Demographic Methods to Assess Food Insecurity: A North Korean Case Study

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Abbreviations:
BMI = body mass index
DPRK = Democratic People's Republic of Korea
MUAC = mid-upper arm circumference
PDS = public distribution system
U5MR = under-five mortality rate
UN = United Nations
UNICEF = World Children's Fund
WFP = World Food Program

Abstract
In complex emergencies, especially those involving famine and/or widespread food insecurity, assessments of malnutrition are critical to understanding the population's health status and to assessing the effectiveness of relief interventions. Although the Democratic People's Republic of Korea (DPRK) has benefited from some of the largest, most sustained appeals in the history of the World Food Program (WFP), the government in Pyongyang has placed restrictions on international efforts to gather data on the health and nutritional status of the affected population.
Question: Lacking direct means to assess the nutritional status of the North Korean populace, what other methodologies could be employed to measure the public health impacts of chronic food shortage?

The paper begins with a review of methods for assessing nutritional status, particularly in emergencies; a brief history of the North Korean food crisis (1995–2001), and a review of the available nutritional and health data on the DPRK. The main focus of the paper is on the results of a survey of 2,692 North Korean adult migrants in China. Recognizing certain biases and limitations, the study suggests that sample households have experienced an overall decline in food security, as evidenced by both the decline in government rations from an average of 120 grams per person per day to less than 60 grams per day, and by the increase in the percentage of households relying on foraging or bartering of assets as their principal source of food. It also is apparent that the period 1995–1998 has been marked by elevated household mortality, declining fertility, and steadily rising out-migration. Taken together, the signs point toward famine, whether that is defined as a discrete event—that is, as a regional failure in food production or distribution leading to elevated mortality from starvation and associated disease—or as a more complex social process whose sub-states include not only elevated mortality, but declining fertility, eating of alternative 'famine foods', transfer of assets, and the uprooting and separation of families.

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Introduction

Among the most serious issues that must be addressed in a complex emergency is food insecurity leading to famine, a condition during which mortality, and malnutrition rates increase piercingly well above baseline a relatively short period of time. Although famine may be viewed as an acute event, it clearly is precipitated by serious underlying factors and lack of recognition or response to rising food insecurity over time.

As a tool for assessing varying degrees of food insecurity, nutritional surveys using anthropometric methods often are employed to monitor

the health and nutrition of people affected by famine. Relevant to this topic, several terms should be defined. Starvation may be regarded as an inability to sustain the basic needs for long-term survival at current energy intake due to severe deprivation of food. Malnutrition is characterized by objective physical or laboratory findings of physical deterioration due to inadequate nutritional intake. Lack of access to enough food may be termed food insecurity. Food insecurity may be transitory, marked by a temporary decline in access to sufficient food due to rising food prices, and/or instability in income or in food production. Alternatively, it may persist chronically during which time, there is a continuously inadequate diet caused by inability to acquire food. Famine represents the most serious form of food insecurity resulting from transient or acute deterioration of access to food.[1]

There are a number of factors that contribute to famine. Underlying determinants such as social, political, and economic stability are tied to a population's ability to respond to food insecurity. Often, famine is the outcome of natural events such as drought or human-made catastrophes like war or civil conflict. Subsequently, it may lead to other crises such as mass population displacement.

As the most severe form of food insecurity, famine is characterized by increased morbidity and mortality due to disease and starvation. Those most strongly affected by famine due to social disruption and civil unrest include refugees and internally displaced populations. The severity of a famine often is gauged by indices of mortality and malnutrition. Although these are separate measures, they are closely linked. Person-Karell documented a relationship between malnutrition prevalence and crude mortality rates in 42 refugee camps in Africa and Asia.[2] With improvement of conditions over time, both the crude mortality rate and prevalence of malnutrition declined. The study concluded that mortality rates in refugee groups could be estimated based on prevailing malnutrition rates.

During complex emergencies, nutritional assessment can estimate the average nutritional status of the population, as well as the prevalence of malnutrition among children. As nutritional status reflects growth, abnormalities in growth are suggestive of malnutrition. Anthropometry is an assessment of growth through simple measurements such as weight, height, and arm circumference. These, in turn, are compared to reference values and described as nutritional indices. Those individuals with measurements failing to meet certain cut-off criteria are designated as malnourished.

One of the most commonly used measures of nutritional status during food crises is weight-for-height. The weight-for-height index reflects recent weight loss and protein-energy malnutrition related to weight loss or wasting. The weight-for-height index is based on international reference standards; a score below two standard deviations (sd) of the mean value classifies as evidence of acute malnutrition. According to the World Health Organization, the prevalence of wasting in children under five years of age typically ranges below 5%.[3] Increases in the prevalence of wasting to levels >5% indicate a serious situation, while prevalence >15% wasting may indicate a critical situation.

During emergency situations, low weight-for-height may be employed as a screening instrument to identify severely wasted children (>3 sd <mean value) who are considered at high risk for death. These measures may be used as a basis for administration of nutritional supplements.

Alternative indicators of nutritional status for adults include body mass index (BMI; weight(kg)/height(m^2)) in which a score <16 indicates severe wasting.[3] Another measurement used during emergencies [for children] is mid-upper arm circumference (MUAC) that can be assessed using a short measuring tape while the patient is standing, sitting, or even lying down. A circumference of 12.5–13.0 cm using age- or height-based references has been defined as a cutoff level consistent with malnutrition. The MUAC is considered to be a sensitive indicator of acute malnutrition and wasting.[3]

In the years following the death of North Korea's "Great Leader" Kim Il Sung in 1994, the reclusive, communist nation was struck by a succession of natural disasters—flooding in 1995 and 1996, followed by a drought in 1997—that brought on a severe food crisis, and placed millions of people at risk of starvation. But, as Goodkind and West note, "even under ordinary climatic conditions, North Korea barely has been able to feed itself."[4] With a single, short, growing season, limited cultivable land, and a population of 21 million people, food production shortfalls would not be unexpected in any year. The collapse of the Soviet Union in 1989 and the loss of agricultural subsidies gave rise to a government campaign of "let's eat only two meals a day" in 1991, growing food shortages, and, finally in 1995, an appeal for international food aid.[5] The Food and Agricultural Organization of the United Nations and the World Food Program (WFP) estimated that North Korea would need to import nearly 2 million tons of food-grain in 1995/1996, and up to 2.5 million tons in 1996/1997.[6]

As international food relief grew exponentially—the WFP shipped 5,000 tons of food to North Korea in 1995 and 367,000 tons in 1998—pressure grew on the North Korean government to allow impartial assessments of the scope of the ongoing crisis and the impact of food aid. A nutritional assessment mission to the DPRK undertaken by the WFP in August 1997, found a 16.5% prevalence of wasting (<-2 Z-scores weight-for-height) and a 38.2% prevalence of stunting (<-2 Z-scores height-for-age) in a non-random sample of 3,695 children <7 years of age in 42 selected nurseries and kindergartens from 19 counties in five provinces. The WFP assessment noted that "a prevalence of wasting >15% is considered a serious situation, and suggested that mortality rates have already increased."[7] In September 1998, the WFP collaborated with United Nations Childrens Fund (UNICEF) and the European Union to conduct a randomized survey of 1,762 children in 3,600 households in 30 North Korean counties. This survey found 15.6% of children aged six months to seven years to be wasted, 62.3% stunted, and 60.6% moderately or severely underweight.[8]

Efforts to gauge the effects of the crisis, however, remained hampered by the North Korean government's reluctance to permit randomized surveys of morbidity and

mortality. Unable to interview North Koreans inside their country, opportunities were sought to interview those who had left. Since 1995 and 1996, significant numbers of North Koreans had been moving across the Chinese border in search of food for themselves and their families. It is estimated that between 50,000 and 150,000 North Koreans are staying temporarily in China, principally in Yanbian Korean Autonomous Prefecture, which is home to nearly one million Korean-Chinese. Bound by ties of kinship and ethnicity, Korean-Chinese families along the border and throughout the prefecture, have tried to help their relatives with food, shelter, cash, and clothing.

Methods

From July 1999 to June 2000, interviews were conducted with a total of 2,692 North Korean arrivals at eight sites along the China border. These sites, all of which had participated in a 1998 study, were selected based on their willingness to participate for another year and on the presence of at least moderate levels of cross-border arrivals.[9] All North Korean respondents were assured that the interview was voluntary and confidential. Only migrants who were 18 years of age or older were interviewed and only one member of a family or household unit travelling together were interviewed. No incentives were given to respondents although interviewers received a small monthly stipend. It is estimated that between 80–90% of all arrivals at the eight sites were interviewed during the three-month period with a non-response rate of <5%.

Respondents were asked to provide a list of all household members who were alive as of January 1995, and to report births, deaths, in-migrations (>1 month duration), and out-migrations (>1 month duration) between the beginning of 1995 and the end of 1999. Respondents were asked about their migration experience and their household food situation in North Korea; they also were measured for mid-upper arm circumference (MUAC). Data were entered and analyzed with SPSS 8.0. The study was approved by institutional review boards at Johns Hopkins University School of Public Health and the in Yanbian Korean Autonomous Prefecture.

Results

Out of 2,692 North Koreans interviewed in China, a mid-upper arm circumference (MUAC) measurement was taken on 2,661 people (measuring the circumference of the left upper arm at the mid-point between the tip of the shoulder and the tip of the elbow).[10] During data checking and cleaning, a total of 79 measurements were discarded as illegible or implausible, leaving 2,582 adults (1,458 males [56.5%], and 1,124 females [43.5%]), ranging in age from 18 to 77 years. The study employed a cut-point of <200 mm for males and of <190 mm for females as an indicator for Grade 4 malnutrition or severe wasting, and of <230 mm for males and of <220 mm for females as an indicator of undernourishment.[11] Adjusting for rounding, it was found that 2.1% (30/1,458) of male respondents were severely wasted, and 16.4% (239/1,458) were undernourished. Among females, 1.3% (15/1,124) were severely wasted, and 9.9% (111/1,124) were undernourished.

Household Food Situation

Regarding their household's food situation in North Korea, respondents first were asked to identify the amounts of food that their household actually had been receiving from the government's Public Distribution System (PDS) since 1995, and, second, to identify the household's primary source of food from 1995 to 1998. Historically, nearly three-quarters of the North Korean population are entitled to purchase heavily subsidized food rations through the government's Public Distribution System. Under this ten-tiered structure based on age and occupational status, a working adult has been entitled to 700 grams of food-grain per day, with children receiving 500 g and elderly 600 g per day. By 1997, according to UN estimates, PDS allocations were averaging only about 100 g per person per day.[12]

Among the 2,692 households in the sample, respondents reported that, in terms of official ration entitlements, household members should have been given an average of 12 kilograms of food per person per month, or approximately 400 grams of food-grain per person per day. This official ration amount did not vary substantially during the four years, 1995 to 1998. In contrast to the ration amounts officially promised, respondents reported a steady decline in the amount of rations that actually were provided. Even at the beginning of the period in 1995, respondents reported that household members were being given an average of only 3.6 kilograms of food per person per month, or about 120 grams of food per person per day. This declined steadily throughout the four-year period to an actual ration of less than 60 grams of food per person per day.

Respondents also were asked to identify their household's primary source of food each year from 1995 to 1998. While 30% of households relied on government rations as the principal source of food in 1995, this had declined to about 2% in 1997 and 1998 (Table 1). Conversely, while 30% of households in 1995 were foraging or bartering for food, more than 40% of the households were foraging or bartering for food in 1997 and 1998. Increases also were seen in the percentage of households either growing or buying most of their food.

Mortality

The 1993 DPRK census recorded a population of 21,213,378, of whom males numbered 10,329,699 and females 10,883,679.[13] The estimated mid-year population for 1996 was 22,466,000, assuming an annual growth rate of 1.6%. The UN estimate of the crude birth rate for 1990–1995 was 21.8 per 1,000, and the estimated crude death rate was 5.5 per 1,000; the crude rate of natural increase was 16.3 per 1,000. Infant mortality was estimated at 24.4 deaths of children under one year old per 1,000 live births.

The 2,692 North Korean respondents who were interviewed in China, reported a total household population in North Korea of 9,958 at the beginning of 1995, of whom 4,901 were male and 5,057 were female. The crude death rate for the sample population, estimated as a four-year average, was 25.2 per 1,000 per year, with annual death rates rising from 16.2 in 1995 to 27.6 in 1996, 31.5 in 1997 and declining slightly to 27.0 per 1,000 in 1998 (Table 2).

Year	Govt. Ration		Buy		Barter		Forage		Gift		Grow		Other		Total Households	
	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
1995	802	(30.1)	651	(24.4)	479	(18.0)	339	(12.7)	34	(1.3)	269	(10.1)	93	(3.5)	2,667	(100.0)
1996	242	(9.1)	756	(28.4)	696	(26.1)	416	(15.6)	39	(1.4)	384	(14.4)	130	(4.9)	2,663	(100.0)
1997	56	(2.1)	760	(28.6)	754	(28.4)	433	(16.3)	37	(1.4)	422	(15.9)	195	(7.3)	2,657	(100.0)
1998	50	(1.9)	833	(31.4)	679	(25.2)	397	(15.0)	45	(1.7)	422	(15.9)	223	(8.4)	2,649	(100.0)

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Table 1—Household's primary source of food by year

Year	Number of Deaths	Mid-Year Population in Households	Death Rate (per 1,000)
1995	161	9,946	16.2
1996	272	9,855	27.6
1997	303	9,616	31.5
1998	250	9,268	27.0
Total/Average	986	9,777 (end 1996)	25.2

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Table 2—Crude death rates in North Korean households (n = 2,692)

Age-specific death rates for the sample households, calculated using mid-interval population estimates (end of 1996) as the denominators, reached a peak of 153.1 per 1,000 for persons 65 years of age and older. The infant mortality rate for 1995–1998 (not shown in the table) was 57.4 per 1,000 live births. Under-five year mortality rate (U5MR) during the period, when calculated by using the mid-interval population in the denominator, averaged 30.3 per 1,000. The U5MR defined by United Nations Children's Fund (UNICEF) as "the probability of dying between birth and exactly five years of age expressed per 1,000 live births", was 214 during the four-year period.[14]

Mortality in the sample households during 1995–1998 also showed a marked seasonal trend. As illustrated in Figure 1, 43.2% of all deaths during the period (426 of 986) occurred in months of May through August, which is North Korea's "lean season," when the harvest of the previous year has been consumed and the new harvest is not yet in. Only 25% of all deaths occurred during the four-month period, September to December, when food is more plentiful. These seasonal mortality patterns, particularly regarding the "lean season," appeared most pronounced during 1996 and 1997 when food shortages reportedly were most acute.

For all deaths reported in the household from 1995 to 1998, respondents were asked to identify cause of death. Out of 986 total deaths, a cause of death was reported for 98.7% (973 deaths); causes were aggregated into three main categories: disease, nutritional deficiency, and injury/accident. The majority of deaths (66.9% or 652 of 973) were attributed to disease, 21.8% (212 deaths) to nutritional deficiency, 9.3% (91 deaths) to injury/accident, and 2.0% (19 deaths) to other causes. Among children under five years of age, 49% of deaths were attributed to nutritional deficiency.

Fertility

As noted before, the UN estimate of the DPRK's crude birth rate for 1990–1995, was 21.8 per 1,000. Households in the sample reported a crude birth rate of 18.5 per 1,000 in 1995 and 1996; the birth rate then declined to 11.3 in 1997 and 5.2 in 1998 (Table 3). The average crude birth rate for the four-year period was 13.4 per 1,000.

Migration

North Korean respondents were asked to report any movements into or out of the household with a duration of one month or more. For each in-migrant or out–migrant, respondents were asked to give their age, gender, year of move, and reason for move. As indicated in Table 4, both the total number of people migrating increased in step-wise fashion from 1995 to 1998, and the rate of net-migration (calculated as a residual of out-migration minus in-migration) increased nearly four-fold from 14.5 per 1,000 in 1995 to 57.8 per 1,000 in 1998.

Of the 560 in-migrants during the four-year period for whom age and gender were reported: 63% were female and 37% were male. Only 9% (50) were <20 years of age, and 20% (112) were >55 years of age. Of in-migrants under the age of 20 years, 58% (29) were male, and 84% (94) of all in-migrants over the age of 55 years were female. Twenty-eight percent of all in-migrants moved into the household primarily to obtain food.

Of the 1,811 out-migrants for whom age and gender were reported, 53% were male and 47% were female. More than 16% of out-migrants were under the age of 20 years, and only 6% were >55 years of age. Of out-migrants >20 years of age, 64% were male, a contrast that is starkest among those 10–19 years old. For out-migrants >55 years of age, females comprised 57%. Thirty-four percent of all out-migrants left the household primarily to obtain food.

Discussion

Most common definitions of famine adopt the concept of a regional failure in food production or distribution leading to elevated mortality from starvation and associated disease.[15,16] Some definitions, however, seek a broader reach to suggest that famine is not a discrete event, but is a lengthy and multi-faceted social process.[17] For Currey,

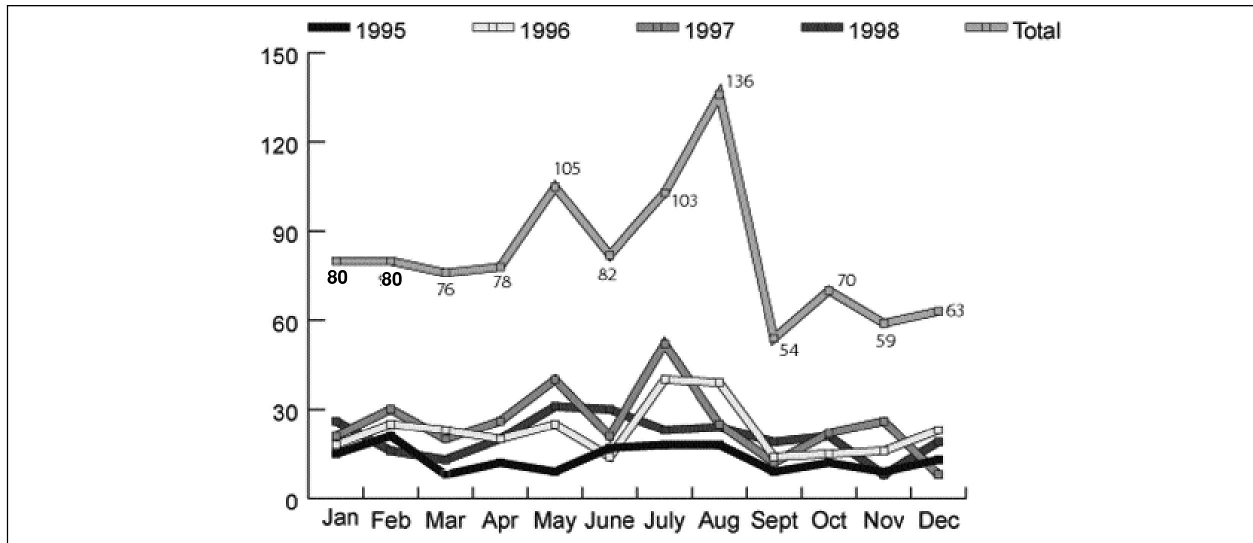

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Figure 1—Number of deaths by month in North Korean households, 1995-1998

Year	Number of Births	Mid-Year Population in Households	Birth Rate (per 1000)
1995	184	9,946	18.5
1996	182	9,855	18.5
1997	109	9,616	11.3
1998	48	9,268	5.2
Total/Average	523	9,777 (end 1996)	13.4

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Table 3—Crude birth rates in North Korean households (n = 2,692)

Year	Number of In-Migrants (>1 Month)	Number of Out-Migrants (>1 Month)	Net Migration	Mid-Year Population	Net-Migration Rate (per 1000)
1995	86	230	144	9,946	14.5
1996	169	374	205	9,855	20.8
1997	167	556	389	9,616	40.4
1998	141	677	536	9,268	57.8
Total/Average	563	1,837	1,274	9,777 (end 1996)	32.6

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Table 4—Net out-migration rates in respondent households (n = 2,692)

famine "might be defined more effectively as the community syndrome that results when social, economic, and administrative structures already are under stress, and are further triggered by one or several discrete disruptions that accelerate the incidence of many symptoms, or crisis adjustments, of which one is epidemic malnutrition."[18] Field suggests that no definition of famine is complete if it "fails to capture the extent of social disintegration that usually accompanies the downward slide into famine conditions."[19]

Social reciprocities and supports crumble under increasing stress. Hoarding and related pathologies (smuggling, black market profiteering, crime) become commonplace. The distress sale of assets (jewelry, animals, land) accelerates. Families divide in search of work or succor; wives may even be cast adrift and children sold. Out-migration increases as ever more people abandon their lands, homes, and communities in desperation. Abnormally high mortality may be the hallmark of famine, but societal breakdown is its essence.[19]

Alamgir calls famine a "complex socio-economic phenomenon" in which "prolonged food-grain intake decline" gives rise to a number of "substates or symptoms," including "increase in inter-regional migration, increase in crime, increased incidence of fatal diseases, loss of body weight, eating of alternative 'famine foods,' changes in nutritional status, mental disorientation, uprooting of families, separation of families, transfer of assets, 'wandering' and breakdown of traditional social bondage [sic]."[20] Young and Jaspars suggest that, "If food security conditions do not improve and famine progresses, people are forced to use coping strategies that become increasingly threatening to the survival of their livelihoods. Productive assets are sold off until people have no other choice but to starve or

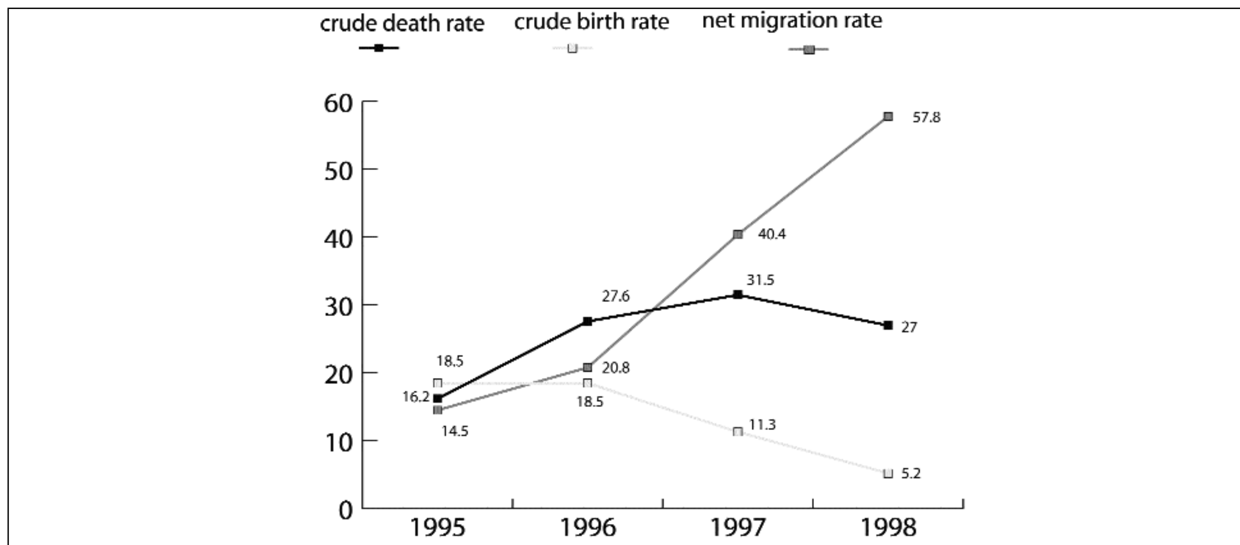

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Figure 2—Death, birth and out-migration rates in North Korean households, 1995 – 1998

migrate in search of relief or other means of support.”[21]

In the longer term, a severe and persistent famine not only will precipitate migration, but will cause fertility to decline as well. After examining the demography of several South Asian famines, Dyson concluded that, “through a variety of well-known mechanisms (e.g., reductions in coital frequency, deferment of marriages, decreases in fecundity, spousal separation through migration), these populations reduced their conception rates as a direct response to increasing levels of distress.”[22]

Although these results confirmed the presence of malnutrition in adult North Korean migrants, the prospects of extrapolating from these data were complicated by two factors. First, migrant and refugee populations do not necessarily present a representative cross-section of the general populace. Second, the North Korean migrants interviewed and measured in China do not present a reasonable proxy measurement of nutritional status even for the household from which they originated in North Korea. Although migration may be motivated by a search for food, and may give evidence of distress and food insecurity, it should be assumed that a household generally will send out its healthiest and hardiest member, particularly when only one household member migrates (as was the case in the majority of North Koreans interviewed in China). This is not to say that sick, disabled, and severely malnourished people do not migrate as well (especially when whole households move). In either case, however, the process employed by the household to “select” a member or members for migration is not random.

Rather than focus on individual nutritional status, this retrospective study sought to assess the impact of food insecurity on demographic changes during the period 1995 to 1998 by interviewing North Korean migrants in China about their households in the DPRK.

The study of North Korean migrants in China is limited by several biases and selection factors that make generalizations unreliable. First, North Korean households are not equally likely to migrate to China. Proximity certainly plays a major role: >80% of all respondents were from North Hamkyong province, directly across the Tumen River from Yanbian Korean Autonomous Prefecture. The physical and political dangers of the journey, on the one hand, may tend to discourage all but the more desperate households from migration; on the other hand, a household must have at least one member both living and healthy enough to survive the outward leg of the cross-border trip.

Second, as noted earlier, since it is likely that a household will send out its healthiest and hardiest member, particularly when only one household member migrates (as was the case in the majority of respondents), the migrants interviewed and measured in China do not present a reasonable proxy measurement of the nutritional status for the household from which they originated in North Korea.

These biases and limitations notwithstanding, however, the study does suggest that sample households have experienced an overall decline in food security, as evidenced both by the decline in government rations from an average of 120 grams per person per day to <60 grams per day, and by the increase in the percentage of households relying on foraging or bartering of assets as their principal source of food. It also is apparent (Figure 2), that the period 1995–1998 has been marked by elevated household mortality, declining fertility, and steadily rising out-migration. Taken together, the signs point toward famine, whether that is defined as a regional failure in food production or distribution leading to elevated mortality from starvation and associated disease or as a “complex socio-economic phenomenon,” whose sub-states include not only elevated mortality, but declining fertility, eating of alternative ‘famine foods’, transfer of assets, and the uprooting and separation of families.

Conclusion

In considering the utility of retrospective, demographic surveys in measuring the health consequences of disasters

and complex emergencies, it may be best to start with what they cannot do or cannot do well. First, they cannot be used to target individuals, households, or even population subgroups for specific interventions, be that in the form of feeding, medical care, or other emergency services. Measurements of nutritional status require either anthropometric and/or clinical assessments with periodic follow-up for trends. Second, they are more reliable in measuring demographic change over longer rather than shorter periods of time. It is commonplace, for example, in emergency health care, to measure mortality in deaths per 10,000 per day.[23] In a refugee camp, where deaths per day might be used to assess both immediate health risks and interventions, such a measurement may be appropriate but, generally speaking, the calculation of death, birth, and migration rates requires a longer time-horizon. Finally, in surveys of migrant and refugee populations, caution should be exercised in making any extrapolations or conclusions regarding the general population.

Lacking the means to obtain reliable data at the source, however, indirect measurements of demographic change, such as the study conducted on the China-North Korea border, can offer empirically-derived indicators of significant population characteristics and trends. Wherever war, internal conflict, natural disaster, or political barriers restrict access to a population of concern, demographic surveys of those displaced may offer the next best thing to being there.

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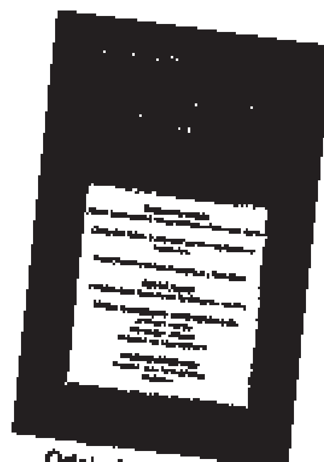

- Original Research
- Special reports
- Comprehenive reviews
- Case reports
- Calendar of International Congresses

The World Association for Disaster and Emergency Medicine (WADEM) shares the common goal of improving and standardizing the quality of prehospital and emergency care that is available to citizens of all nations. WADEM is dedicated to the ideals of Learning and Practice through a commitment to publishing the journal, Prehospital and Disaster Medicine. WADEM also recognizes the organizations that have shown commitment and dedication in the fields of public education, continuing medical education, scientific research, and analyses of medical field practices.