Growth pattern of Saudi schoolboys in a high-altitude area of Saudi Arabia

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أنماط نمو تلاميذ المدارس السعوديين في منطقة مرتفعة بالمملكة العربية السعودية

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الغرض من هذه الدراسة هو بحث نمو تلاميذ المدارس في منطقة مرتفعة بالمملكة العربية السعودية ، واستقصاء مدى ملاءمة تطبيق معايير المركز الوطني للإحصاءات الصحية بالولايات المتحدة لتقدير درجة نمو الأطفال في مثل هذه المناطق . ولقد انتهت الدراسة إلى أن استعمال معايير المركز الوطني للإحصاءات الصحية بالولايات المتحدة ليس ملائماً لتقدير نمو تلاميذ المدارس في منطقة عسير . وثمة حاجة إلى إجراء المزيد من الدراسات للتحقق مما إذا كانت النتائج التي توصلت إليها هذه الدراسة مرتبطة بالارتفاع أم لا .

The aim of the present study was to examine the growth of schoolboys in a high-altitude area of Saudi Arabia, and to investigate the appropriateness of using the US National Center for Health Statistics (NCHS) standards for the assessment of children's growth in such areas. The study concluded that the use of NCHS standards is not appropriate for the assessment of growth of schoolboys in Asir Region. Further studies are needed to determine whether the findings of this study are altitude-dependent or not.

Schéma de la croissance des écoliers saoudiens dans une région de haute altitude en Arabie saoudite

Le but de cette étude était d'examiner la croissance des écoliers dans une région de haute altitude en Arabie saoudite, et d'examiner l'opportunité de l'utilisation des critères du Centre national américain de statistiques sanitaires (NCHS) pour évaluer la croissance des enfants dans ce genre de régions. L'étude a conclu qu'il n'était pas approprié d'utiliser ces critères pour évaluer la croissance des écoliers dans la Région d'Asir. Des études complémentaires sont nécessaires pour déterminer si on est parvenu à cette conclusion en raison de l'altitude ou non.

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Introduction

The measurement of growth of an individual child or of a group of children is one of the most sensitive and commonly used indicators of child health [*1*]. There has been much controversy regarding the validity of the use of growth standards based on well nourished children, mostly of Caucasian origin, growing in a good environment in developed countries, as references for the assessment of nutritional status in developing countries [*2,3*].

The city of Abha, capital of Asir Province (population 1 200 000) in southwestern Saudi Arabia, lies in the high mountains of Asir, at an altitude of about 2250 metres above sea level, and approximately 200 kilometres from the northern border of Yemen. The climate is temperate, with daily temperatures ranging from 5 to 32 °C, and an annual rainfall of 450 millimetres. Data on the pattern of growth of Saudi children in a high-altitude area of Saudi Arabia such as Abha are available for preschool children but not yet for the school population [*4,5*].

Aim of the study

The aim of the present study was to compare anthropometric data on weight and height for schoolboys in Abha with the US National Center for Health Statistics (NCHS) reference in order to study the growth pattern of Saudi children and to investigate the appropriateness of using the NCHS standards for the assessment of children's growth in such areas [*6*].

Material and methods

Sampling procedures

A two-stage stratified random sample of 1407 boys (of whom 1364 responded after the exclusion of very ill children from the study) from nine primary schools were selected for the present study, out of a total of 17 such schools in Abha. The sample constituted about 25% of the original school population of 5537 children in all schools.

In the first sampling stage, all 17 primary schools were classified into three groups, according to geographical location and socioeconomic level (roughly categorized into high, middle and low social classes based on an expert opinion). Then, using the equal allocation method of sampling, three schools were randomly selected from each of the three groups.

In the second sampling stage, six classes were selected randomly from each of the nine selected schools to represent the different grades. Thus, a total of 54 classes were included in the sample. Each class was considered as a cluster, and all boys in the selected classes constituted the target group of the present study.

Techniques

The children were measured by one trained male nurse for consistency.

- Weight: Boys were weighed barefoot and in underclothes, using a beam balance, to the nearest 100 grams. The scale was calibrated at the beginning of each working day.
- Height: Height was measured to the nearest 0.25 centimetres using a fixed wall ruler with a sliding headpiece. The child stood with heels, buttocks, shoulders and occiput touching the wall. The head was held erect with external auditory meatus and the lower border of the orbit in one horizontal plane. The headpiece was then lowered until it made light contact with the hair, and the reading was taken.

All such measurements were taken at the school health unit in Abha city, according to

a preplanned time schedule that allowed the pupils of one class to be examined on a day when they would cause the least disturbance to other pupils.

Statistical analysis

Individual data for the three growth indicators, weight-for-age, height-for-age and weight-for-height, were compared with those of the NCHS reference population [6]. A computer program placed each value in one of four centile bands; below 10th, 10–49th, 50–89th and above 90th, using data from height and weight. The results were compared by chi-square analysis. The 5th, 50th and 95th percentiles for weight and height measurements were calculated for the previous three growth indicators. The observed percentiles were smoothed and plotted on the NCHS growth curves for comparative purposes [6].

Results

Table 1 shows the physical characteristics of the sample studied in terms of weight and height by age. Figures 1–3 represent

Table 1 **Means (± SD) of weights and heights by age of 1330 schoolboys in Abha, Asir Region**

Age (years)	No.	Weight (kg)	Height (cm)
6	63	19.8 (3.35)	116.3 (4.86)
7	230	20.9 (4.24)	118.6 (5.29)
8	182	22.4 (4.04)	122.9 (6.10)
9	203	25.6 (4.98)	128.9 (5.96)
10	230	27.9 (6.42)	132.2 (7.28)
11	218	32.2 (8.93)	137.9 (6.40)
12	155	34.5(10.72)	141.2 (7.39)
13 to 14	49	39.6(16.44)	145.8 (8.22)

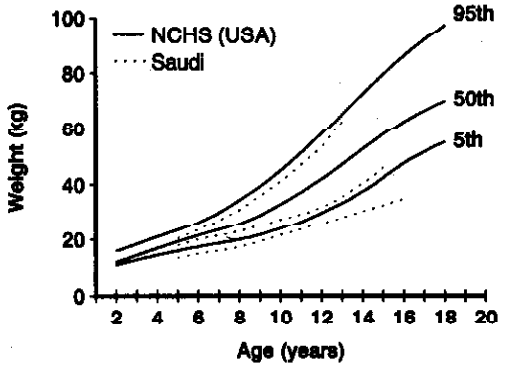

Figure 1 **Percentiles of weight-for-age of Saudi schoolboys**

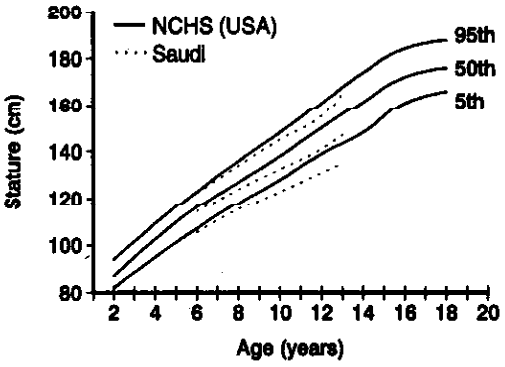

Figure 2 **Percentiles of height-for-age of Saudi schoolboys**

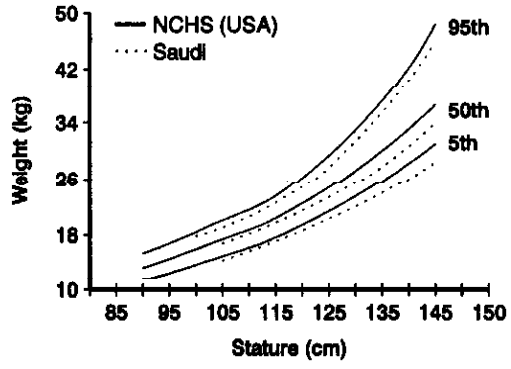

Figure 3 **Percentiles of weight-for-height of Saudi schoolboys**

weight-for-age, height-for-age, and weight-for-height for all children.

The weight-for-age figures in the present study were lower than those pertaining to the NCHS reference population for all ages ($p < 0.0001$). For children at the 95th centile, despite the presence of a minimal difference between the local and the reference groups, the difference in weight stayed almost constant at all ages. However, for the 5th and 50th centiles, the difference in weight increased exponentially by age.

The height-for-age figures were lower than those of the reference population for most ages ($p < 0.001$). For children at the 95th centile, the stature was fairly similar to the reference population up to the age of 8 years, older than which the centile departed downward and continued at a lower level than the reference until the age of 13 years. However, for the 5th and 50th centiles, the difference in height was evident at all ages, and this difference increased with age.

The weight-for-height figures were lower than those pertaining to the reference population for all ages. Both the 95th and the 50th centiles were lower but parallel to the respective NCHS centiles at all ages. On the other hand, children growing at the 5th centile started their growth with a potential that is as good as that of their NCHS counterparts at the age of 6, after which their centile declined and became lower than that of the reference population.

Discussion

The growth of southwestern Saudi boys in the present study was less than that of the reference population. This was in agreement with other studies in other areas of the country [*7,8*]. This divergence from the reference population may reflect both nutritional and ethnic variations between children in the present study and the NCHS data representing American children [*9*].

However, this difference was greater in weight-for-age ($p < 0.0001$) than in height-for-age ($p < 0.001$), a distribution that is different from that of a national study [*8*] of Saudi schoolchildren, where the difference from the reference population was greater in height-for-age than in weight-for-age. The distribution of the present study was also different from that of urban black South African boys [*10*].

Such greater difference in weight (than in height) between the high-altitude children of the present study and those of the reference population could be attributed to the growth-retarding effects of high-altitude hypoxia [*11*]. These effects have been attributed to the negative energy balance and the interference with protein metabolism leading to a significant weight loss in such high-altitude areas [*12*].

When data of weight-for-height indicator, which is considered as an indicator for acute malnutrition [*14*], were investigated in the present study, Saudi children showed more wasting than did their American counterparts at all ages. This finding was not in agreement with that of Al-Sekait et al. [*8*], which was suggestive of overnutrition. However, such overnutrition was more evident among adolescent children over the age of 12 years, for whom overweight is likely to be a common problem [*15*]; this age was beyond the scope of the present study.

Conclusion and recommendations

The use of NCHS growth standards is not appropriate for the assessment of growth of schoolchildren in the area examined. There is a need for further studies to determine whether the growth patterns in the present

study are altitude-dependent or not. However, whether altitude, climate, or socioeconomic status—or a combination of them—are responsible for such patterns or not, new national standards for growth of schoolchildren are needed; such standards should represent the optimum achievable growth in all geographical areas of the country.

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