**Original Article**

# RISK ANALYSIS OF GROWTH FAILURE IN UNDER-5-YEAR CHILDREN

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**Background** – **Growth failure in under-5-year children is a multidimensional phenomenon. Undernutrition in infancy and early childhood is thought to adversely affect cognitive development. A cross-sectional anthropometric survey was carried out in Karaj, Iran to measure the risk factors of wasting and stunting in under-5-year children.**

**Methods** – **From February to April 2002, 600 under-5-year children were selected by multistage random sampling. Household's demographic and socioeconomic measures as well as child health and anthropometric characteristics were analyzed using Chi-square, *t*-test, ANOVA, and multiple logistic regression. To make a comparison with the results of National Center for Health Statistics (NCHS), we used Epi Info 6 software. Our data collection methods were weighing by scales, observation, and checklist.**

**Results** – **The male to female ratio was one. The prevalence of underweight, stunting, and wasting was 13.9%, 20.3%, and 4.9%, respectively. Most malnourished children belonged to the mothers who had low literacy and no history of measles vaccination and breast-feeding. Data also indicated that the principal risk factors for underweight were birth weight below 2.5 kg, a shorter-than-3-year interval from mother's previous birth, and urban life ($p < 0.05$).The principal risk factors for stunting were being younger than 6 months and birth weight below 2.5 kg ($p < 0.05$).**

**Conclusion** – **Our results support the biological and epidemiologic evidence that underweight, stunting, and wasting represent different processes of malnutrition and have different risk factors.**

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**Keywords:** Anthropometry • malnutrition • risk factors • stunting • wasting



## Introduction

Data on the prevalence of protein-energy malnutrition in developing countries indicate that on average, stunting (a deficit in height for age) and wasting (a deficit in weight for height) affect over 40% and 10% of under-5-year children, respectively.[1] It has been observed that the most obvious difference in length or height growth is between the populations living in developing and developed countries; the difference is also evident between well-off and poor subpopulations.[2] The difference is usually ascribed to a deficit incurred in early life. In other words, length growth is more easily impaired during early childhood and once such a deficit has developed, complete catch-up growth in later life is hard to achieve.[3, 4]

Most of malnourished people live in the developing nations of Asia, Africa, and Latin America where the most gravely affected are the young children and pregnant or lactating women from low income families.[5]

Biological and epidemiological evidence clearly indicates that stunting and wasting represent different processes of malnutrition.[6, 7] Stunting is often associated with long-term dietary inadequacy, repeated infections, or both. Wastin indicates that a child has an unusually low body tissue and fat mass compared with an individual of

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his or her length. Wasting peaks in prevalence between 12 and 24 months of age, when dietary insufficiency and diarrheal diseases are most frequent.[6] The long-term consequences of growth stunting in early life is the major reason why the populations in developing communities are on average shorter than those in developed communities.[3, 4]

One documented functional consequence of stunting is reduced learning ability in school.[8] The main and immediate causes of children's growth failure are a lack of adequate food and the high incidence of infectious disease. Thus, adequate food and nonfood input are required for good nutrition. Poverty is the major cause of inadequate food intake.

Research is needed on risk factors for stunting and wasting in different ages and in different environmental and socio-cultural settings. Evaluation of nutritional status of population groups has been undertaken in many areas of the world. Attempts have been made to standardize procedures and methodologies in order to allow comparison of the results derived from different studies. However, since malnutrition is etiologically heterogeneous among populations,[9] the risk factors for malnutrition vary among them. Differences in morbidity, child caregiving behaviors, and access to health care among others warrant a population-specific approach when studying the risk factors for malnutrition.

The objective of the present study was to determine the risk factors for underweight, stunting, and wasting among under-5-year children in Karaj, Iran. Demographic, socioeconomic, and health variables were studied in relation with wasting, stunting, and underweight.

## Materials and Methods

A cross-sectional survey on the prevalence of malnutrition and its risk factors was carried out from February to April, 2002 in Karaj (a big city near Tehran). The weight and height of under-5-year children were measured. Multi-stage random sampling method was used and the sample size was estimated assuming type one error to be 5%; malnutrition prevalence, 25%; and precision, 0.05. With a design effect of 2, the sample size reached 600. The area of study was 45 km away from Tehran and the population lived in various socioeconomic statuses. At the time of this study, Karaj had a population of about 1 ½ million residing in 9 city blocks. In urban areas, we selected 2 clusters from each block and 20 under-5-year children from each cluster (we selected 3 clusters from 2 city blocks because of population density). In rural areas, we selected 10 clusters (villages) from each of which 20 under-5-year children were picked out.

Manpower used for the study consisted of the authors and 4 community health workers. Before the study, the team met on 2 separate sessions to discuss the aims, objectives, and methodology of the survey and to develop perfect strategies for the survey. Anthropometry teams were trained and standardized for collecting data. The team conducted a pilot study on a small population in order to make any necessary corrections to the checklist.

Data were collected from children during house to house visits until the required number for the cluster was reached. The individual to be interviewed had to be a mother with children aged 0 to 5 years. Visits were made mostly in the evenings when most of the responders were expected to be at home. The information about risk factors of stunting and wasting was recorded in a standardized way using a well-designed checklist which included the following sections: socioeconomic status, family composition, housing situation, child's health care, age, weight, height, birth weight, length of time from previous birth, and the history of measles vaccination and underlying diseases.

Body weight was recorded on portable, accurate, and calibrated scales for over-2-year children and with infantile accurate and properly calibrated scales (Seca, Germany) for under-2-year children. The recording of height using a portable stadiometer was performed for every child. Children's age was calculated from birthday to the time of the study.

Analysis of the data was carried out using Epi Info 6 and SPSS version 9 (SPSS, Inc., Chicago, IL). Z-scores were then generated for weight-for-age, height-for-age, and weight-for-age indicators using the data of the National Center for Health Statistics (NCHS).

In addition to descriptive statistics, bivariate analysis was performed employing Chi-square, Student *t*-, and analysis of variance tests. For multivariate analysis, logistic regression was used. Wasting, underweight, and stunting were considered as dependent variables separately and all significant risk factors in bivariate analysis were

**Table 1.** Frequency distribution of underweight, stunting, and wasting of the studied children, Karaj, Iran, 2002.

| Type of malnutrition | Frequency *n* = 567* | Proportion (%) |
|---|---|---|
| Underweight (> -2SD from mean) | 79 | 13.9 |
| Stunting (> -2SD from mean) | 115 | 20.3 |
| Wasting (> -2SD from mean) | 25 | 4.9 |

* Thirty-three questionnaires were excluded from 600.

considered as independent variables. In order to measure the extent of correlation, the odds ratio was applied. The significance level was 5%. For odds ratio, confidence interval was calculated. One-way ANOVA was used to compare the means of ordinal variables.

## Results

In this study, 600 under-5-year children were studied. Thirty-three questionnaires were excluded because of incomplete data. Thus, the response rate was 94.5%. Of the studied children, 49.7% were females and 50.3% were males. Children from rural and urban areas comprised 33.7% and 66.3% of those studied, respectively. The mean (± SD) of the children's age was 27.3 (± 17.3) months. Overall, the proportion of underweight, stunted, and wasted children in the study was 13.9%, 20.3%, and 4.9%, respectively (Table 1).

Other descriptive statistics based on malnutrition status are shown in Table 2. The difference in the prevalence of stunting and wasting by age was significant ($p < 0.05$). The children 6 to 11 months of age were significantly more wasted and those younger than 6 months were significantly more stunted. No significant correlation was found between the prevalence of wasting, stunting, and underweight on one hand and sex, occupation of mother or father, father's literacy, measles vaccination, birth order, family size, number of children in family, type of feeding, rural or urban residence, and socioeconomic status on the other hand.

The children with mothers of lower literacy were more likely to be underweight than those whose mothers were of higher literacy (15.9% versus 10.4%, $p < 0.05$). The children who had been born within a shorter-than-3-year period from their mother's previous child delivery were more significantly underweight than those whose birth had taken place more than 3 years after their mother's previous delivery (20% versus 10%, $p < 0.05$). Birth weight under 2.5 kg was significantly more common among the stunted and underweight children than others (35.3% versus 18.2% and 29.4% versus 11.8%, respectively; $p < 0.05$).

Clear differences in risk factors for underweight and stunting (Table 3) emerged from the multiple logistic regression analysis. In bivariate analysis, the variables listed in Table 3 were significantly associated with underweight and stunting. The difference in factors associated with underweight and stunting indicated that birth weight, age, and a shorter-than-3-year period from their mother's previous child delivery were important risk factors for malnutrition.

Low birth weight (less than 2,500 g) (odds ratio [OR] 2.99, confidence interval [CI]: 1.63 to 5.4), a short interval (less than 3 years) from mother's previous child birth (OR: 2.18, CI: 1.32 to 3.5), and urban life (OR: 1.93, CI: 1.08 to 3.4) were the most important risk factors for underweight. Low birth weight (OR: 2.6, CI: 1.5 to 4.5) and being younger than 6 months (OR: 2.4, CI: 1.4 to 4) were the most important risk factors for stunting.

In bivariate analysis, there was a statistically significant relationship between age and wasting and between mother literacy and underweight. However, in multivariate analysis, these relationships were obscured.

## Discussion

Malnutrition has been one of the world's major problems and as stated above, most of malnourished people live in the developing nations of Asia, Africa, and Latin America, where the most gravely affected are young children and pregnant or lactating women from low income families.[5] This study revealed that 13.9%, 20.3%, and 4.9% of the studied children were underweight, stunted, and wasted, respectively.

A study in Nigeria in 1996 showed that 36.7% of under-5-year children were stunted and 40.8% of them were wasted.[5] In another study on

**Table 2.** Percentage distribution and means for selected characteristics of the studied children by type of malnutrition, Karaj, Iran, 2002. (*n* = 567)**

| Categorical variables | Type of malnutrition | | |
|---|---|---|---|
| | * Underweight /Normal % | * Stunting /Normal % | Wasting /Normal % |
| Sex | | | |
| Male | 12.3 / 87.7 | 21.4 / 77.6 | 5.6 / 94.4 |
| Female | 15.6 / 84.4 | 19.1 / 80.8 | 4.3 / 95.7 |
| Age (mo) | | | |
| – 5 | 8.6 / 91.4 | 32.9 / 67.1+ | 2.9 / 97.1+ |
| 6 – 11 | 17.1 / 82.9 | 9.7 / 80.3 | 7.9 / 92.1 |
| 12 – 23 | 11.1 / 88.9 | 16.7 / 83.3 | 4.6 / 95.4 |
| 24 – 35 | 16.2 / 83.8 | 20.5 / 79.5 | 6 / 94 |
| 36 – 47 | 14.1 / 85.9 | 19.2 / 80.8 | 3 / 97 |
| 48 – 60 | 15.5 / 84.5 | 16.5 / 83.5 | 5.2 / 94.8 |
| Birth weight | | | |
| < 2500 g | 29.4 / 70.6+ | 35.3 / 64.7+ | 7.4 / 92.6 |
| ≥ 2500 g | 11.8 / 88.2 | 18.2 / 81.8 | 4.6 / 95.4 |
| Previous birth interval | | | |
| < 3 yr | 20.3 / 79.7+ | 23.5 / 76.5 | 6.5 / 93.5 |
| ≥ 3 yr | 10 / 90 | 18.3 / 81.7 | 4 / 96 |
| Type of feeding | | | |
| Breast-feeding | 12.8 / 87.2 | 20.5 / 79.5 | 4.5 / 95.5 |
| Formula | 23.5 / 76.5 | 29.4 / 70.6 | 11.8 / 88.2 |
| Mix | 18.8 / 81.2 | 16.3 / 83.7 | 6.3 / 93.7 |
| Mother's education | | | |
| Under high school certificate | 15.9 / 84.1+ | 21.1 / 78.9 | 6 / 94 |
| Over high school certificate | 10.4 / 89.6 | 18.8 / 81.2 | 3 / 97 |
| Father's education | | | |
| Under high school certificate | 15.1 / 84.9 | 19.4 / 80.6 | 5.5 / 94.5 |
| Over high school certificate | 12.2 / 87.8 | 19.4 / 80.6 | 4.1 / 95.9 |
| Mother's job | | | |
| Housewife | 14.5 / 85.5 | 20.3 / 79.7 | 5 / 95 |
| Clerk | 10.5 / 89.5 | 18.4 / 81.6 | 5.3 / 94.7 |
| Father's job | | | |
| Worker | 10.6 / 89.4 | 18.2 / 81.8 | 6.1 / 93.9 |
| Clerk | 15.4 / 84.6 | 18.4 / 81.6 | 5.9 / 94.1 |
| Nonclerical job | 8.5 / 91.5 | 22/78 | 3.4 / 96.6 |
| Residence | | | |
| Urban | 16.2 / 83.8+ | 21.5 / 78.5 | 5.9 / 94.1 |
| Rural | 9.4 / 90.6 | 17.8 / 82.2 | 3.1 / 96.9 |
| Measles vaccination | | | |
| Yes | 14 / 86 | 17.4 / 82.6 | 5.2 / 94.8 |
| No | 20.8 / 79.2 | 29.2 / 70.8 | 4.2 / 95.8 |
| Socioeconomic status | | | |
| Low + mod | 14.5 / 85.5 | 19.3 / 80.7 | 4.8 / 95.2 |
| High | 13.9 / 86.1 | 20.7 / 79.3 | 5 / 95 |
| Continuous variables | | | |
| Birth order | 2 + 0.12 / 1.6 + 0.20 | 1.9 + 0.10 / 1.7 + 0.29 | 1.8 + 0.17 / 1.6 + 0.12 |
| Family size | 4.2 + 0.13 / 4.3 + 0.56 | 4.1 + 0.11 / 3.9 + 0.29 | 4.0 + 0.25 / 4.1 + 0.27 |
| Number of children | 2.0 + 0.12 / 1.7 + 0.22 | 1.9 + 0.10 / 1.8 + 0.29 | 1.8 + 0.17 / 1.7 + 0.13 |

*≥ + 2SD from mean; +$p < 0.05$; **33 questionnaires excluded.

Brazilian children, the prevalence of stunting was 14.4%.[10] Thus, the prevalence of malnutrition in the present study was similar to that of Brazilian children and less than that of the Nigerian study.

The results of this community-based study indicated that the highest prevalence of wasting was seen in the children aged more than 6 months. This result was the same as that of another study in Iran performed in 1997,[11] and a study in the Philippines during 1988 to 1990.[12] It seems that the supportive attitude of mothers, development of prenatal care, and breast-feeding could play a role in reduction of malnutrition in under-6-month children. After 6 months of age, with increasing activity of the child and beginning of complementary food this rate will increase.

In the present study, no association was found between malnutrition and the child's father's job.

**Table 3.** Relative odds* for risk factors for underweight and stunting in under-5-year children, Karaj, Iran, 2002.

| | Type of malnutrition | | |
|---|---|---|---|
| | **Underweight** | **Stunting** | **Wasting**** |
| < 2.5 kg birth weight | 2.99+ | 2.6+ | 1.7 |
| < 3 year with previous birth | 2.18+ | 1.45 | 1.56 |
| Low mother's literacy | 1.48 | 1.19 | 2.16 |
| Urban life | 1.93+ | 1.36 | 2.17 |
| < 6 mo age | 0.99 | 2.4+ | 0.95 |

* Adjusted odds ratio by logistic regression; ** By logistic regression there is not any significant factor for wasting; + $p < 0.05$.

In some other studies, father's job was considered as a measure of father's income and was shown to be related to impaired length growth.[13] Although there was no significant association between mother's job and the types of malnutrition, the prevalence of underweight and stunting was higher among the children of house-maker mothers compared with unemployed mothers' children. It has already been shown that the children of employed mothers are better nourished than those of house-makers.[14] It seems that employed mothers are of higher literacy and take care of their children better. Our study showed that mothers of low literacy were more likely to have underweight children than other mothers (OR: 1.48). This was also observed in the studies performed in the Philippines[12] and Kenya.[14]

In all types of malnutrition, it was shown that the proportion of the children not immunized against measles were more than that of children with normal weight and height. It has also been shown that children, following measles infection, become vulnerable to many other infections such as diarrheal disease which could on its own part culminate in malnourishment.

Short interval from the mother's previous birth was a risk factor for underweight. Apart from its effect through decreasing birth weight, children born within 3 years of a sibling are generally prone to deprivation. The reason could be that they may have received inadequate care from their mothers or experienced more competition for household resources such as food or health care.[15] A recent comparative analysis of demographic and health survey data also indicates that short interval from previous birth is a significant risk factor for stunting among children in 19 developing countries.[16]

Birth weight below 2,500 g was an important risk factor for underweight and stunting. This influence of birth weight on children's well-being is consistent with other findings that showed links between birth weight and growth in infancy and afterwards.[17]

In the present study, urban life was shown to be a risk factor for underweight. Although in some studies[10, 12] rural children were more likely to suffer from malnutrition than urban children, our study did not prove this. In our study, most of the rural areas had a health care center for a defined population which actively delivered health care to villagers; this may partly justify the different results.

In our study, breast-fed children were better-nourished than other children. Thus, breast-feeding promotion could particularly have a positive influence on children's nutritional status.

The significant associations between children's nutritional status and maternal factors indicate that the interventions must focus not only on children but also on their mothers. It has also been suggested that empowering women by improving their health may prove to be one of the best approaches to children's health promotion in the third world.

The risk factors associated with malnutrition in this study suggest several potential applications for interventions to improve children's nutritional status. The infants born with low birth weight and within 3 years of an elder sibling should be singled out for interventions. The interventions to reduce malnutrition prevalence should include or contribute to increasing children's birth weight, increasing women's access to prenatal care, encouraging family planning to increase birth spacing, development of health care services, and enhancing mother's literacy.

Our study had some limitations. Some data items (such as birth weight and immunization history) depended on mothers' recollection and so may not be very precise. Because of few interviewers for collecting data, inter-observer bias in measuring variables might exist though attempts were made to train them in order to reduce this bias.

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