Risk Factors for Stunting and Wasting at Age Six, Twelve and Twenty-four Months for Squaller Children of Karachi, Pakistan

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bstract

Objective: A high proportion of stunting and wasting in children under-five has been reported from developing countries. This paper presents the nutritional status of a two year cohort of urban squatter child ren in Karachi, Pakistan and assesses risk factors for wasting and stunting at the reference ages of six, twelve and twenty-four months.
Methods: A birth cohort of 738 children were visited at specific intervals by trained nurses to collect information on anthropometric measurements, feeding practices and intercurrent illnesses. Socioeconomic and demographic information included water and sanitation facilities, availability of electricity, type of house construction material and average monthly income. Information about the mother's reproductive history was also obtained.
Results: At two years the proportion of stunting and wasting was 41.8% and '10.6% respectively. Intrauterine growth retarded children had a higher risk of stunting and wasting at all reference ages as compared to children who were appropriate for gestational age. In the logistic regression models, intrauterine growth retardation was the only significant risk factor that remained in all models at each reference age.
Conclusion: The consistent association of IUGR for stunting and wasting adds to the growing body of evidence that by improving maternal health we will ultimately hieak the vicious cycle of malnourishment and improve the health and well—being of future generations. We suggest interventions to improve the nutritional status of Pakistani urban children living in squatter settlements focused on mothers and children (JPMA 50:341, 2000).

Introduction

The protein-energy malnutrition-infection complex results in stunting (a deficit of length relative to age) and wasting (a deficit in weight relative to length) which is believed to be a strong predictor of functional impairment on a wide range of biological, behavioral and social dimensions in children and adults, especially from developing countries[1,2]. however, there is biologic and epidemiologic evidence that indicates that stunting and wasting are due to a range of risk factors such as socioeconomic status, morbidity, dietary practices and environmental factors[3,4]. For children under two in developing countries, the proportion of wasting is an increasing function of age with a rapid increase in the second year when acute infectious diseases, such as diarrhea and respiratory infections are more frequent, whereas the proportion of stunting increases up to 18 months with a decline at 24 months[3-5].
A high proportion of stunting and wasting in children under-five[6] has been reported from developing countries. For example, the prevalence of stunting in children at one year of age was 19% among Bedouin Arab infants[7] and 69.4% in Guatemala[8], though for children living in pen-urban settlements in Lahore, Pakistan the prevalence of stunting increased from 15% at six months to 57% at 18 months[9] . On the other hand, the prevalence of wasting is much lower and ranges from 19.4% in one year olds in Sri Lanka[8] and to 13.4% and 10.9% among boys aged[12-17] months in urban and rural areas of Philippines respectively[5]. This indicates a grave nutrition problem that needs to be urgently addressed. Developmental impairment, a long-term sequelae of malnourishment, is a major public health problem

in developing countries[10]. The effect of developmental impairment is manifested in diminished learning ability in school[11], a higher risk of mortality among women during childbirth[12], and of poor pregnancy outcomes such as intrauterine growth retardation and infant mortality[13,14], This inter-generational effect of inadequate nutrition impedes the fulfillment of an individual's potential throughout life and that of whole nations striving to achieve their potential in growth and development.

In a study reported from the Philippines[5], area of residence, low birth weight and maternal education were shown to be strong predictors of wasting and stunting among children. In addition, due to the heterogeneity of populations in dietary behavior, socio-cultural traditions like feeding practices and child care-taking behavior, morbidity patterns or environmental conditions, risk factors for malnutrition may vary in different environment and soclo-cultural settings. There is a dearth of regional or country-specific information on the major risk factors for stunting and wasting. Information on risk factors such as intrauterine growth retardation, birth weight, age, maternal education or area of residence will assist in developing appropriate intervention strategies for those in need of attention.

The purpose of this paper is to estimate the proportion of wasting and stunting based on a two year cohort of urban squatter children in Karachi, Pakistan, In addition, the risk factors for wasting and stunting, such as socio-economic, demographic, maternal and biologic factors, feeding practices and morbidity, at the ages six, twelve and twenty-four months will be assessed.

Materials and Methods

The study was conducted in four urban squatter settlements of Karachi that has operational Primary Health Care (PHC) programs[15]. These settlements are visited regularly by community health workers for disease prevention activities such as growth monitoring, health education, identification of at-risk children and mothers etc.

The data for this research were collected by trained nurses recruited for this purpose who visited the study children in their homes at one, three, six, nine, twelve, eighteen and twenty four months ("contact times"). This cohort of children comprises of babies born to mothers included in the pregnancy outcomes study conducted to assess risk factors for intrauterine growth retardation[13], Thus, details of the data collection for this portion of the study are reported elsewhere[13]. Socio-ecoriomic and demographic information were collected on water and sanitation facilities, availability of electricity, type of material used for house construction, household composition and average monthly income. Infonnation about the mother includes reproductive history, details of the current pregnancy and anthropometric measurements like height and weight.

A total of 994 mothers from 1,000 enrolled pregnant women were followed to delivery. After obtaining informed consent from the parents, 854 live-born babies with detailed information on birth outcomes were enrolled for the prospective child survival study. Due to lack of information on gestational age and considering only singleton births, the sample size at the beginning of the study was 738. However, due to inability to contact the family, death and attrition, the number of study children decreased to 565 by the end of the study.

Anthropometric measurements of weight and length were taken and information obtained on feeding practices and intercurrent illnesses at the contact times. Information on feeding practices related to type of milk consumed (breast or bottle[a]), water or any semisolids or solids. Data on morbidity status was based on mothers' reports of an episode of otitis media[b] or lower respiratory tract infection[c] during the month prior to each contact time, while diarrhea[d] was restricted to any episode during the two-week period prior to the date of visit.

Anthropornetric data collection and analysis

All anthropometric measurements were obtained in a standardized fashion. Weight was measured on weighing scales accurate to within 20gms with the baby minimally clothed. The crown-heel length was taken on a flat wooden surface with head and foot boards to mark the fully stretched length and measured with a paper tape while at 24 months height rather than length was measured. For the remainder of this paper the term height will be used instead of length. All measurements were taken in duplicate, and mean of the two readings were used in data analysis.

Using the anthropometric program of Epi Info[16], gender and age specific weight and height measurements for the three nutritional indicators of height-for-age, weight for-height and weight-for-age[17] and Z-scores relative to the international reference population[e] were computed.

A child's nutritional status was categorized as underweight, wasted or stunted[18]. Underweight was defined as Z-scores of weight-for-age of less than -2 and stunting as Z-scores of height-for-age below -2. Wasted was defined using the standard definition as Z-scores for weight-for-height below -2 but we have re-defined wasted throughout this paper as those children with Z-scores of weight-for-height below -1.5.

Potential Risk Factors

The risk categories considered were socio-economic, demographic, maternal, biologic, behavioral and morbidity status. The soclo-economic category variables included income per person [monthly household income divided by number of person in the household], housing construction material, type of the water supply and availability of electricity. Demographic variables consisted of crowding, consanguinity and paternal education; and maternal characteristics included education, employment, age, height, weight, birth-to-conception interval and parity. Biologic factor were limited to intrauterine growth retardardation, gender, prior stunting or wasting; behavioural factors were related to feeding practices; and morbidity status to episode of diarrhea, otitis media or lower respiratory tract infections.

Intrauterine growth retardation (IUGR) was defined as birth weight-gestational age below the 10th percentile according to Brenner et al[19], else the new born was categorized as appropriate for gestational age (AGA).

For any three of references ages, if the child was identified as stunted in the preceding evaluation, s/he was labeled with a history of being "stunted". For example, at 12 month reference age, if the child was stunted at 9 months, then the child had a history of prior stunting. Prior wasting was defined similarly.

At each contact time a child was classified as "breast fed" or "non-breast fed" depending on whether or not breast milk was given irrespective of other foods such as non-human milk, water or semi-solids in the diet. Similarly, we labeled a child as having a "former history of being breast fed" if s/he was breast fed in the previous contact time.

The morbidity status was computed based on reported episodes of diarrhea, otitis media or lower respiratory tract infections. At a given reference age and its two preceding contact times the total number of episodes of each of the above morbidity measure were computed. For each morbidity measure, if at least two episodes were reported as these three successive contact times then the child was categorized as suffering from the morbidity at the reference age. For example, at the reference age of six months, a child was classified as having diarrhea if she had diarrhea in at least two of the three contact times (1,3 and 6 months); other wise the child was classified as not suffering from diarrhea.

Among maternal characteristic, maternal anthropometric measures of height and weight were classified in to binary variables. Women were labeled as short statured if there height was below 145 cm or underweight if their weight was below 40 kgs. These cut-off values for height and weight represent approximately1.5 standard deviations below their respective means.

We have earlier defined income per person for each house hold. We labeled households as "low income" if the income per person was less than Rupees 200[f]. This cut-off value is about half a standard deviation below the mean monthly income per person.

Statistical analysis

The analysis in this paper includes descriptive and inferential statistics. The descriptive portion deals with age-specific proportions of being underweight, stunted, extremely wasted and wasted.

Furthermore, gender specific proportions of extremely wasted, wasted and stunted, by age. are reported.

The underweight nutritional status was considered only in the descriptive analyses as stunting is a more sensitive measure than weight-for-age, especially in stunted populations[20]. In addition, extreme wasting is described only in the descriptive portion of the analyses as the numbers of extremely wasted children were too few for bivariate and multivariate analyses. The bivariate associations between socio-economic, demographic, maternal, biologic. behavioral and morbidity status variables with stunting and wasting were investigated, and odds ratios and p-values were calculated[21]. It needs to be highlighted that the outcome variables were analyzed separately at each reference age.

Due to multi-collinearity and possible confounding among some of the risk factors identified in the bivariate analyses, multiple logistic regression were run to assess the effect of each risk factor in the presence of other variables in the model. The criteria for including variables in the multiple logistic regression analyses was a p-value of <0. I upon bivariate associations and biological relevance. Logistic regression models were constructed separately for each reference age. For each risk category, the potential risk factors that met our selection criteria were entered in the logistic regression model and significance of the regression coefficients were noted. Those risk factors which had a p-value of <0.05 were identified for inclusion in the subsequent model, priority of addition was based on the magnitude of their p-values. The final regression models only include risk factors with a p-value of <0.05[22]. Data analyses were performed on SAS Version 6. 10 statistical software for personal computers[23].

Results

The proportion of underweight children rises steadily from 6 percent at 3 months to 51 percent at 24 months as illustrated in Table 1. During the 3 - 18 months age interval, the percentage of stunting rose from 27% to 68% but in the subsequent study period it declined to 42% (Table 1).

a = Either formula or fresh milk.

b = Pus, serous or bloody discharge from one or both ears at any time during the past month.

c = Rapid breathing, high fever and intercostal retractions with or without cough and sputum production at any time during the past month.

d = Diarrhea was defined as three or more watery stools in one day.

e = National Center for Health Statistics (NCHS)/Centers for Disease Control and Prevention (CDC)/World Health Organization.

f = Approximately US$7.

g = Includes illiterate, able to read and write, as well as formal schooling till Class 5.

From 3 to 6 months, the proportion of stunting increased by 54 percent which was the highest increase observed during the study period. The percentage of extreme wasting remained unchanged during age 3 to 9 months and then steadily increased to 11% at 24 months; whereas the percentage of wasting remained unchanged during age 3 to 6 months and then increased to 26% at 24 months (Table 1).

Table 1. Percentage of underweight, stunted and wasted study children by age, Karachi, Pakistan.

Age (months)	n	Nutritional status: Under-weight	Stunted	Wasted	Wasted as defined here
3	633	6.3	27.5	2.4	4.0
6	641	12.0	42.3	2.6	3.6
9	618	30.3	51.0	2.8	6.3
12	618	40.9	52.6	6.6	12.0
18	579	45.8	67.9	8.1	20.6
24	565	50.6	41.8	10.6	26.0

Underweight = < -2 SDs Weight for Age
Stunted = < -2 SDs Height for Age
Wasted = < -2 SDs Weight for Height
Wasted as defined = < -1.5 SDs Weight for Height in this paper

Gender differences in the proportions of stunting, extreme wasting and wasting was not statistically significant at the contact times. However, prior to 9 months, the proportion of extreme wasting or wasting in girls were slightly higher than that in boys but the situation was reversed in the subsequent study period. Similarly, the proportion of stunting among girls was slightly higher than that among boys until age 12 months, with a reversal in the subsequent study period.

Table 2 shows the unadjusted odds ratios and p-values of risk factors for stunting and wasting at the reference ages of 6, 12 and 24 months. For stunting, similar risk factors were identified across the three reference ages though this was not the case for wasting. Several socioeconomic characteristics such as income per person, water supply and electricity, were significantly associated with stunting. Inferior housing construction increased the odds for wasting and peculiarly lack of piped water was protective for wasting.

Among the maternal factors shown in Table 2, maternal education[9] was significantly associated with stunting but not wasting. In addition, the first child in the family had a significantly lower risk of being stunted as compared to subsequent children.

IUGR children had a higher risk of stunting and wasting at all three reference ages as compared to AGA children. For example, at 3 months, IUGR children were twice as likely to be wasted as compared to AGA children with the odds of wasting steadily decreasing to 1.61 at 24 months. On the other hand,

the odds of stunting for IUGR children increased from 1.60 at 3 months to 2.19 at 24 months (Table 2). Prior stunting, as defined earlier, was highly associated with subsequent stunting. For example, children who were stunted at three months were more likely to remain stunted at 6 months study period our children lag behind the NCHS standards. A possible explanation for this phenomena could be due to feeding practices and exposure to a more contaminated environment as compared to western countries.
In our study population, breast feeding is the predominant source of nutrition during the first nine months but subsequently inappropriate addition of solid foods with a concomitant decrease in breast feeding coupled with greater exposure to the environment due to the mobility of children results in the aforementioned disparity in the proportion of extremely wasted and wasted children as compared to the NCHS standards.
In our study population, the proportion of stunted children rose steadily from 27.5% at 3 months to 67.9% at 1 8 months. Similar patterns are reported from other developing countries[5,7,9,24-26]. It is important to note that the spurious improvement observed in the percentage of stunted children at 24 months is similar to that reported by Ricci et al5 for which the juncture of the length and stature medians at 24 months of age in the NCHS reference population[27] is the most likely explanation.
Our results do not demonstrate statistically sign ificant gender differences in the proportion of stunting, extreme wasting, wasting and underweight and therefore does not support the popular belief that Pakistani and Indian girls[25] are discriminated in terms of nutrition. However, a study from the Philippines5 reports significant gender differences, albeit favouring girls, in the proportion of stunting and wasting which could be due to a larger sample size in the Philippines study as compared to our study and the Indian study[25].
Though a number of socio-economic and demographic factors were associated with stunting and wasting in the bivariate analysis, only a few socio-economic and none of the demographic factors retained their significance in the final logistic regression models. In addition, our results demonstrate a significant association between diarrhea! episodes at 6 months and stunting. However, associations between morbidity status and wasting but not stunting has been reported by Ricci et al[5] at various age intervals. As mentioned earlier, this disparity could be explained by a larger sample size in the Philippines study[5] as compared to our study. These findings reflect the complexity of the influence that an inter-play of poverty, unhygienic living conditions, poor sanitation, genetic and other environmental factors have on the acute and chronic nutritional status of children which have also been reported in other studies[5,7].
Some of the principal predictors of stunting among maternal characteristics and behaviour were maternal education, parity and feeding practice. Some of these factors indirectly affect nutritional status of the child. For example, maternal education could influence child care, feeding practices and health seeking behavior which may have an impact on the nutritional status of the child. Interestingly, our results substantiate the common belief of enhanced child care for the first child in the family as shown by its protective association even after adjustment for other covariates in the final multivariate logistic regression models (Tables 2 and 3).

Table 2.. nadjusted odds ratios and significance level for risk factors of stunting and wasting at the reference ages, Karachi, Pakistan.

Risk categories	Stunting			Wasting		
	6 months	12 months	24 months	6 months	12 months	24 months
Socio-economic						
Income per person low (ref adequate)	0.76n.s.	1.55**	1.52**	1.17n.s.	1.19n.s.	0.82n.s.
House construction[a] kutcha (ref pucca)	0.98n.s.	1.03n.s.	1.17n.s.	3.45n.s.	5.11*****	1.83***
Water supply[b] not piped (ref piped)	2.00****	1.70****	1.25n.s.	0.45n.s.	0.52***	0.68**
Electricity No (ref yes)	3.24*	8.30***	1.76n.s.	3.08n.s.	n.a.	2.31n.s.
Demographic						
Crowding[c] Over (ref adequate)	1.05n.s.	1.71***	1.65***	0.76n.s.	1.03n.s.	1.13n.s.
Consanguinity Related (ref not related)	1.12n.s.	1.45**	1.20n.s.	0.74n.s.	0.65*	0.75*
Paternal Education Primary[d] (ref secondary)	1.03n.s.	1.43**	1.27n.s.	1.18n.s.	1.31n.s.	1.08n.s.
Maternal						
Education Primary[d] (ref secondary)	1.70***	2.01****	2.94****	0.55n.s.	0.71n.s.	0.78n.s.
Employment[e] Yes (ref No)	1.00n.s.	0.72n.s.	0.84n.s.	1.89n.s.	2.31***	0.99n.s.
Age (yrs) 30+ (ref <30)	1.00n.s.	1.04n.s.	1.03n.s.	1.43n.s.	1.14n.s.	0.89n.s.
Height (cms) <145 (ref ≥145)	1.46n.s.	1.85**	1.86**	1.57n.s.	1.25n.s.	1.05n.s.
Weight (kgs) <40 (ref ≥40)	1.03n.s.	1.24n.s.	2.67***	0.64n.s.	1.94*	1.87*
Birth to conception Interval (months) <24 (ref ≥24)	1.05n.s.	0.86n.s.	0.82n.s.	0.77n.s.	1.01n.s.	1.06n.s.
Parity First child (ref >one child)	0.93n.s.	0.40****	0.56**	0.62n.s.	0.83n.s.	1.08n.s.
Biologic Variables						
IUGR Status IUGR (ref AGA)	1.60***	1.70***	2.19****	2.39**	1.82**	1.61**
Gender Girls (ref boys)	0.78*	0.83n.s.	1.02n.s.	0.62n.s.	1.19n.s.	1.31*
Prior Stunting Stunted (ref Not stunted)	5.38****	13.15****	19.84****	-	-	-
Prior Wasting Wasted (ref Not wasted)	-	-	-	16.80****	18.49****	7.25****
Feeding Practice						
Current status Not Breast fed (ref breast fed)	2.22***	1.79***	0.59n.s.	1.78n.s.	0.81n.s.	0.74n.s.
Previous status Not breast fed (ref breast fed)	2.56**	1.93***	1.20n.s.	1.23n.s.	0.75n.s.	0.84n.s.
Morbidity Status						
Diarrheal Episodes 2-3 (ref 0-1)	1.98***	0.86n.s.	1.62n.s.	n.a.	0.76n.s.	0.87n.s.
Otitis Media Episodes 2-3 (ref 0-1)	n.a.	1.81n.s.	0.70n.s.	n.a.	n.a.	1.42n.s.
LRTI Episodes 2-3 (ref 0-1)	1.37n.s.	1.81n.s.	n.a.	n.a.	3.71n.s.	n.a.

a Pucca = concrete wall and roof,
kutcha = concrete walls and roof or entire structure completely from wood, tin, asbestos or mud

b Piped = Tap in house
Not piped = Community tap

c Over = ≥6 persons per room
Adequate = <6 persons per room

d Primary = Includes illiterate and able to read and write categories

e Yes = Employed either inside or outside the house
No = House wife

n.a. Number in any cell ≤1

n.s. Non-significant

* p-value ≤0.10

** p-value ≤0.05

*** p-value ≤0.01

**** p-value ≤0.001

Table 3. Final logistic regression models for stunting and wasting at the reference ages, Karachi, Pakistan.

Risk Categories and Risk Factors	Stunting 6 months	Stunting 12 months	Stunting 24 months	Wasting 6 months	Wasting 12 months	Wasting 24 months
Socio-Economic						
Income per person						
Low (ref: Adequate)		1.57***				
House Construction						
Kutcha (ref: Pucca)					4.81****	1.78**
Water Supply						
Not Piped (ref: Piped)	1.87****	1.53***				
Maternal						
Education						
Primary						
(ref: Secondary)	1.54**	1.68**	2.73****			
Employment						
Yes (ref: No)					2.27**	
Weight (kgs)						
< 40 (ref: 40)			2.33**			
Parity						
First Child						
(ref: > One Child)		0.37****	0.52**			
Biologic Variables						
IUGR Status						
IUGR (ref: AGA)	1.53**	1.78***	2.17****	2.39**	1.78**	1.56**
Feeding Practice						
Current Status						
Non-Human milk						
(ref: Breastfed)	2.06**	2.04****				
Morbidity Status						
Diarrheal Episodes						
2 - 3 (ref: 0 - 1)				2.05***		

Until 12 months of age, provision of breast milk significantly reduced the odds of stunting by a factor of half for both bivariate and multivariate logistic regression models. The superior nutritional status of breast-fed children have also been reported from studies conducted in Chile[28]. Though we had included provision of semi-solids into our composite index for feeding patterns, the effect of breast milk on nutritional status was still maintained, thereby emphasizing the role of continuing breast feeding till 12 months even if the child is on solids.

It is important to note that in the chronic poverty-stricken milieu of the urban squatters, the dilution of nonhuman milk is well known. The significant increased risk of not breast feeding for stunting shown in our results maybe due to this effect. Empirical data to support this hypothesis is not available as we did not collect information on the nutrient content of either breast milk or non-human milk. However, the superior nutritional value of breast milk with regard to its nutrient content and protection against infectious diseases is well documented[29-31]. Surprisingly, breast feeding did not influence the odds of wasting at any of the reference ages. This could be explained by few children in the wasted category who are not breast fed as compared to those stunted.

At all three of our reference ages, a strong relationship was observed between IUGR status and stunting as well as wasting. Similar studies report either IUGR or low birth weight as predictors of stunting and wasting[5,32] (Tables 2 and 3). However, it is important to note that despite the sizeable effect of IUGR in the final logistic models for wasting and stunting, the excess risks due to socio-economic and environmental factors were not reduced. This relationship suggests that socio-economic and environmental factors have a direct effect on stunting and wasting over and above its indirect effect through IUGR, which we have earlier reported[13]. Similar findings have been reported from other developing and developed countries[5,7,33].

Birth intervals, maternal height, or maternal age did not remain in our final logistic regression models for either stunting or wasting (Table 3). This does not mean that these maternal variables do not have any influence on stunting and wasting but rather that these variables operate indirectly through IUGR. We have earlier demonstrated a strong association between these specific factors and IUGR[13]. However, conflicting evidence for a significant effect of birth intervals over and above that for low birth weight for stunting. has been reported by Ricci et al[5].

In conclusion, the strong and consistent association of IUGR for stunting and wasting adds to the growing body of evidence that by improving maternal health we will ultimately break the vicious cycle of mal-nourishment and improve the health and well-being of future generations. More specifically, we suggest potential applications for interventions to improve the nutritional status of Pakistani urban children living in squatter settlements focused on both mothers and children. Improvement of a mother's reproductive health can be achieved by intervention strategies on family planning to reduce family size and increase birth spacing, provision of appropriate antenatal care and dietary advice during pregnancy. Specific strategies to improve children's nutritional status is by promoting breast feeding and reducing the use of nonhuman milk especially during infancy. The current UNICEF strategy of establishing "Baby Friendly Hospitals" in the country where health education during pregnancy and in the immediate postpartum period for promoting breast feeding is a step in the right direction. Finally, the impact of socio-economic factors over and above that of IUOR reported in our study argues for long-term economic development plans to alleviate the chronic poverty in these settlements.

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