# The Growth Status of North Korean Refugee Children in China

*Pak Sunyoung*

**Abstract**

*This paper is an assessment of the growth status of 55 North Korean refugee children 3 to 18 years old residing in a Sino-North Korean border area. Body measurements were taken during visits made from 26 July to 5 August 1999 and from 21 January to 28 January 2000. The growth status was assessed by comparing refugee children's height and weight with both the NCHS growth reference curves and South Korean means. The raw data on weights and heights were converted into anthropometric indices (Z-scores of weight-for-age, height-for-age, and weight-for-height) relative to NCHS reference values. Most of the children have Z-scores of below –2 for height (mean HAZ: –2.63) and between –2 and –1 for weight (mean WAZ: –1.81). The percentage of the children who are retarded in height (% <–2 HAZ: 70.9) is much higher than that of those retarded in weight (% <–2 WAZ: 27.3). These children are more stunted than underweighted. They are also 1.8 to 24.2 cm shorter and weigh .1 to 18.9 kg less than their South Korean peers. The difference in height has a tendency to increase in adolescence.*

**Keyword:** North Korea, food crisis, children, refugee, growth, nutrition

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Pak Sunyoung (Bak, Sun-yeong) is an assistant professor in the Department of Anthropology, College of Social Sciences, Seoul National University. She received her Ph.D. from the State University of New York at Buffalo in 1995. She has written many articles including "A Study of North Korean Biological Standards of Living Using Anthropometric Data from North Korean Escapees" (in Korean) (*Korean Cultural Anthropology* 35.1) (2002). E-mail: suny@snu.ac.kr.

## Introduction

The North Korean food crisis had already been in progress before it gained international attention with the heavy flood in the country that aggravated the problem in 1995. The North Korean children/adolescents who passed their growth period in the mid-1990s suffered severe growth retardation. The investigation by the EU/UNICEF/WFP reported in 1998 that a considerable number of children aged up to 7 years exhibited growth retardation from malnutrition in all regions of North Korea (EU/UNICEF/WFP 1998). An analysis of the 1998 EU/UNICEF/WFP reports estimates that as of 1998 North Korean children are shorter than South Korean children at least by 12 cm by age 7 (Pak 2000).

Children who experience severe malnutrition in the growth period are highly likely to become adults with extensive functional impairments, such as reduced immune function and physical strength as well as impaired cognitive and emotional development, which may have long-term adverse social consequences. Only a very limited amount of data is available to assess the long-term effects of the food crisis on the growth and development of North Korean children. The most reliable data on North Korean growth and development available now are the reports by the EU/UNICEF/WFP (1998). Unfortunately, the data is limited in that only children aged up to seven years were under investigation, and indirect indices, such as those describing the rate of malnutrition by age and overall mean growth indices, are reported instead of direct growth measurements and growth indices by age and by sex.

Since it is impossible to investigate North Korean children firsthand, The North Korean Famine Study Group conducted research from 26 July to 5 August 1999 and from 21 to 28 January 2000 in a Sino-North Korean border area to study the current situations of displaced North Koreans. This paper reports the growth status of 55 North Korean refugee children aged 3 to 18 years studied by the researcher during these visits. The study was carried out as an effort to assess the immediate impact as well as the long-term effects of the current food crisis on the growth and development of North Korean children.



This research first attempts to make an assessment of the living conditions and welfare status of North Korean refugee children in China by analyzing their growth data. The growth status of the children was assessed by comparing their height and weight with both National Center for Health Statistics (NCHS) growth reference curves and South Korean means. Then, a comparative analysis of growth characteristics of North Korean refugee children in China and those of South Korean peers was conducted. The paper attempts to estimate the future disparity in body size between adults of the two Koreas and infer the implications of the disparity. Because the subjects of this research are North Korean refugee children in China, the results of the research may not necessarily apply to the general population of North Korean children. Nevertheless an analysis of actual measurements of children aged up to the late teen years will provide significant complementary data for an accurate assessment of the growth and development status of North Korean children in general.

Childhood growth has been widely employed as an important indicator of health and nutritional status of human populations (Huss-Ashmore and Johnston 1985), because growth impairment in children is not just a direct consequence of malnutrition but also an indicator sensitive to the overall welfare level of the society. The nutritional status of children can be measured in several ways: dietary intake, biochemical evaluation of urine and blood, clinical evaluation of symptoms and signs, and anthropometric assessment. The most commonly used method, however, is nutritional anthropometry (Dwyer 1991). It is relatively easy to employ, can be used in large-scale surveys as well as in clinical conditions, and is relatively sensitive to changes in the nutritional status of young children. The popularity of anthropometric parameters of nutritional status is partly due to their convenience of application for their high sensitivity and accuracy and also because they can be evaluated by a single set of well-standardized international references and manipulated by well-established statistical procedures. A reference is not intended to be a norm

(i.e., a standard to be attained), but rather measures to which growth may be compared. The most acknowledged international reference data is the NCHS growth reference curves (WHO 1978).

The most frequently used anthropometric parameters in evaluation of nutritional status are weight-for-age, weight-for-height, and height-for-age. Three kinds of malnutrition can be distinguished using knowledge of a child's height, weight, and age (Seoane and Latham 1971). Acute short-term malnutrition is characterized by low weight-for-age, low weight-for-height, and normal height-for-age relative to mean reference values. Past chronic undernutrition is characterized by low weight-for-age, low height-for-age, and normal weight-for-height relative to reference values. Present acute malnutrition on chronic undernutrition is characterized by low weight-for-age, height-for-age, and weight-for-height values relative to reference values. Waterlow (1972) distinguished these three types as wasting (acute), stunting (chronic), and wasting-stunting (acute on chronic). Growth measurements that deviate from reference values are expressed in one of three ways: percentage of reference mean (or median), Z-scores, or percentile. Z-scores[1] are especially useful for growth studies in situations where the majority of children fall below the lowest published percentiles for United States children, as is the case with situations in most underdeveloped countries (WHO 1983). Z-scores are also useful in that they mean the same thing across all ages, are easy for statistical manipulation, and can be used to quantify relative growth status of the children whose measurements fall below the entire range of reference values.

1. Z-score indicates where an individual measurement falls relative to the whole range of distribution of reference group. For instance, a Z-score of –2 means the individual measurement is smaller than the median of reference group by two standard deviations.



## Results

### *Characteristics of the Sample*

The sample consists of 55 North Korean refugee children I met in Yanji (Yeongil in Korean) during the study periods. Of these children, 20 lived on the street, 17 lived in church-run secret hideouts, and 18 resided with their parents. Their age and sex structure is summarized in Table 1.

*Table 1. Age and Sex Structure of the Sample*

| Age (year) | Male | Female | Total |
|---|---|---|---|
| 3–4 | | 1 | 1 |
| 4–5 | 2 | | 2 |
| 6–7 | | 2 | 2 |
| 7–8 | 1 | 1 | 2 |
| 9–10 | 2 | 1 | 3 |
| 10–11 | | 1 | 1 |
| 11–12 | 3 | 2 | 5 |
| 12–13 | 2 | | 2 |
| 13–14 | 6 | 2 | 8 |
| 14–15 | 6 | 3 | 9 |
| 15–16 | 8 | 1 | 9 |
| 16–17 | 8 | 1 | 9 |
| 17–18 | 2 | | 2 |
| Total | 40 | 15 | 55 |

As shown in Table 1, most of the subjects were males. Female children were either placed in hideouts or lived with their family except one child who crossed the border with her brother. According to the native inhabitants of the area, female children living on the street were rarely seen. Children living on the street were mostly aged from 13 to 17 years while most children below the age of 13 lived with their family or in the hideouts. The length of time these children stayed outside their home varied from just a few days up to four

years. Over 80 percent of the children studied had stayed in China for less than one year at the time of the investigation. The majority of the street children had crossed the border more than once. A significant number of these children had experiences of escaping from the concentration camps they had been placed in upon getting caught while in China or crossing the border.

It is not certain how much the nutritional status of these children has improved since their arrival in China. The words of the children that they eat definitely better in China imply that their environments in China may be generally more favorable to children's growth than the environment in North Korea. However, presently available data is too meager to appropriately assess the relationship of the duration of their stay and the environments in which they find themselves in China with their present growth status. This is because each child's exact duration of stay in China cannot be confirmed, and it is impossible to accurately assess the quality of the environment to which the child was exposed in that time. Therefore all that can be said for now is that children who were somewhat better nourished during their stay in China are expected to show slightly improved growth status on the average than they would have had they stayed in North Korea.

Table 2 is the summary of the parental status of the refugee children. The accuracy of the parental statuses, however, cannot be confirmed because the data were obtained through interviews with children, in the cases of those living on the street and in the hideouts. The church-run hideouts provide shelter as well as private education for the displaced North Korean children residing in China. Because of their illegal status, these children are neither allowed to officially enter the school system, nor can they openly commute to the hideouts. So these facilities also function as boarding schools for the children who are staying in China with their family. Hence the parental survival rate of the children in the hideouts is comparatively higher than that of the street children.

*Table 2. Parental Status of the Sample Children*

| | Father | Mother |
|---|---|---|
| Deceased | 14 | 12 |
| Divorced | 1 | |
| Missing | 4 | 8 |
| Ill | 3 | 3 |
| No disease reported | 27 | 29 |
| No information | 6 | 3 |
| Total | 55 | 55 |



Of the 20 street children, only 14 provided information on parental status. All except one child stated that at least one of their parents was deceased, missing, or sick at the time of the research. Of the 20 street children, 16 came from Musan of the Hamgyeongbuk-do province in North Korea where mining is the major industry. Most of these children's parents had been miners there who suffered greatly when the food rationing stopped. Either one or both of these children's parents died or went missing in the harsh struggles to survive the food shortage. In the middle of these family crises, children without guardians seemed to have been driven to the street.

Food crisis in a society does not necessarily cause malnutrition among the entire members of the society and to the same degree. However, it is estimated that people in all regions and ages in North Korea suffer malnutrition to a relatively equal degree due to tight social control (Chung 1999). Nevertheless, even in normal times there is disparity in children's growth and development in socialist countries, depending on the parents' socioeconomic status (Bielicki et al. 1981). Furthermore, as the situation of the food shortage worsens and draws out, socialist state control is bound to weaken. According to the FAO/WFP special report (1998), there is no equitability in individuals' access to food, and disparities exist among collective farms, between urban and rural areas, and among regions, resulting in particularly serious food problems in certain regions and segments of the population. According to the testimonies of North Korean escapees, class differences in economic levels are intensifying along with the

overall social crisis in the country. Many refugee children interviewed for this study also report marked disparity in living conditions among classmates depending on parents' social standing. This suggests that nutritional problem may be disproportionately higher among marginal members of the society, with prolonged food shortages weakening the social welfare system.

*Collection and Analysis of the Data*

Measurements were taken for height, weight, subcutaneous fat thickness, and arm circumference. The researcher conducted measurements according to internationally standardized procedures (Lohman et al. 1988). Due to the circumstances in the field, however, the equipment used did not quite meet international standards (a steel ruler, a spring scale, and a fabric ruler were used for height, weight, and arm circumference measurements respectively. Subcutaneous fat was measured with a standard equipment).

Height and weight were analyzed first because both the published international reference and South Korean data were available for the purpose of comparison with these measurements. The raw data on weight and height were converted into anthropometric indices using EpiInfo EPINUT (CDC and WHO 1997) based on the NCHS growth reference curves (Dibley et al. 1987; Hamill et al. 1977). These indices were expressed in terms of Z-scores relative to the international growth reference values.

The three anthropometric indices used to evaluate the growth status of the study sample were Z-scores of weight-for-height (WHZ), weight-for-age (WAZ), and height-for-age (HAZ) (Waterlow 1972). Following the recommendation by the World Health Organization (WHO 1978, 1986), children whose anthropometric indices fall below the Z-score of –2 (about 2.2% of the lower end of the reference group belongs here) are classified as malnourished. The Z-scores below –3 (about .013% of lower end of reference group belongs here) indicate severe malnutrition. A low HAZ score is an indicator of chronic undernutrition while a low WHZ score indicates acute malnutrition.



WHZ score, however, can be useful only up to 11.5 years of age in males and 10 years of age in females, and thus cannot be applied to the entire sample of this study.[2] Therefore, the additional use of the WAZ score, an indicator of underweight, along with the HAZ score, is recommended in the assessment of the extent of either acute malnutrition or acute malnutrition on chronic undernutrition.

*Main Findings*

Table 3 shows the means of the anthropometric indices of the children. Most of the children have Z-scores below –2 for height-for-age and between –2 and –1 for weight-for-age. Growth in weight of the refugee children is less retarded relative to growth in height. Compared with male refugee children, female refugee children show a relatively better growth status. The results are consistent with results from the EU/UNICEF/WFP investigation (EU/UNICEF/WFP 1998; Pak 2000). However, a direct comparison of female children with male children is not easy because most female children resided with their family. Males aged up to 11.5 years and females aged up to 10 years have the mean WHZ score of .195 and 0% of acute malnutrition, indicating that they are not acutely malnourished (see Tables 3 and 4).

Table 4 shows the percentages of the children with Z-scores of below –2. The percentage of the children who are retarded in height is higher than that of those retarded in weight. These children are obviously more stunted than underweighted and none are wasted, which means that they are chronically undernourished but not acutely malnourished. It appears that catch-up growth in height is rather

2. It is generally recognized that WHZ is meaningful as an indicator of nutritional status only before a child reaches its puberty. For when a child reaches its puberty, genetic predispositions kick in, resulting in extreme variance in height among individuals, thus making WHZ unsuitable as an indicator of nutritional status. Accordingly, the NCHS reference data presents WH of females aged up to 10 years and of males aged up to 11.5 years. Therefore, it is impossible to calculate WHZ score for older children (Hamill et al. 1977).

*Table 3. Mean Anthropometric Indices of North Korean Refugee Children*

| Age (years) | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | HAZ | WAZ | WHZ* | HAZ | WAZ | WHZ* |
| 3–4 | | | | .200 | –.840 | –.950 |
| 4–5 | –2.095 | –1.235 | .115 | | | |
| 6–7 | | | | –1.210 | .150 | 1.380 |
| 7–8 | –1.050 | – .580 | .250 | –1.440 | –1.020 | .050 |
| 9–10 | –1.765 | –1.67 | –.720 | – .120 | .140 | .380 |
| 10–11 | | | | –1.900 | –1.540 | |
| 11–12 | –1.603 | –1.217 | .870 | –3.620 | –1.540 | |
| 12–13 | –2.920 | –1.915 | | | | |
| 13–14 | –3.000 | –2.165 | | –2.490 | –1.295 | |
| 14–15 | –2.36 | –1.668 | | –2.903 | –1.743 | |
| 15–16 | –2.436 | –1.860 | | –3.220 | –2.420 | |
| 16–17 | –3.565 | –2.093 | | –1.590 | – .960 | |
| 17–18 | –2.765 | –1.965 | | | | |
| Mean | –2.628 | –1.811 | – .015 | –2.095 | –1.149 | .448 |
| Total mean | HAZ: –2.483 | | WAZ: –1.630 | WHZ: .195 | | |

*Only six refugee males aged up to 11.5 years and five refugee females aged up to 10 years are included in the calculation of WHZ because WHZ as an index for nutritional status is not meaningful beyond the ages mentioned above.

*Table 4. The Percentages of Growth Retarded North Korean Refugee Children (% Z-score < –2)*

| | Males | Females | Total |
|---|---|---|---|
| Stunted (HAZ) | 77.5 | 53.3 | 70.9 |
| Underweighted (WAZ) | 32.5 | 13.3 | 27.3 |
| Wasted (WHZ*) | 0 | 0 | 0 |

* Only six refugee males aged up to 11.5 years and five refugee females aged up to 10 years are included in the calculation of WHZ because WHZ as an index for nutritional status is not meaningful beyond the ages mentioned above.



limited even though the children have gained weight from better nutrition since leaving North Korea. Growth in height reflects nutritional status accumulated from inside the womb, while growth of human body occurs following age patterns. Therefore catch-up growth in height is closely related to the timing of recovery of nutritional status.

The EU/UNICEF/WFP carried out a nationwide growth research in DPRK in 1997 and reported that 16% of the children aged six months to seven years were suffering from acute malnutrition (wasting) and 62% from chronic malnutrition (stunting) (EU/UNICEF/WFP 1998). When compared with these North Korean nationwide means, the refugee children aged up to seven years do not seem to be particularly disadvantaged nutritionally (Table 5). Of course, this is not conclusive because only five of the subject children belong to this age group, thus rendering a direct comparison of two groups impossible. However, it may be reasonably assumed that the North Korean refugee children residing in China do not appear to be more malnourished than the children in North Korea at the time of the research by the EU/UNICEF/WFP.

*Table 5. Comparison of DPRK Children and Refugee Children Aged up to Seven*

| | DPRK (n = 1762) | Refugee (n = 5) |
|---|---|---|
| Wasted (% WHZ < –2) | 15.6 | 0 |
| Stunted (% HAZ < –2) | 62.3 | 20 |
| Underweighted (% WAZ < –2) | 60.6 | 0 |
| Mean WHZ | – .95 | .408 |
| Mean HAZ | –2.57 | –1.282 |
| Mean WAZ | –2.29 | –.602 |

Source: EU/UNICEF/WFP (1998).

Tables 6 and 7 are the summary of the figures of the height and weight of the North Korean refugee children in comparison with the

mean height and weight of the South Korean children in 1997 reported by Korea Research Institute of Standards and Science (KRISS 1997). The North Korean refugee children are 1.8 cm to 24.2 cm shorter and weigh .1 kg to 18.9 kg less than their South Korean peers. The differences in height and weight have a tendency to increase in the adolescent phase. This is because malnutrition delays the rate of maturation among the refugee children. Growth velocity in height peaks around puberty. South Korean females reach peak height growth at the age of 11 to 12 years and males at the age of 13 to 14 years (Pak 1996). It may be assumed that the disparity in height between the North Korean refugee children and South Korean children is at its highest level around puberty due to the delayed maturation among the North Korean refugee children. In addition, resulting adult height discrepancies can be expected to be smaller than what is observed between North and South Korean adolescents due to North Korean children's lengthened growth period.

*Table 6. Comparison of Height of Refugee and South Korean Children*

Unit: cm

| Age (years) | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | Refugees | South | Difference | Refugees | South | Difference |
| 3–4 | | | | 95.3 | 98.9 | 3.6 |
| 4–5 | 97.1 | 105.0 | 7.9 | | | |
| 6–7 | | | | 111.4 | 119.0 | 7.6 |
| 7–8 | 118.0 | 124.8 | 6.8 | 115.0 | 122.5 | 7.5 |
| 9–10 | 125.8 | 134.8 | 9.0 | 132.3 | 134.1 | 1.8 |
| 10–11 | | | | 130.8 | 141.1 | 10.3 |
| 11–12 | 136.0 | 145.4 | 9.4 | 124.3 | 147.1 | 22.8 |
| 12–13 | 129.2 | 151.9 | 22.7 | | | |
| 13–14 | 134.6 | 158.8 | 24.2 | 142.9 | 155.4 | 12.5 |
| 14–15 | 146.4 | 165.9 | 19.5 | 141.7 | 158.2 | 16.5 |
| 15–16 | 153.8 | 168.4 | 15.1 | 140.1 | 159.5 | 19.4 |
| 16–17 | 149.3 | 170.1 | 20.8 | 152.5 | 159.7 | 7.2 |
| 17–18 | 158.5 | 170.7 | 12.2 | | | |



*Table 7. Comparison of Weight of Refugee and South Korean Children*

Unit: kg

| Age (years) | Males | | | Females | | |
|---|---|---|---|---|---|---|
| | Refugees | South | Difference | Refugees | South | Difference |
| 3–4 | | | | 13.0 | 15.2 | 2.2 |
| 4–5 | 15.2 | 17.0 | 1.8 | | | |
| 6–7 | | | | 21.5 | 22.4 | .9 |
| 7–8 | 22.0 | 24.7 | 2.7 | 20.0 | 23.8 | 3.8 |
| 9–10 | 23.3 | 31.4 | 8.1 | 30.0 | 30.1 | .1 |
| 10–11 | | | | 27.0 | 34.6 | 7.6 |
| 11–12 | 30.7 | 39.6 | 8.9 | 29.5 | 39.0 | 9.5 |
| 12–13 | 28.5 | 43.4 | 14.9 | | | |
| 13–14 | 31.5 | 50.4 | 18.9 | 38.8 | 47.6 | 8.8 |
| 14–15 | 40.2 | 54.8 | 14.6 | 38.0 | 50.4 | 12.4 |
| 15–16 | 44.3 | 56.6 | 12.3 | 34.0 | 52.0 | 18.0 |
| 16–17 | 44.9 | 59.6 | 14.7 | 49.0 | 52.3 | 3.3 |
| 17–18 | 50.0 | 60.4 | 10.4 | | | |

This study demonstrates that North Korean children residing in China show severe growth retardation in height in comparison with international reference values. They show marked growth retardation even compared with South Korean peers. Since it is clear that North and South Korean children do not belong to genetically different populations, it may be assumed that the disparity in growth status came from disparity in nutritional status. The growth data on North Korean refugee children in China is based on a very small-sized sample which is in no way representative of North Korean children. Therefore, it is difficult to make a meaningful estimation on the disparity in growth between North and South Koreans based on the results from this study. Because there are no known mean growth values of North Korean children who have reached puberty it is difficult to tell how closely the growth values of the study subjects approach to the North Korean means. (The 1998 EU/UNICEF/WFP research covers only children aged up to seven years.) If we consider that the refugee chil-

dren in China probably came from the lower strata of North Korean society, the actual differences in growth between North and South Korean children might not be as great as those found between the refugee children and South Korean children. On the other hand, the fact that the refugee children had a better diet even for a few months may have somewhat offset the presumed class differences in North Korea. When compared with the children in North Korea aged up to seven years whose mean growth values are known, the refugee children belonging to the same age group do have a better growth status. However, it should be noted that these children came to China with their parents and had a relatively normal family life there. Without more solid knowledge of the sociodemographic backgrounds of these children, a reasonable estimation of their growth status, relative to the North Korean means, cannot be made.

If we could compare the population growth figures of North and South Korean children directly, the differences in growth status between them would become much clearer and easier to understand. Unfortunately, the EU/UNICEF/WFP (1998) reported only the total average Z-scores relative to the NCHS growth reference curves, without providing us with age and sex specific means (see Table 5). Thus, from the reported average Z-scores, I had to estimate the mean height of North Korean children and compare it with that of South Korean children reported by the KRISS in 1997. The height difference between North and South Korean children at the age of seven for both males and females is at least 12 cm (Pak 2000). Due to the delayed maturation from poor nutrition among North Korean children, the effects of malnutrition at this age will persist until later stages in their life, resulting in the largest disparity in height between the two groups manifesting around puberty. Hence, when these currently seven year-old children reach their adolescence, I expect the mean height difference to be well over 12 cm.

Childhood growth is greatly influenced by the environment in which a child is growing up. When these children reach their full adulthood, the disparity in height may decrease due to the influence of a common genetic make-up (Martorell 1984; Marshall and Tanner 1986). However, how much catch-up in growth can take place is not free from environmental influences (Tanner 1986). Thus, improvement in food supply and medical care in North Korea will be the key to reducing the height gap between North and South Koreans. In addition, the degree of catch-up growth among North Korean refugees depends on the stage of growth at which they gain access to an adequate nutritional supply. Improved nutritional supply in the later period of growth will likely result in heavier weight rather than taller height. Therefore, it can be reasonably expected that even after the food supply recovers to the pre-crisis level in North Korea, the height discrepancies between North and South Koreans will remain greater than those of pre-crisis time for some time. Physical differences between North and South Koreans will become more noticeable.



*Social Implications of the Food Crisis*

The reason researchers studying the effects of the food crisis on human growth and development give their attention to childhood growth data is not because small body size itself poses a problem, but because such growth data is a good indicator of overall welfare levels. It is also important because the conditions that give rise to children's growth retardation also affect such things as immune function, work capacity, cognitive capabilities, and social competence (Beaton 1989; Martorell 1989). Judging from the seriousness of North Korean food crisis that had been going on for several years, it is expected to have extensive long-term effects on the growth and development of North Korean children. Consequences of malnutrition experienced in the growth period include not just immediate adverse effects such as decreased immune function and a subsequent rise of morbidity and mortality rates, but also long-term effects such as reduced work capacity and impaired cognitive, emotional, and social functions. Accordingly, the social cost North Korean society has to bear in the long run will be enormous.

### 1) Immune Function

First, malnutrition in pregnant women is directly associated with the birth of underweighted or premature babies, who in turn suffer from high morbidity and mortality rates (Martorell and Gonzalez-Cossio 1987). Malnourished children have decreased immune function and subsequently are more susceptible to infectious diseases. They suffer even minor illnesses longer and severely. Consequently the rate of death increases (Chandra 1991). Infectious diseases such as diarrhea decrease the absorption rate of nutrients, having serious consequences for children (Chen 1983). Furthermore, adults who experienced growth retardation in childhood tend to have decreased thymus function that may cause poor health conditions and a short life span (Clark et al. 1989). Therefore, lowered health levels due to poor nutrition in infancy and young childhood will become a burden on the individual, his/her family, and even society as a whole.

The medical supply system in North Korea started to falter beginning in the late 1980s, and the country's infectious disease control and immunization program have almost completely collapsed by the time the food crisis began in full scale in mid-1990s (see Chang 1999). In situations like this, in which various infectious and contagious diseases are not properly controlled, severe malnutrition and subsequently weakened immune function seemed to lead to a high mortality rate, thus making it difficult to estimate the number of deaths by starvation alone. In North Korea where high mortality rates among infants/young children and elderly people are reported, a high mortality rate in the former group in particular will eventually lead to a diminished work force, thus creating long-term social problems (Lim and Han 1999).

### 2) Body Size and Physical Strength

Children exposed to continuous or recurring malnutrition during the growth period will have difficulties in attaining ideal adult height, even if compensated with a longer growth period. In addition, cardiovascular, respiratory, and circulatory functions are also affected, leading to reduced work capacity in adulthood (Frisancho 1993).



It has been argued that declined work productivity caused by decreased body size and physical strength may slow down economic growth (Jo 1999). Adults who have a small body size due to chronic undernutrition in the growth period are certain to have a decline in physical strength. However, the significance of the reduced work capacity in itself depends on the kind of work these children will have in adulthood (see Martorell 1989 for a debate on work capacity and body size). Small body size can increase energy output per energy intake. But this phenomenon is usually observed in laboratory conditions. In actual life, a small-sized person may be excluded at the start, depending on the kind of work involved. Therefore, it must be considered that, despite the fact that keeping body size small may save tremendous energy in the context of the whole society, relatively tall people generally tend to have advantages in a population in which there are internal variations in body size. In any case, because adults with small body size and lower work capacity due to past chronic undernutrition have a limited choice of jobs and need to exert themselves harder and longer than normal people in order to finish the same job, their overall quality of life is likely to be lowered.

### 3) Rate of Maturation

Children who suffer chronic undernutrition reach their puberty later than those who do not. Puberty is a period of rapid body growth at which time the difference in height between early-maturing and late-maturing children becomes the greatest and the latter find it hard to adjust. Moreover, because mental maturation and physical maturation are connected, children who mature late are behind not only in body growth but also in intellectual development (Tanner 1978). For that reason, they experience relative disadvantages in contemporary societies where school education is organized by age. Moreover, internationally, the fact that North Korean children on the average mature later than children of neighboring countries can be a considerable loss for the whole country.

4) Behavioral Development

Malnutrition is also connected with lower cognitive ability and impaired emotional development and learning capability (Cravioto and Arrieta 1986). The human brain develops rapidly during the period between the last trimester of pregnancy and two years after birth. The period most vulnerable to poor nutrition is known to be between the last trimester and one year after birth. Yet there seems to be a priority in the supply of nutrients within the body and, fortunately, the brain is one of the areas in the body that are relatively well protected from the harmful effects of external environments such as poor nutrition. Even so, it has been known that an episode of severe malnutrition in this period results in decreases in brain mass and the number of nerve cells. Such ill biological effects are irreparable even with treatment afterwards (Frisancho 1993). This is primarily based on results from animal experiments, but it is reported that similar changes were observed in autopsies of children who died of malnutrition. Nevertheless, the actual extent to which biological changes in the central nervous system from malnutrition are directly related to later impairment of intellectual ability is not clearly known.

Many studies report that there exists a relationship between an episode of severe malnutrition in childhood and impaired intellectual capability after growth. However, they do not show a definite causal relationship between the two because of the impossibility of controlling extranutritional variables. One thing that is certain is that children do experience serious impairment in intellectual development when they return to the poor environment that caused malnutrition in the first place. It is dramatically demonstrated by the study on the consequences of the Dutch Hunger during World War II. No significant differences in physical or mental abilities were found between conscript soldiers who experienced famine while inside the womb or immediately after birth and those who did not (Stein et al. 1975). Some studies show that children who suffered malnutrition due to illness at infancy outside of the socioeconomic context of poverty do not particularly exhibit impairment in intellectual ability (Ellis and Hill 1975; Klein et al. 1975; Lloyd-Still et al. 1974; Valman 1974).



Yet the Dutch Hunger is unique in world famine history in that the children had been in a good growth environment until they were subjected to serious famine and had excellent recovery conditions after the famine. Unfortunately, most occurrences of famine do not resemble these circumstances. Famine these days occurs when there is a sudden food shortage in a society already experiencing some degree of undernutrition due to poverty. Hence, the recovery environment will be undoubtedly different from the case of the Dutch Hunger.

Most children who experience famine grow in a state of chronic undernutrition even after the famine. The effects of chronic undernutrition on children's behavioral development are even less clear than those of acute malnutrition. Countless reports state that children with chronic undernutrition have lower intelligence than children without (Cravioto and Arrieta 1986). However, these reports do not provide definite evidence that chronic undernutrition in itself has adverse effects on intellectual development independently. This is because chronic undernutrition in most cases occurs in a poor social environment unfavorable to cognitive development. However, having no conclusive evidence does not mean that nutrition is proven to have nothing to do with intellectual development. Of course, IQ variability that socio-environmental variables explain always tends to be larger than IQ variability nutritional variables explain. However, even after controlling for all non-nutritional variables, there is still some IQ variability that depends on nutritional status. Nutriotional levels must have some connection to intellectual development.

Even when undernutrition does not have direct effects on the workings of the nervous system, it is very likely to have adverse effects on children's attentional strategies, motivational competences, and explorative activities, thus indirectly impairing learning ability (Barrett and Frank 1987; Cravioto and Arrieta 1986). For now, the dominant speculation is that the intellectual functions of children may become impaired not because chronic undernutrition causes impairment in nervous development but because it restricts a child's learning experiences.

In fact, hungry children are easily irritated because of the increased sensitivity to stimulation. They become lethargic and indifferent and have short attention spans. These characteristics of malnourished children bring out corresponding changes in the attitude of caretakers, making caretakers less responsive to the children under their care. This lowers the frequency and quality of interactions between the child and caretaker and makes for a more deprived environment for the child's mental and emotional development (Chavez and Martinez 1984). Therefore, it can be inferred that children who suffer chronic and recurring malnutrition will have lower learning capabilities compared with the children who do not.

To summarize, there is no decisive evidence for a causal relationship between malnutrition and decreased intelligence. This is because malnutrition occurs mostly in a poor socioeconomic environment which itself has harmful effects on intellectual development, and also because there are no biologically quantifiable measurement of brain functions that are not influenced by these same socio-environmental factors. Consequently, many researchers, recognizing the importance of the recovery environment, have been trying to gain a concrete understanding of which aspects of the environment are especially important in a child's development. It means that ultimately, the extent of developmental impairment that North Korean children will suffer after the famine will depend primarily on recovery conditions. In order to prevent serious impairment in development in the long run among children showing growth retardation at the present time, good recovery environments should be consistently improvement in the food situation, it will take considerable time and efforts to rebuild social and cultural systems such as the family, educational system, etc. that were damaged from society-wide famine.

5) Social Interactions

Many studies have reported that physical characteristics influence social interactions and that height in particular is closely related to upward social mobility. Biological, psychological, and cultural elements are known to be involved in the relationship between height and upward social mobility in a complicated manner (Bogin 1999). Therefore, even if growth retardation does not cause impairment in biological functions, it may have significant social implications. For most societies have ideal body image and those who are closer to this ideal are more favorably rewarded in many ways. Stature in a population displays a typical normal distribution. However, according to studies conducted in the U.S.A. and Europe, those whose height is above the society's average tend to have a higher level of education, move upward socially, and have more successful careers on the average (Pak 1995). There are many genetic or environmental hypotheses that attempt to explain the relationship between height and ability. Each hypothesis has its own logical basis and supporting evidence (Pak 1996).



Aside from these hypotheses, the relationship between height and ability can also be understood by examining socio-cultural values involving stature. Whatever the cause of the height-ability relationship observed in a society may be, sociocultural values involving stature in a society may on the average work to favor relatively taller people. Most societies are reported to consider above average height falling within the society's normal range desirable (Cassidy 1991). In fact, research results confirm that those who come close to the society's ideal are better rewarded in marriage, finding jobs and getting promotions, etc. regardless of their objective abilities. Children smaller in stature during the growth period are also at a disadvantage in social interactions with peer group or adults (Pak 1995). However, not all members of a society have the opportunity to reach the ideal height in the society. While environmental factors such as nutritional status are decidedly important in growth of stature when genetic influences are eliminated, not all classes in the society equally enjoy good environments that facilitate optimal body growth.

Exposure to chronic long-term undernutrition during the growth period causes reduced adult height and relatively shorter legs. If the food situation in North Korea is extended, the physical differences between North and South Koreans will likely to become more pronounced. Such differences could very well become the basis for being

able to physically distinguish between North and South Koreans. An analysis of the discrimination induced by the standards of ideal body size in South Korean society will help predict the way physical differences between North and South Koreans may work in social interactions between the two groups.

## Conclusion

It is impossible to assess North Korean children's growth status in general based only on the data from this research on the North Korean refugee children in China. They are too small in numbers to represent the whole child population in North Korea. However, this data set could be useful as a reference for other researchers. It could also be used as an index of the general well-being of North Korean refugee children.

The consequences of malnutrition in its functional aspects are well known from historical experiences. They include increased mortality and morbidity rates caused by decreased immune function, impaired cognitive and socio-emotional developments, delayed maturation, and reduced adult body size. Social consequences include the change in population structure, which eventually leads to a shrinking work force, possible decline of work productivity due to small body size, and social disadvantages attached to those who fail to gain a socially ideal body size. In order to ascertain the long-term effects of the food crisis on growth and development of North Korean Children, and to assess the potential social problems that the current food crisis will entail in the long run, more research is necessary. Although there is data on the effects the famine in North Korea had on growth and development of infants and young children in North Korea (for instance, EU/UNICEF/WFP 1998), there are no studies on its effects on adolescents. To be able to assess the long-term effects of the famine, it is necessary to identify the growth status of adolescents as well as young children. This is especially true considering the fact that the food crisis in North Korea has been going on for several years. Even with the critical stage having passed, a chronic food shortage situation is very likely to develop. Therefore, the continuous collection of data is necessary for a better understanding of the long-term effects of early childhood malnutrition and the growth tendency of adolescents experiencing chronic food shortage. Under the current political circumstances, which do not allow direct investigation, it seems that the only way to carry out this mission is to keep collecting all available data and make the best possible educated guesses based on them.



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