLE 1
THE MEAN HEIGHT (CM) AND WEIGHT (KG) OF SAUDI ARABIAN CHILDREN AGED 0-5 YEARS BY AGE AND SEX

Age in Months	Males			Females			Total No. of Children (3795)
	No. of Children	Height	Weight	No. of Children	Height	Weight	
0	279	62.1	5.3	189	62.5	5.1	468
6	266	70.6	7.7	222	72.7	7.5	488
12	365	79.5	9.5	328	77.7	9.3	693
24	320	87.8	11.6	242	85.9	11.4	562
36	308	95.4	13.3	236	93.7	13.2	544
48	275	100.5	15.0	227	99.0	14.8	502
60	282	107.1	16.7	256	106.3	16.4	538

TABLE 2
% OF WEIGHT FOR HEIGHT OF SAUDI ARABIAN MALE CHILDREN AGED 0-5 YEARS IN SD SCORES OF THE NCHS/CDC REFERENCE POPULATION BY AGE GROUP IN MONTHS

Age in Months	No. of Children (1922*)	SD Scores of weight for height (% of Age-group)		
		< -3 SD	< -2 SD	> 2 SD
< 6	224	8 (3.6)	33 (14.7)	12 (5.4)
6-11.99	229	17 (7.4)	2 (22.7)	14 (6.1)
< 12	453	25 (5.5)	85 (18.8)	26 (5.7)
12	341	29 (8.5)	103 (30.2)	6 (1.8)
24	300	8 (2.7)	52 (17.3)	1 (0.3)
36	297	16 (5.4)	68 (22.9)	4 (1.3)
48	263	12 (4.6)	49 (19.6)	5 (1.9)
60	268	9 (3.4)	39 (14.5)	5 (1.9)
All Ages	1922	99 (5.2)	396 (20.6)	47 (2.4)

** Children with Z-score values outside the range -4 and +6 were excluded from the analysis*

TABLE 3
% OF WEIGHT FOR HEIGHT OF SAUDI ARABIAN FEMALE CHILDREN AGED 0-5 YEARS IN SD SCORES OF THE NCHS/CDC REFERENCE POPULATION BY AGE GROUP IN MONTHS

Age in Months	No. of Children (1525*)	SD Scores of weight for height (% of Age-group)		
		< -3 SD	< -2 SD	> 2 SD
< 6	157	7 (4.4)	24 (15.3)	5 (3.2)
6-11.99	194	12 (6.2)	50 (25.8)	14 (7.2)
< 12	351	19 (5.4)	74 (21.1)	12 (3.4)
12	300	16 (5.3)	61 (20.3)	14 (4.7)
24	234	8 (3.4)	40 (17.1)	6 (2.6)
36	226	7 (3.1)	45 (19.9)	5 (2.2)
48	218	3 (1.4)	25 (11.5)	8 (3.7)
60	246	8 (3.3)	45 (18.3)	10 (4.1)
All Ages	1575	61 (3.9)	290 (18.4)	55 (3.5)

** Children with Z-score values outside the range -4 and +6 were excluded from the analysis*

TABLE 4
% OF WEIGHT FOR HEIGHT OF SAUDI ARABIAN CHILDREN (BOTH SEXES) AGED 0-5 YEARS IN SD SCORES OF THE NCHS/CDC REFERENCE POPULATION BY AGE GROUP IN MONTHS

Age in Months	No. of Children*	SD Scores of weight for height (% of Age-group)		
		< -3 SD	< -2 SD	> 2 SD
< 6	381	15 (3.9)	57 (15.0)	16 (4.2)
6-11.99	423	29 (6.9)	102 (24.1)	16 (13.8)
< 12	804	44 (5.5)	159 (19.8)	32 (4.0)
12	641	45 (7.0)	164 (25.6)	18 (2.8)
24	534	16 (3.0)	92 (17.2)	7 (1.3)
36	523	23 (4.4)	113 (21.6)	9 (1.7)
48	481	15 (3.1)	74 (15.4)	12 (2.5)
60	514	17 (3.3)	84 (16.3)	13 (2.5)
All Ages	3497	160 (4.6)	686 (19.6)	91 (2.6)

** Children with Z-score values outside the range -4 and +6 were excluded from the analysis*

TABLE 5
% OF HEIGHT FOR AGE OF SAUDI ARABIAN FEMALE CHILDREN AGED 0-5 YEARS IN SD SCORES OF THE NCHS/CDC REFERENCE POPULATION BY AGE GROUP IN MONTHS

Age in Months	No. of Children*	SD Scores of height for age (% of Age-group)		
		< -3 SD	< -2 SD	> 2 SD
< 6	159	2 (1.3)	12 (7.5)	8 (5.0)
6-11.99	194	6 (3.1)	24 (12.4)	12 (6.2)
< 12	353	8 (2.3)	36 (10.2)	20 (5.7)
12	304	11 (3.6)	38 (12.5)	20 (6.6)
24	230	7 (3.0)	24 (10.4)	26 (11.3)
36	223	9 (4.0)	19 (8.5)	16 (7.2)
48	215	14 (6.5)	36 (16.7)	8 (3.7)
60	245	5 (2.0)	23 (9.4)	5 (2.0)
All Ages	1570	54 (3.4)	176 (11.2)	93 (5.9)

** Children with Z-score values outside the range -6 and +6 were excluded from the analysis*

TABLE 6
% OF HEIGHT FOR AGE OF SAUDI ARABIAN MALE CHILDREN AGED 0-5 YEARS IN SD SCORES OF THE NCHS/CDC REFERENCE POPULATION BY AGE GROUP IN MONTHS

Age in Months	No. of Children	SD Scores of height for age (% of Age-group)		
		< -3 SD	< -2 SD	> 2 SD
< 6	233	11 (4.7)	26 (11.2)	9 (3.9)
6-11.99	235	11 (4.7)	41 (17.4)	18 (7.7)
< 12	468	22 (4.7)	67 (14.3)	27 (5.8)
12	346	21 (6.1)	40 (11.6)	21 (6.1)
24	300	9 (3.0)	33 (11.0)	28 (9.3)
36	298	8 (2.7)	25 (8.4)	18 (6.0)
48	262	11 (4.2)	29 (11.1)	7 (2.7)
60	273	11 (4.0)	35 (12.8)	5 (1.8)
All Ages	1947	82 (4.2)	229 (11.8)	106 (5.4)

TABLE 7
% OF HEIGHT FOR AGE OF SAUDI ARABIAN CHILDREN (BOTH SEXES) AGED 0-5 YEARS IN SD SCORES OF THE NCHS/CDC REFERENCE POPULATION BY AGE GROUP IN MONTHS

Age in Months	No. of Children	SD Scores of height for age (% of Age-group)		
		< -3 SD	< -2 SD	> 2 SD
< 6	392	13 (3.3)	38 (9.7)	17 (4.3)
6-11.99	429	17 (4.0)	65 (15.2)	22 (5.1)
< 12	821	30 (3.7)	103 (12.5)	39 (4.8)
12	650	32 (4.9)	78 (12.0)	40 (6.2)
24	530	16 (3.0)	57 (10.8)	40 (7.5)
36	521	17 (3.3)	44 (8.5)	32 (6.1)
48	477	25 (5.2)	65 (13.6)	13 (2.7)
60	518	16 (3.1)	58 (11.2)	10 (1.9)
All Ages	3517	136 (3.9)	405 (11.5)	174 (5.0)

TABLE 8
% OF WEIGHT FOR AGE OF SAUDI ARABIAN CHILDREN (BOTH SEXES) AGED 0-5 YEARS IN SD SCORES OF THE NCHS/CDC REFERENCE POPULATION BY AGE GROUP IN MONTHS

Age in Months	No. of Children*	SD Scores of weight for age (% of Age-group)		
		< -3 SD	< -2 SD	> 2 SD
< 6	468	9 (1.9)	43 (9.2)	11 (2.4)
6-11.99	491	27 (2.5)	95 (19.3)	0 (0.0)
< 12	959	36 (3.8)	138 (14.4)	11 (1.1)
12	695	56 (8.1)	154 (22.2)	12 (1.7)
24	565	22 (3.9)	120 (21.2)	11 (1.9)
36	562	22 (3.9)	130 (23.1)	7 (1.2)
48	518	21 (4.1)	95 (18.3)	12 (2.3)
60	557	21 (3.8)	96 (17.2)	14 (2.5)
All Ages	3856	178 (4.6)	733 (19.0)	67 (1.7)

** Children with Z-score values outside the range -6 and +6 were excluded from the analysis*

TABLE 9
% OF WEIGHT FOR AGE OF SAUDI ARABIAN FEMALE CHILDREN AGED 0-5 YEARS IN SD SCORES OF THE NCHS/CDC REFERENCE POPULATION BY AGE GROUP IN MONTHS

Age in Months	No. of Children*	SD Scores of weight for age (% of Age-group)		
		< -3 SD	< -2 SD	> 2 SD
< 6	187	4 (2.1)	19 (10.2)	8 (4.3)
6-11.99	221	11 (5.0)	39 (17.6)	0 (0.0)
< 12	408	15 (3.7)	58 (14.2)	8 (2.0)
12	327	21 (6.4)	61 (18.7)	12 (3.7)
24	245	11 (4.5)	39 (15.9)	7 (2.9)
36	245	11 (4.5)	55 (22.5)	4 (1.6)
48	229	6 (2.6)	39 (12.0)	5 (2.2)
60	264	9 (3.4)	37 (14.0)	8 (3.0)
All Ages	1718	73 (4.3)	289 (16.8)	44 (2.6)

** Children with Z-score outside the range -6 and +6 were excluded from the analysis*

TABLE 10
% OF WEIGHT FOR AGE OF SAUDI ARABIAN MALE CHILDREN AGED 0-5 YEARS IN SD SCORES OF THE NCHS/CDC REFERENCE POPULATION BY AGE GROUP IN MONTHS

Age in Months	No. of Children*	SD Scores of weight for age (% of Age-group)		
		< -3 SD	< -2 SD	> 2 SD
< 6	281	5 (1.8)	24 (8.5)	3 (1.1)
6-11.99	270	16 (5.9)	56 (20.7)	0 (0.0)
< 12	551	21 (3.8)	80 (14.5)	3 (0.5)
12	368	35 (9.5)	93 (25.3)	1 (0.3)
24	320	11 (3.4)	81 (25.3)	4 (1.3)
36	317	11 (3.5)	75 (23.7)	4 (1.3)
48	289	15 (5.2)	56 (19.4)	7 (2.4)
60	293	12 (4.1)	59 (20.1)	6 (2.1)
All Ages	2138	105 (4.9)	444 (20.8)	25 (1.2)

** Children with Z-score values outside the range -6 and +6 were excluded from the analysis*

TABLE 11
COMPARISON OF ANTHROPOMETRIC INDICATORS OF NUTRITIONAL STATUS IN PRESENT STUDIES WITH PREVIOUS STUDIES IN SAUDI ARABIA AND OTHER MIDDLE EASTERN COUNTRIES

Year	Pre-School Children Population	Sample Size	Weight/ Height < -2SD	Height/ Age < -2SD	Weight/ Age < -2SD
1988	Rural, Saudi Arabia [11]	842	12%	41%	44%
1988	Privileged, Saudi Arabia [12]	315	1%	2%	3%
1988	Less Privileged, Saudi Arabia [13]	270	3%	14%	14%
1983-4	Kuwait [16]	2554	2.6%	12.2%	6.4%
1982-3	Yemeni [20]	1493	5.6%	38.8%	26.3%
1982	Rural, Iran [20]	404	7.2%	55.7%	36.6%
1985-6	Rural, Lebanon [20]	117	1.7%	4.4%	3.4%
1978	National, Egypt [20]	6965	1.0%	38.8%	16.6%
1975	Tunisia [20]	1799	1.3%	39.5%	20.2%
1986	Present Study	3517	19.6%	11.5%	19.5%

reference population median in weight for age are presented in tables 8-10 for the study sample. While 19% were below -2 SD (an indicator of undernourishment) for both sexes, less than 5% were below the cut off of -3 SD for severe under-nutrition and only 1.7% were above 2 SD. Apart from the proportions above 2 SD, these figures are lower in females than males.

In Table 11 the nutritional indicators obtained in the present study are compared with values previously obtained for certain localities in Saudi Arabia and some Middle Eastern countries. The percentage less than -2 SD of the reference population median of weight for height is strikingly higher in this study compared to previous results from even Rural Saudi Arabia children and other countries. The other nutritional indicators seem to a certain extent to be comparable to other values previously reported for Saudi Arabia and other Middle Eastern countries.

DISCUSSION

The previous reports on the growth pattern of Saudi Arabian children emanated from sporadic attempts based on sample sizes smaller than that recommended by Waterlow (Waterlow et al, 1977) and others (Armitage and Berry, 1987; Sebai and Reivke, 1981; Serenius et al, 1988; Serenius and Swailem, 1988). Reliable conclusions from these studies have been hampered by these small sample sizes and differing method of analysis (Al-Sekait et al, 1992; Serenius, 1988). The present study of a cross-section of Riyadh pre-school children offers a clearer position of the growth pattern of Saudi children resident in the capital. In another report (Al-Frayh and Bamgboye, 1992), the factors affecting the observed growth pattern is described.

A striking observation is that in both sexes the distribution of weight for height concentrated mainly in the lower centile ranges of the NCHS/CDC reference population. Analysis of weight for height, an indicator of wasting in standard deviation scores (SD) of the NCHS/CDC reference population also showed that 19.6% are below the usual cut off point of -2 SD scores, an unusually high proportion. This observed rate of acute malnutrition of the Saudi pre-school children is surprisingly higher than the 12% obtained in an earlier study for Saudi rural pre-school children (Sebai and Reivke, 1981). The rate is also considerably higher than the report from Kuwait (where their children in this age group were found comparable with the reference population) and similar or higher than some other middle eastern countries (Bayoumi and Mousa, 1985; Keller and Fillmore, 1983). However, the figure obtained from the previous study on rural Saudi Arabian pre-school children could have been affected by the small sample size in each age group of children (NCHS, 1976; Bayoumi and Mousa, 1985). That the observed faltering growth started during the second half of the first year of life and peaked between 12 and 24 months in both sexes is in consonance with reports of previous observations of effects of dietary deficiencies and increase in diarrhoea diseases in this particular 12 to 24 months age-group (WHO, 1986: WHO, 1983).

A possible explanation is that in Saudi Arabia, the birth-interval is small compared to other countries, and weaning normally takes place at this age-group (Al Nasser et al, 1991; Serenius et al, 1988). This may have contributed to the deficit in tissue and fat mass compared to the amount expected in a child of the same height in the reference population (WHO, 1986; Bayoumi and Mousa, 1985). In the males, there appears to be a trend towards decreasing proportion of children considered acutely malnourished (weight for height less than -2.0 SD scores) with increasing age after 36 months. But no particular pattern has been demonstrated in the females. The significantly higher proportions (21.6%) in weight for height of Saudi pre-school children at 36 months found in this study had also been reported in a study among the privileged Saudi children in Riyadh City (Serenius, 1988). Because of the very high per capita income of Saudi Arabia, and the fact that food and other essential items are subsidised by the government, this observed deficit from the reference population may be better attributed to genetic and other social factors, including reproduction behaviour.

Another interesting finding is that weight for age, an indicator of under-nourishment, has a similar pattern with weight for height, an indicator of current malnutrition. Of all children in this study, 19% were undernourished (weight for age below -2.0 SD of the reference median). This figure exceeded the 14% reported for the less privileged urban children in Riyadh but considerably lower than the 44% reported for rural Saudi pre-school children (Serenius et al, 1988; Serenius and Swailem, 1988). It is, however similar or slightly lower than rates reported in some Arab countries like Egypt, Tunisia, Jordan and Yemen (Keller and Fillmore, 1983) and higher than the rate in Kuwait (Bayoumi and Mousa, 1985). It is however important to note that the data on which the indicator (weight for age) for the privileged and less privileged Saudi children was calculated were obtained from less than 300 children, a very low sample size compared to the recommended number of at least 200 in each age (Waterlow et al, 1977). Therefore, the findings from this study seem better to reflect the true pattern of growth of Saudi Arabian pre-school children. On the contrary, height for age, an indicator of stunting, and a characteristic of past nutritional deficiency, is slightly similar to the reference population. The deficiency in height for age is slightly higher in males than females but not statistically significant. While about 30% of the Kuwait children were above 2.0 SD scores of the NCHS/CDC standards, the figures in the Saudi children were 5.9% for females and 5.4% for males (Bayoumi and Mousa, 1985).

However, the results show that the Saudi children are slightly shorter than the American children but also slightly taller than the Kuwait children. A similar finding was reported for children 6 years to 18 years in a cross-sectional study of the growth of children in the Kingdom of Saudi Arabia (Al-Sekait

et al, 1992). In the study on school children and adolescents, the deficiency of height for weight observed in the present study for the pre-school children disappeared. In fact, the overall proportion of wasted and stunted children is an indicator obtained in a cross-tabulation of the SD scores of weight for height and height for age which was 1.5% in this study was 0.1% in the Sekait's study (Al-Sekait et al, 1992), but higher than a similar 0.3% recorded for the Kuwait children (Bayoumi and Mousa, 1985).

In conclusion, Saudi Arabia is a highly affluent and rapidly advancing society, with a great improvement in the socio-economic status and health care delivery systems. These factors query the validity of the interpretations of the observed nutritional indicators in this study. The possible effects of genetic and other social factors, as opposed to nutritional deficiencies, may be a better explanation for the observed deficiencies in weight for height and weight for age compared to the NCHS/CDC reference population (Sebai and Reivke, 1981; Al-Frayh and Bamgboye, 1992; Bayoumi and Mousa, 1985). Also the roles of racial differences, consanguinity, inadequate health education nutrition programmes, childhood diseases such as diarrhoea and endocrine dysfunction, reproductive behaviour, weaning and feeding habits of the children on the observed high proportion of stunted children deserve to be looked into. Finally, there is a need to examine the suitability of the reference population (NCHS/CDC) cut off points Saudi Arabian population and further studies are suggested to make the picture clearer.

ACKNOWLEDGEMENT

The authors are grateful to King Abdulaziz City for Science and Technology (KACST) for providing the fund for this project. Also thanks to Ms Vangie V Simbulan for secretarial assistance.

References

AL-FRAYH A S and BAMGBOYE E. Socio-demographic factors and the nutritional status of Saudi Arabian pre-school children (in preparation)

AL-FRAYH A R, JABBAR F A, HAQUE K N et al (1990). Survey of auxiological variance and growth standards in Saudi newborns at various gestational ages and the pre-school children in the Kingdom of Saudi Arabia. A final report of Project AR-5-170. King Abdulaziz City for Science and Technology, Riyadh, Saudi Arabia, Report No 33

AL-NASSER A N, BAMGBOYE E A and ALBUNNO M K (1991). A retrospective study of factor's affecting breast feeding practices in a rural community of Saudi Arabia. *Saudi Med J*, 12 (3), 236-240

AL-SEKAIT M A, AL-NASSER A N and BAMBBOYE E A (1992). The growth pattern of school children in Saudi Arabia. *Saudi Med J*, 13 (2), 141-146

ARMITAGE P and BERRY G (1987). Statistical methods in medical research. *Blackwell Scientific Publications*, (London), 2nd Edition, 372-375

BAYOUMI A and MOUSA M A A (1985). Kuwait nutritional survey: comparison of the nutritional status of Kuwaiti children aged 0-5 years with the NCHS/CDC reference populations. *Bulletin of the World Health Organization*, 63 (3), 521-526

KELLER W and FILLMORE C M (1983). Prevalence of protein energy malnutrition. *World Health Statistics Quarterly*, 36, 129-167

NATIONAL CENTER FOR HEALTH STATISTICS (1976). Growth charts. US Department of Health, Education and Welfare, Public Health Service, Health Resources Administration, Rockville, MD, (HRA 76-1120, 25, 3)

SEBAI Z A and REIVKE W A (1981). Anthropometric measurements among pre-school children in Wadi-Turaba, Saudi Arabia. *J Trop Paediatr*, 27, 150-154

SERENIUS F (1988). Attained growth of privileged Saudi children during the first 3 years of life. *Acta Paediatr Scand*, Suppl 346, 80-92

SERENIUS F, FOURGEROUSE D and SEBAI Z (1988). Growth and nutritional status of rural pre-school children in Saudi Arabia. *Acta Paediatr Scand*, Suppl 346, 104-120

SERENIUS F and HOFVANDER Y (1988). The ecological context of child health in Saudi Arabia. *Acta Paediatr Scand*, 346, Suppl, 15-28

SERENIUS F and SWAILEM A R (1988). Growth and nutritional status of less priveleged urban children in Saudi Arabia. *Acta Paediatr Scand*, Suppl 346, 93-103

SERENIUS F, SWEILEM A R, EDRESSEE A W and HOFFLANDER Y (1988). Patterns of breast-feeding and weaning in Saudi Arabia. *Acta Paed Scand*, Suppl 346, 121-129

SULLIVAN K (1990). Anthro software computer package. Nutrition Division CDC, Atlanta, USA

US FOOD AND NUTRITION BOARD, COMMITTEE ON NUTRITION ADVISORY TO CDC (1974). Comparisons of body weights and body heights of groups of children. US Department of Health Education and Welfare, CDC, Public Health Service, Atlanta, Georgia

WATERLOW J C, BUZINA R, KELLER E, LANE J M, NICHAMAN M Z and TANNER J M (1977). The presentation and use of height and weight data for comparing the nutritional status of children under the age of 10 years. *Bulletin of the World Health Organization*, 55 (4), 489-498

WORLD HEALTH ORGANIZATION (WHO) (1983). Measuring change in Nutritional Status. Guidelines for assessing the nutritional impact of supplementary feeding programmes for vulnerable groups. Geneva, (ISBN 92 4154160)

WORLD HEALTH ORGANIZATION WORKING GROUP (1986). Use and interpretations of anthropometric indicators of nutritional status. *Bulletin of the World Health Organization*, 64 (6), 929-941

WORLD HEALTH ORGANIZATION GLOBAL NUTRITIONAL INDICATORS (1989). Anthropometric indicators update 1989. Nutrition Unit, Geneva, NUT ANTREF, 1: 89, 56-62