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Improving trend of growth of Asian refugee children in the USA: Evidence to support the importance of environmental factors on growth

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In order to better define the trends and patterns of growth for children of Asian refugee families residing in the USA, we studied the anthropometric data from 12 states collected by the Centers for Disease Control and Prevention (CDC) Pediatric Nutrition Surveillance System (PedNSS) from 1979 to 1993. The Asian refugee children under 5 years of age showed a progressive and significant decline in the prevalence of low height-for-age and low weight-for-age, while those nutritional indices remained stable for low income white children and black children. By 1993, the growth status of Asian refugee children was comparable with that of other ethnic groups. This marked improvement over a short period strongly suggests that the poor growth status earlier observed among recently immigrated Asian children was due to nutritional and health factors related to socioeconomic conditions, rather than to genetic factors, as is often suggested. Detailed analysis of each birth cohort born at different time periods found that low anthropometry during infancy is a strong predicator of smaller body size later in childhood.

Key words: height, weight, stunting, growth, anthropometry, Asian refugee children.

Introduction

It is well accepted that the growth of well fed, healthy children, from different ethnic backgrounds and different continents is relatively similar, and socioeconomic status is a major determinant of nutritional status.[1–4] Many Asian children, particularly those who immigrated to the USA as refugees from Southeast Asia in the late 1970s and early 1980s, were noted to have significantly shorter stature when compared with other low income children in the USA.[4–10] The US Centers for Disease Control and Prevention (CDC) Pediatric Nutrition Surveillance System (PedNSS), which has been collecting anthropometric data of low income infants and children participating in various public health and nutrition programs continuously since 1975, provides a unique database to examine the pattern, trends, and determinants of growth status of low income children.[11]

The majority of the Asian children monitored by the system are of Southast Asian refugee background. These children were generally low in height and weight when initially assessed. By the middle 1980s, there was clear evidence that their growth status had improved but was still lagging behind the height and weight of children of other races and ethnic backgrounds.[4–10] The purpose of this study was to (i) better define the growth trends of Asian children compared with trends among children of other ethnic groups, and (ii) determine the relationship of growth status in infancy to growth attainment at later ages.

Methods

Sources of data

The CDC Pediatric Nutrition Surveillance System

Since 1975, the CDC Division of Nutrition and Physical Activity has assisted states in monitoring key growth and hematologic indicators of nutritional status of low income US children who participate in publicly funded health and nutrition programs such as the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) and the Early Periodic Screening, Diagnosis, and Treatment Program (EPSDT) or who attended clinics funded through Maternal and Child Health Program (MCH) block grants.[11–13] This surveillance system provides a framework for tabulating and interpreting state-specific information on the nutritional characteristics of low income children. Since its inception, the participating regions have increased from five states in 1973 to 44 states, the District of Columbia, Puerto Rico, and seven Indian Reservations in 1993. Nearly 5000 clinics provide data to the system, with a total of 7 million records collected annually from approximately 3 million children.

The Special Supplemental Nutrition Program for Women, Infants, and Children

Data for the majority of the infants and children monitored by the PedNSS were based on clinic service records of a Special Supplemental Nutrition Program for the Women, Infants and Children program (WIC). The WIC program, which was initiated in 1972, is administered by the Food and Nutrition Service of the US Department of Agriculture.[14,15]

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The program provides supplemental foods plus health care referrals and nutrition education at no cost to low income pregnant women, breastfeeding and non-breastfeeding post-partum women, infants, and young children up to 5 years of age who are found to be at nutritional risk.[14,15] In order to qualify to participant in this program, the annual income must fall within 185% of the Federal poverty level. In 1995, the poverty level was US$15 150 for a family of four; 185% of that figure amounted to an income of no more than $28 028 that year for the average family.

Subjects

In order to study the trend in growth status of Asian children and the comparison of growth status among different ethnic groups under 5 years of age, we selected the 12 states (Arizona, Colorado, Florida, Illinois, Indiana, Kentucky, Louisiana, Michigan, Montana, New Jersey, Oregon, and Tennessee) that consistently participated in the PedNSS from 1979 to 1993. During the 15-year period, the 12 states had a total of 180 748 Asian individual records. A total of 17 720 649 records for white and black children were collected in the same 12 states.

The majority of the Asian children monitored by the PedNSS are of the South-east Asian refugee background. This was evident during the period of 1977–88, when the number of Asian children in the PedNSS increased by 10-fold parallel with the influx of refugees from Cambodia, Laos, and Vietnam to the USA.[11] We did not include in this study states such as California and New York, which already had more non-refugee than refugee Asian residents. For the 12 states included in this study, officials from either the state WIC office or the state nutrition office verified that the majority of Asians enrolled in their programs in recent years were of South-east Asian refugee origin.

In the PedNSS system, height or recumbent length is measured to the nearest 0.1 cm. A measuring board is used to measure the child's recumbent length if the child is less than 24 months, otherwise, a standing stature is measured for child older than 24 months. Weight was measured to the nearest 0.1 kg using a pediatric scale or other beam balance scale.[13,16] All the records were entered to a standardized paper form or to an automated system in the clinics, then transferred to the CDC PedNSS database.

The new research growth reference

In recent years, several studies have shown that the current National Centre for Health Statistics/World Health Organization (NCHS/WHO) international reference based on the Fels sample (< 2 years of age), and the part based on the national sample (≥ 2 years of age) are not comparable. When the two curves are compared, there is a clear disjunction of the height-for-age and weight-for-height at 24 months of age.[17–20] Also, the weight-for-age curve has a disjunction at 24 months for uppercentiles. These disjunctions make it difficult to compare the growth status of children younger than 2 years of age with that of those older than 2 years of age. In addition, several studies have found that the infancy portion of the current international reference which is based on the Fels sample does not fit with the growth pattern of infants regardless of whether they were breast-fed or formula-fed.[21–24]

Because of the limitations of the current international growth reference, a new growth reference was developed for research purpose by the CDC Division of Nutrition and Physical Activity, which eliminated the marked disjunction at 24 months.[25] The main advantages of the new research reference are that it is based on a very large sample size and advanced smoothing techniques were used that all the data are drawn from the same data source. Thus it overcomes many of the irregularities seen in the current international growth reference, especially the discontinuity or 'disjunction' in the growth curves at 24 months of age.[25]

The anthropometric indicators

Three growth indices were used for this study: height-for-age, weight-for-age and weight-for-height. A standard deviation (SD) score or *Z*-score for each index was computed for each child's measurement against the research reference. The individual *Z*-score is calculated by subtracting the reference median value from the individual value and then dividing that difference by the reference SD value for the given age or height. Low height-for-age, low weight-for-age and low weight-for-height were defined as a value below –2 *Z*-score of the reference.[23,26] Based on these definitions, the expected or baseline prevalence for each indicator is 2.3%. An increased prevalence of low height-for-age indicates significant growth stunting for a given population. On an individual basis, low height-for-age, or shortness, can be the result of normal variation of growth or stunting related to a long-term health or nutritional disorders. The *Z*-score of anthropometric indices allows the combing of age and sex of children to facilitate analysis. The expected mean *Z*-score is 0 and expected SD of *Z*-score is 1.0 for the reference population.

Any height-for-age *Z*-scores below –5 or above +3 were excluded because these extreme values were most likely due to errors in measurement or data entry. For weight-for-age values, the exclusions were *Z*-scores below –4 or above +5, and for weight-for-height values, the exclusions were *Z*-scores below –4 or above +5.[23] Mean *Z*-scores are also used to demonstrate trends and patterns of growth.

Results

Figure 1 summarizes the prevalence of low height-for-age for three ethnic groups of infants and children aged 0 through 59.9 months. The influx of large numbers of Asian refugees in the late 1970s and early 1980s was followed by a peak in the prevalence of low height-for-age among Asian children during 1981 and 1982. During this period, the low height-for-age prevalence for Asian children was two to three-fold higher than that for other ethnic groups of low income children. From 1983 to 1993, the prevalence of low height-for-age began to decline in all the age groups of Asian children. The overall prevalence of low height-for-age declined from 14.3% in the peak year of 1982 to 7.3% in 1993, representing a relative reduction of more than 49% ($P < 0.0002$, test of trend). During this period, there was a slight increase in the prevalence of low height-for-age for black children. However, this prevalence was stable in white children. By 1993, the prevalence of low height-for-age for Asian children was very close to that of other ethnic groups.

In order to decide whether the reduction in the prevalence of low height-for-age among Asian children was related to a

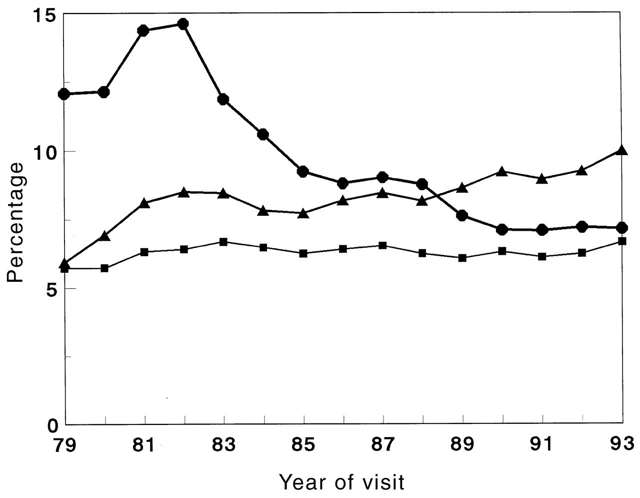

Figure 1. The age-adjusted prevalence of low height-for-age (< –2 *Z*-score) for three ethnic groups of children, aged 0–59.9 months, 1979–93. (■), white; (▲), Black; (●), Asian.

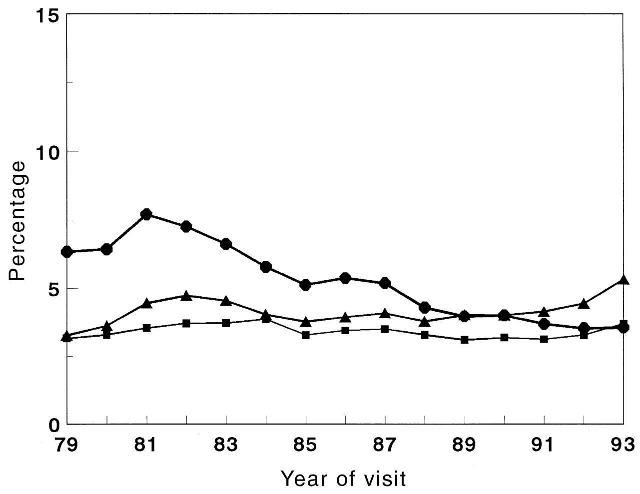

Figure 3. The age-adjusted prevalence of low weight-for-age (< –2 *Z*-score) for three ethnic groups of children, aged 0–59.9 months, 1979–93. (■), white; (▲), Black; (●), Asian.

reduction in a subpopulation of children who were very short, or related to a general improvement of the entire height distribution, we used the height-for-age *Z*-score to compare the age-standardized height distribution for Asian children. Figure 2 compares the height distribution of Asian children aged 0 through 59.9 months for two different time periods. In contrast to the mean height-for-age *Z*-score of zero for the reference, the mean height-for-age *Z*-score for Asian children was –0.66 for 1979 through 1981, and –0.11 for 1991 through 1993 ($P < 0.0001$, by analysis of variance). Also, the height-for-age distribution of the two periods for the two different age groups had a similar variance and shape, without a marked downward skew. Thus, the reduction in the prevalence of low height-for-age observed among Asian children is the result of a general improvement in the entire height distribution over the 15-year period.

Similar to the trend of low height-for-age, Asian children showed a marked decline from 1979 to 1993 in the prevalence of low weight-for-age ($P < 0.0001$, test of trend), while other ethnic groups remained relatively stable (Fig. 3). The reduction in the prevalence of low weight-for-age was also the result of a general upward shift of the entire weight-for-age distribution over the 15-year period.

The trend of low weight-for-height shown in Fig. 4 suggests that Asian refugee children had a relatively low rate of thinness even in the earlier years, and throughout the years the improvement is slight. The trend of weight-for-height was stable for white and black children.

Figure 5 compares the mean height-for-age *Z*-scores across age for four cohorts of Asian refugee children grouped according to birth occurred in four different time periods. These four cohorts have a distinct pattern of growth. The earlier cohort had the lowest height-for-age in infancy and continued to have the lowest up to five years of age. In contrast, the later year cohorts were consistently taller. This finding indicates that later childhood growth status is strongly influenced by the status in early infancy. This cohort effect is also true for weight-for-age (Fig. 6).

Discussion

This study indicates a continuation of the improving trend of growth for Asian refugee children, previously observed in the

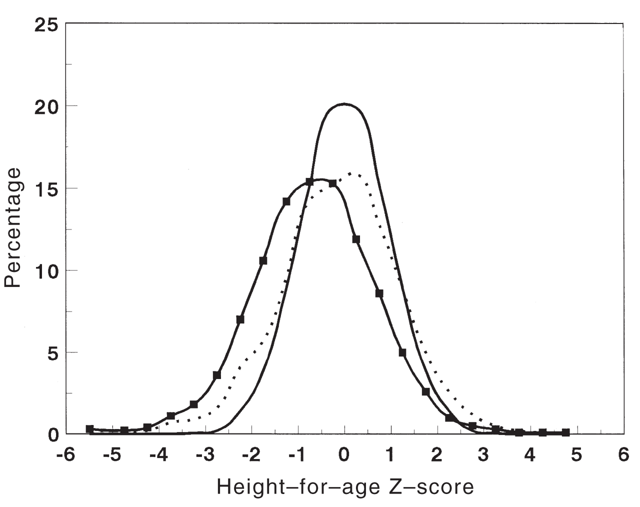

Figure 2. The frequency distribution of height-for-age *Z*-score of Asian children, aged 0–59.9 months, for two different time periods. (■), years 79–81; (…), years 91–93; (–), reference.

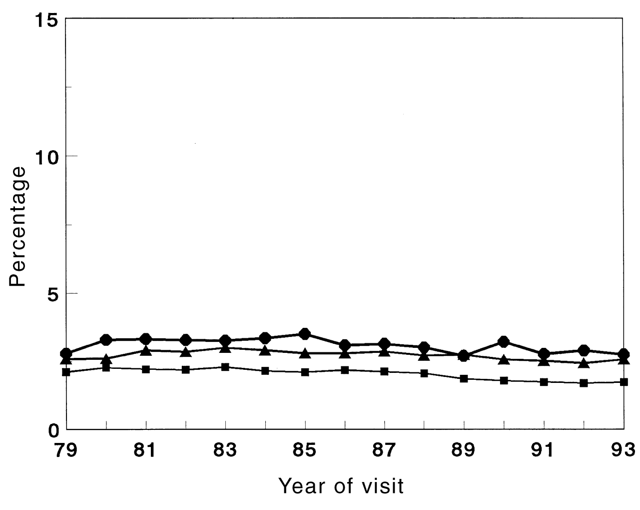

Figure 4. The age-adjusted prevalence of low weight-for-height (< – 2 *Z*-score) for three ethnic groups of children, aged 0–59.9 months, 1979–93. (■), white; (▲), Black; (●), Asian.

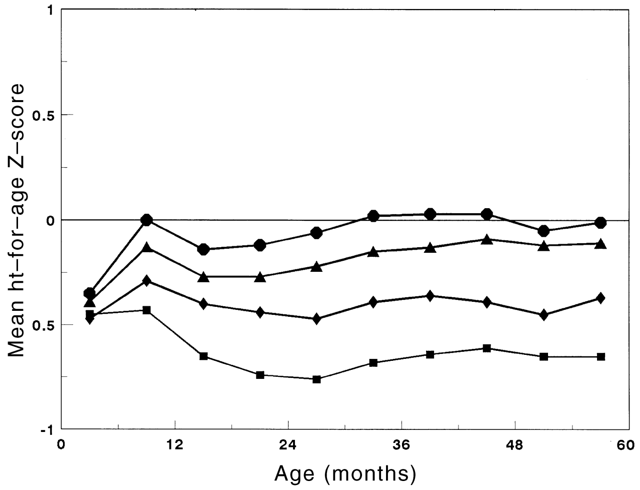

Figure 5. The mean height-for-age *Z*-score of Asian children: A comparison of four birth cohorts across age. (■), years 79–81; (◆), years 82–84; (▲), years 85–87; (●), years 88–90.

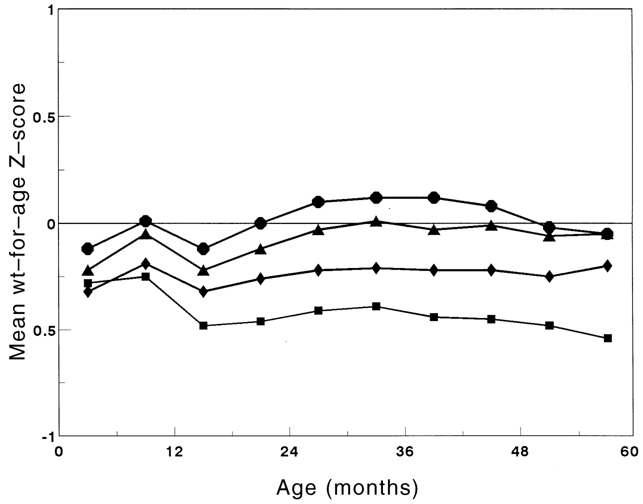

Figure 6. The mean weight-for-age *Z*-score of Asian children: A comparison of four birth cohorts across age. (■), years 79–81; (◆), years 82–84; (▲), years 85–87; (●), years 88–90.

late 80s.[4] By 1993, the Asian children monitored by the PedNSS had almost caught up with other racial and ethnic groups. These remarkable changes suggest that the small stature of Asian refugee children observed in earlier years was due to health and nutritional factors rather than to genetic differences in growth potential.

Often the small body size of Asian children and adults, in contrast with that of other populations, has been used to support the concept of genetic-based variation in human growth.[25] The dramatic change observed here clearly indicates that the environmental factors play a prominent role. Even though Asian refugee families as a group were relatively poor when they first arrived in the USA, general living conditions and the availability of health and nutrition services were likely to be significantly better than in their native communities. Also, throughout the years in the USA, their economic conditions improved, which in turn improved the health and nutrition status of their children.

It is well accepted that, on a population basis, high prevalence of low height-for-age reflects stunted growth due to long-term poor health and nutrition associated with adverse socioeconomic conditions. Worldwide, the prevalence of stunting varies dramatically from 2 to 3% in developed countries to 50–60% in some of the less developed countries[23]. The current study demonstrates that growth can be improved within a relatively short period of time, and supports the proposition that childhood anthropometry can be used as an objective index of socioeconomic conditions.[27] The earlier study also had shown that the rate of low birth weight for Asian infants significantly declined for the years 1978–89, reaching the same level as the rate of low birth weight for white infants.[4]

Low weight-for-height generally is used as an index of thinness or wasting, potentially indicating inadequate protein and energy intake and/or a severe illness such as diarrhea.[27] It is not surprising that the prevalence of wasting was not elevated among the Asian refugee children, even in earlier years, because they were not experiencing severe deprivation.[28]

Weight-for-age is a composite index reflecting both height-for-age and weight-for-height. When weight-for-height is normal, the weight-for-age index tends to parallel that of height-for-age. Thus, the relatively high prevalence of low weight-for-age (Fig. 3) reflects the high prevalence of stunting among Asian children.

The significant decline in the prevalence of low height-for-age and low weight-for-age, as shown by this study, is the result of a generalized upward shift of the entire height or weight distribution of the Asian children. This finding indicates that when the prevalence of malnutrition is high, all the children in a population are affected, not just those in the low end of the distribution.[28] When conditions improved, all the children became taller and heavier, and the entire distribution shifted to the right. This finding implies that the prevalence of low anthropometry is a useful indicator of the nutritional status of a population, but we must keep in mind that the whole population is affected, not just those who fall below a fixed cutoff.

By 1993, the prevalence of low height-for-age of low income Asian children (0–59.9 months) reached a range similar to that of other ethnic low income children (Fig. 1). However, Fig. 5 shows that the time required to 'catch up' was different for different birth cohorts. The Asian children who were older in 1992 belonged to the cohort of children born in 1988. As a group, they were still shorter than were those born in later years. This cohort effect suggests that the nutritional status of infancy or early childhood is a strong determinant of the nutritional status of later childhood. One possibility is that malnutrition is most likely a process that starts early, possibly even during intra-uterine growth. For this reason, interventions for protein–energy malnutrition should be started during the mother's pregnancy or the child's early infancy. Another possibility is that common factors affecting health and nutrition exert their influence starting in the fetal period and continuing throughout childhood. These results imply that in the interpretation of growth of older children, whether for a clinical purpose or on a population-based assessment, it is helpful to take into account their growth status during early infancy.

Our study has potential limitations commonly found in surveillance systems that use routine clinical data. Because the source data come from multiple clinics and the techniques of measurement are not tightly controlled, the quality of anthropometric measurements can not be guaranteed. However, we checked the data quality for the states in this analysis by using the PedNSS anthropometric data quality assurance indices[13] and found it generally high and reasonably stable. The records of the children with missing ages were automatically excluded during the data transaction before it transferred to the PedNSS database. The per cent of missing height/length and weight were 1.4 and 0.8%, respectively, and biologically implausible value of mean height-for-age *Z*-score, mean weight-for-age *Z*-score, and mean weight-for-height *Z*-score were 0.8, 0.4 and 0.6%, respectively. Also, not all Asian children included in the analysis were from refugee backgrounds. The PedNSS lacks detailed information on the origin of Asian children and the length of time since their families immigrated to the USA. However, we verified that most of Asian children enrolled in their programs during this time period were of South-east Asian refugee origin by contacting the state WIC or nutrition officials of the 12 states. Both of these limitations are intrinsic to a surveillance system that uses routine clinical data. However, those limitations should not significantly affect the comparison of trends across time, provided that the quality of data and the proportion of Asian children from non-refugee families are reasonably stable over time. The use of the new research reference also may constitute a limitation of the study, but it is important in contrast to the current NCHS/WHO growth reference. Overall, this study demonstrates that routinely collected data from ongoing surveillance can provide highly useful information to address important public health issues.

In summary, the dramatic improvement in growth status observed in subsequent cohorts of Asian refugee children over a 15-year period suggests that better socioeconomic conditions resulted in improved early childhood growth, and in turn, improved growth status in later childhood. It appears that the longer the Asian refugee families have resided in the United States, the better the nutritional status of their children. Alternatively, the results suggest that the longer the children are exposed to a better diet and health services, the taller they grow. The evidence strongly supports the proposition that environmental factors such as diet and access to health services play a major role in the variations of growth often observed among different populations.[1–3] It also indicates that the proper evaluation of children's growth need to take family and early childhood background into account.

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美國亞洲難民兒童生長的改善：
支持環境因素對生長的重大意義

摘　　要

爲了更好的解釋亞洲難民兒童移民美國后生長的趨向和模式，我們研究了1979 — 1993 年由疾病控制和預防中心（ CDC ），兒童營養監視體系（ CDC PedNSS ）從 12 個州收集的身體測量數據。結果發現：五歲以下的亞洲難民兒童身高較矮和體重較輕的數目呈進行性的和明顯地下降。到 1993 年時，亞洲難民兒童的生長狀況與其它人種已相似，這種短期內的明顯改善，強烈地指出了亞洲移民兒童不良的生長狀況主要與社會經濟有關的營養和健康因素有關，遺傳因素是次要的，作者分析了不同時期出生的兒童發現，在嬰兒時人體測量數據較低者，可預知兒童晚期個體較小。

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