Comparison of different scores in the assessment of nutritional status in the children: a follow-up study among 0-36 months old children

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In this prospective study we followed 366 children of 0 to 36 months old for one year in the city center of Kocaeli province, Turkey. We assessed the nutritional status each month by using z-score, percent-of-median and percentiles of weight for age, height-for-age and weight-for-height. The z-score is found to detect significantly different rates of malnutrition than the other two scores. As for the prevalence of malnutrition found in the first visit, stunted children were predominant as compared to the underweight and wasted children according to all the three scores. [Turk J Med Res, 1997; 15(2):81-84]

Key Words: Malnutrition, z-score, Anthropometric measures, Children

The increasing number of children under age five are continuing to make up an important proportion of the world's population (1,2). The impairment of their physical, mental and neuromotor development due to improper nutrition will end up with unhealthy generations in the future (3,4).

Only 1% or 2% of the world's children exhibit visible signs of malnutrition. But an estimated 190 million children under five are chronically malnourished. Long before malnutrition becomes visible, it amplifies the worst consequences of illness. The risk of dying from a given disease is doubled for mildly malnourished children, and tripled for those moderately malnourished. In total it is a factor in one third of the 13 million under-five deaths each year (2).

Different rates of childhood malnutrition are reported from different countries. These differences can be due to not only the socioeconomic and cultural level of the communities and the families or the delivery of health care services, but also to the heterogenity of the indicators, indices, scores and the reference populations used.

Although some authorities prefer to use their national growth curves or reference populations, most of them insist that only one international reference should be used to facilitate the comparison of communities (5-7). The reference population referred to be most suitable as an international standard is the National Center for Health Statistics (NCHS) standard.

Received: March 31, 1995 **Accepted:** April 29, 1997

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Irrespective of the reference population used, an anthropometric indicator is known to provide a measure of an individual's growth status, as a percent-of-median score, as a percentile score or as a proportion of the standard deviation often referred to as a z-score (8,9).

There are several anthropometric indices to measure malnutrition such as weight-for-age, height-for-age, weight-for-height, midupper arm circumference, skinfold thickness and some body proportions. Among these the most frequently used ones are weight-for-age, height-for-age and weight-for-height indices (10-12).

The use of most suitable and accurate score and index is an important issue in the epidemiological studies measuring malnutrition, and also in growth monitoring, the "G" of the GOBI-FFF slogan of the UNICEF; furthermore it will enhance the comparison of the malnutrition prevalence of different communities.

In this prospective study we followed the nutritional status of a group of healthy children in an urban area of Turkey for one year. The aim of the study was to monitor children's growth using the percent-of-median, percentile and z-scores and compare the growth according to these three as far as the weight-for-age, height-for-age and weight-for-height indices were concerned and with reference to the NCHS reference population.

MATERIAL AND METHOD

This prospective cohort study was carried out on a randomly selected sample group of 390 healthy children aged 0 to 36 months in the Izmit city center of Kocaeli province, Turkey. The study region was an industrialized urban area, in which the primary health care services are under the responsibility of the health centers of Ministry of Health. During the study period there were 13 health house regions in the city center and a midwife was responsible for the maternal and child health care services of each region. The study sample represented the 0 to 36 months old children population in these regions. Data were collected by the responsible midwives at house visits during one year (June 1990-May 1991) from the 366 of the selected sample.

Before starting the study the midwives were informed and trained about the study methods and data collection for reducing the interobserver variation and observer bias. A questionnaire was applied to the mothers of the children which included questions about breast-feeding, artificial feeding and presence of ARI (acute respitary infection) and diarrhea symptoms in the previous month. Weight and height of the children were measured as recommended by WHO (13,14) during the monthly house visits.

Weight-for-age, height-for-age and weight-for-height z-scores, percent-of-median scores, and percentile scores, and also the age of the children were computed by using the NCHS/CDC (National Center for Health Statistics/Center for Disease Control) reference population and the Anthropometry Software Package developed by the Centers for Disease Control (CASP-Version 3.1).

As for the percent-of-median score the following table was used to defined the malnourished children (6-8):

Indicator	Description of the malnutrition	Percent of median score of alnutrition	Name of the classification
Weight for age	Underweight	< 75	Gomez
Height for age	Stunted	< 90	Waterlow
Weight for height	Wasted	< 80	Waterlow

Children equal to and below -2.00 z-scores and/or equal to and below the 3rd percentile score were also considered to be malnourished.

The formula for the z-score was as follows :

$$\frac{\text{actual anthropometric value-median reference value}}{\text{standard deviation}}$$

RESULTS AND DISCUSSION

The findings of the first visit and total visits are summarized in Tables 1 and 2. As seen in the tables we computed the percentages of malnutrition for different age groups with regard to three different scores, namely, z-scores, percent-of-median scores and percentile scores. According to the results of the first visit, 4.9 of children were found to be underweight, 14.8 stunted and 1.6 wasted as far as the z-scores were concerned (see Table 1).

With these numbers it can be concluded that our study population is somewhere in between developing and developed nations (3,5,6,15-17).

The fact that the percentage of stunted children is the highest (14.8 in z-scores, 16.1 in percentile scores and 4.9 in percent-of-median scores) may be concluded as that malnutrition is somewhat chronic in that area (6, 7,12,13,17,18).

In a study carried out by Ozyurda in Park training health center area in Ankara the percentage of stunted children (0-6 years old) was found to be 8.06 where as of underweight children to be 3.34 in percentile scores. In the Turkish Demographic and Health survey, 1993, among the 1-59 months old children the percentage of stunted children was found to be 18.9, the percentage of Underweight children 9.5 and the percentage of wasted children 3.0 according to Z-scores and NCHS reference population (20). Stunted is a term signifying the retardation in skeletal growth, in other words height deficit may be an indicator of the duration of malnutrition. Furthermore height-for-age is an index giving a picture of the past nutritional history (11). To a certain extent stunting might depend upon a genetic predisposition (6), but it is frequently found to be associated with poor overall economic conditions, especially mild to moderate, chronic or repeated infections, as well as inadequate nutrient intake. These factors might accumulate, but the stunting might not be evident even for some years (7). In the study group, too, it can be observed from the table that the percentage of stunted children is increasing with age.

Table **1.** Percentages of malnutrition according to the different scores and indices during the first visit

	MALNUTRITION%								
	Weight-for-Age (Underweight)			Height-for-Age (Stunted)			Height-for-Weight (Wasted)		
Age (months)	Z-score	Per. Med. score	Perc score	Z-score	Per. Med. score	Perc score	Z-score	Per. Med. score	Perc score
0-3 (n=67)	-	-	-	3.0	-	3.0	1.5	-	1.5
4-6 (n=36)	2.8	2.8	2.8	8.3	2.8	8.3	-	-	1.5
7-12 (n=76)	6.6	5.3	6.6	7.9	5.3	9.2	3.9	2.6	3.9
13-24 (n=110)	3.6	1.8	7.3	21.8	7.3	22.7	0.9	-	2.6
25-36 (n=77)	9.1	6.5	7.3	24.7	6.5	28.6	1.3	1.3	3.3
Total (n=366)	4.9	3.3	5.7	14.8	4.9	16.1	1.6	0.8	3.3
Z-score versus other scores		t=2.27* p<0.05	t=1.42" p<0.05		t= 5.20* p<0.001	t= 1.22** p>0.05		t= 1.74* p>0.05	t=1.91** p>0.05

* Z-score versus percent-of-median score
** Z-score versus percentile score
(The statistical test was applied to totals only and they were compared as paired groups)

Table 2. Percentages of malnutrition according to the different scores and indices during all the visits.

	MALNUTRITION%								
	Weight-for-Age (Underweight)			Height-for-Age (Stunted)			Height-for-Weight (Wasted)		
Age (months)	Z-score	Per. Med. score	Perc score	Z-score	Per. Med. score	Perc score	Z-score	Per. Med. score	Perc score
0-3 (n=151)	-	-	-	2.6	0.7	2.6	0.7	0.7	0.7
4-6 (n=234)	0.4	0.9	1.3	5.6	2.6	8.1	0.9	0.9	1.3
7-12 (n=698)	3.2	1.7	3.4	5.7	1.9	6.2	2.0	0.7	2.3
13-24 (n=1135)	1.8	0.5	2.5	10.7	4.1	12.1	0.7	0.1	1.5
25-36 (n=983)	5.0	2.5	5.7	10.1	4.0	11.3	1.0	0.3	1.5
Total (n=3201)	2.9	1.4	3.5	8.7	3.3	9.8	1.1	0.3	1.6
Z-score versus other scores		t=5.77* p<0.001	t=4.46** p<0.001		t= 10.70* p<0.001	t= 4.25** p<0.001		t= 3.99* p<0.001	t=2.94** p<0.01

* Z-score versus percent-of-median score
** Z-score versus percentile score
(The statistical test was applied to totals only and they were compared as paired groups)

Unfortunately stunted children might never completely recover in height. The degree of improvement in height depends on how long and at what age the child had been malnourished (6). Sometimes stunting can be even irreversible, besides it might have adverse outcomes on mental development also. All these indicate that the nutritional status of our study population needs immediate intervention.

One other important finding that can be observed from the tables is that the percentage of malnutrition determined by the z-score is less than the percentage of the malnutrition determined by the percentile score; whereas it is more than the one determined by the percent-of-median score. The differences are not at all statistically significant at the first visit; however all of them are found to be statistically significant as far as all the visits were concerned (p<0.01, see Table 2).

This might be interpreted as that the percent-of-median score misses some malnourished children. The finding might be justified when the limitations of the percent-of-median score are taken into consideration. It does not take into account the variability in the relative width of the distributions of the weight-for-age, height-for-age and weight-for-height indices : that is a given percent-of-median score for an index is not constant across ages and does not have the same meaning for different indices (9). One of the studies state that at different ages a percent-of-median score will not correspond to the same z-score or the percent-of-median score is likely to underestimate the prevalence of malnutrition relative to the z-score (21).

The percentage of malnutrition determined by the z-score in our study being less than the one determined by the percentile score, can be verified when a z-score of -2.0 is reported to correspond to a percentile score of approximately 2.3 on reference growth charts (21). However in this study, the children equal to or below the 3rd percentile were considered to be malnourished. The disadvantage of using the percentile score is that it cannot measure or monitor the growth of individual children who are above or below the outer percentiles that is less than 3rd and more than 97th percentiles of the reference population (9). For example some children with congenital or hereditary abnormalities, with cerebral palsy or some heart defects have percentile scores below the 3rd percentile; besides many children in developing countries fall below the 3rd percentile. Using the percentile score might be problematic in the comparison of the developing countries especially.

To overcome such problems using the z-score in measuring malnutrition and growth monitoring might be recommended. The cutoff points of the z-scores can be as small as -3.0 or even -6.0 ; in other words it can measure malnutrition beyond the outer percentiles of the reference population. Another advantage of the z-score is that a single cut-off point may be comparable across all indices and at all ages (6,8,9). The z-score is also easy to calculate because it is already adjusted for age. It can be readily calculated by hand, using tables of NCHS reference data and standard deviations prepared by the World Health Organization (22) or with the anthropometric software package developed by CDC as it was done in this study.

However in majority of the studies made in Turkey the percentile score is used (23,24) the National standards of Olcay Neyzi is also used in a considerable number of studies (25,26), There are also some studies using the percent-of-median score as the one carried out by Ezmeci in Bayburt (27) In a study that was carried out in Antalya, Ahatli Health Center Area the National Standards of Neyzi and Kbksal were compared with the NCHS'CDC reference population in the local children of 0 to 59 months old age group. Differences were found between the three standards. (28) In that same study Z-score was also used the percentage of stunted children was found to be 15.2 % that is far more than the percentage of underweight children (3.7%).

CONCLUSIONS

In this prospective study we found that the z-score determined significantly more ratios of malnutrition than the percent-of-median and less than the percentile scores, as far as the monthly measurements of the three indices namely weight-for-age, height-for-age and weight-for height were concerned.

Prospective studies are believed to show the actual risks and causes of health events. Therefore it is wise to plan further studies in order to choose the most suitable score to be used especially during prospective studies for determining the causes of malnutrition such as inadequate food intake, infections, physicosocial disturbances, delivery of health services etc. and for determining the right time for intervention for therapeutic purposes.

Since growth monitoring is a tool for systematically following the growth of groups at risk, for the early detection of several disturbances altering health and for preventing severe consequences, the best score to carry out an ideal growth monitoring must be determined with follow-up studies similar to this study.

One fact this study shows is that using different scores in growth monitoring or in follow-up studies might give completely different interpretations and might end up with several adverse outcomes concerning child health.

Çocuklarda beslenme durumunu takip için farklı skorların karşılaştırılması: 0-36 aylık çocuklarda izlem çalışması

Bu prospektif çalışmada Kocaeli ilindeki 0-36 aylık 366 çocuk izlem altına alındı. Ayda bir Z-skoru, yaşa göre ağırlık, yaşa göre boy ve boya göre ağırlık için ortalama yüzdesi ve persentilleri hesaplandı. Z skoru diğer iki skora göre malnutrisyonun değişik derecelerini belirlemede anlamlı derecede farklı bulundu. İlk ziyarette tespit edilen malnutrisyonlara göre orta derecede beslenme bozukluğu olan çocuklar, zayıf ve çok ağır beslenme bozukluğu olan çocuklara göre daha sık bulundu. [T Klin Araştırma 1997; 15(2): 81-84]

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