Dietary diversity and anthropometric status of 6–36 months old children of Mumbai city

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ABSTRACT

Background: Dietary diversity (DD) is an indicator of food security, accessibility, availability, and also a significant predictor of growth. Poor feeding practices are responsible for low DD which affects the nutritional status of child. **Objective:** The objective of the study was to assess the association of DD with nutritional status of urban slum children. **Methodology:** Data were collected using structured interview schedule on 823 children from 16 slums of western suburbs of Mumbai city. DD score was calculated using food frequency questionnaire as per Food and Agriculture Organization. Weight and height measurements of all children were taken using standard techniques, and nutritional status was assessed using Z scores in terms of wasting, stunting, and underweight as per the World Health Organization norms. **Results:** About 5.4% children were severely wasted, 10.2% children were severely underweight, and 24.7% children were severely stunted. About 22.1% children had low DD scores, 41.3% had scores indicating medium diversity, and 36.6% children had high scores for DD. Children who were severely undernourished, i.e. those whose Z scores were ≤3 tended to have lower DD scores than their better-nourished counterparts for all three nutritional status indicators - weight for height, weight for age, and height for age. **Conclusion:** DD plays an important role in improving the nutritional status of child. Therefore, there is need to educate mothers in terms of DD to improve nutritional status of children.

Key words: *Dietary diversity score, Stunting, Weight, Weight for age*

A high proportion of children in India are undernourished. The fourth National and Family Health Survey [1] indicated that 35.7% of Indian children under 5 years of age were underweight, 21.0% were wasted with 7.5% being severely wasted, and 38.4% were stunted. Young children under 2 years of age are highly vulnerable because they have relatively higher nutritional needs for their growth and development than older children in this age group. Good nutritional status depends on the provision of both macro- and micro-nutrients, through a wide variety of foods and diverse diets.

Dietary diversity (DD) is important as humans cannot obtain all the necessary nutrients from a single food. DD is also regarded as a pillar of food security, accessibility, availability, and utilization [2]. Moursi *et al.* conducted a study on 723 children in Madagascar, aged 6–23 months and observed that DD scores were positively correlated with mean micronutrient density adequacy [3]. Similarly, Potts *et al.* observed among American children that food variety was associated with nutrient adequacy [4].

DD has been established as a significant predictor of growth. More than a decade ago, Arimond *et al.* [5] highlighted the importance of DD in their analysis of demographic and health information for children aged 6–24 months in 11 countries in Africa and Latin America Rah and coworkers [6] observed in Bangladeshi children that reduced DD was strongly associated with stunting. Given the high prevalence of undernutrition in India, we aim to assess the feeding patterns, DD and its association with the nutritional status of urban slum children in Mumbai city. Mumbai city was chosen because the NFHS-4 report indicated that the percentage of stunting among slum children was 29.3%, 24.9% of children were wasted, and 30.7% were underweight. Furthermore, a report by the Society for Nutrition, Education and Health Action a voluntary organization, on approximately 1500 slum children indicated that about one-third of the children under 5 years of age had low weight for age, two-thirds (47%) had low height for age, and 17% had low weight for height [7].

METHODOLOGY

Sample Selection

A total of 823 children between 6 and 36 months were recruited from 16 slum areas located in the western suburbs of Mumbai city, after obtaining written informed consent from their mothers or main caregivers. All 16 slums were being looked after by two voluntary agencies, namely, Committed Communities Development Trust and the Centre for the Study of Social Change. A sampling frame was prepared including all children in the age group of interest, who were on the rolls of the government program Integrated Child Development Services and or included by the NGO for their services. Children were then selected by simple random sampling. The final sample consisted of 823 children whose mothers were willing to impart information. From these 823 children, the nutritional status assessment was possible for 461 children. Among the remaining 362, 41 mothers were not willing to have the nutritional status assessed, while the remaining was lost to follow-up because of outmigration due to various reason including slum demolition by Municipal authorities. This study was part of a larger study entitled "Development of shelf stable ready to use nutrient dense food mixes and nutrition education modules for reducing child undernutrition" supported by the Rajiv Gandhi Science and Technology Commission, Government of Maharashtra.

Ethical Approval

Before the start of the research, the project was approved by the Intersystem Biomedical Ethics Committee in June 2013.

Data were collected using a structured, pre-tested interview schedule. The interview schedule was finalized after testing and validation with 50 families who lived in other similar slums. These 50 families were not included in the study sample. General information about the child including name, age, and sex, and area of residence; family size and income were recorded. Age of the child was recorded from the child's birth certificate.

Assessment of DD

DD scores were calculated using 24 h diet recall as per Food and Agriculture Organization (FAO) (2010) [8]. The FAO tool has been developed for global use. It assesses inclusion of foodstuffs and ingredients not recipes consumption of seven food groups was considered: (1) Grains/roots/tubers, (2) legumes/nuts, (3) dairy, (4) flesh foods, (5) egg, (6) vitamin A rich fruits and vegetables, and (7) others fruits and vegetables. A score of 1 was assigned if a particular food group was consumed and 0 if it was not consumed. The scoring system was as follows:

6–8 months	9–11 months	More than 12 months
0–1 food group=0	0–2 food groups=0	0–2 food groups=0
2 food groups=1	3 food groups=1	3 food groups=1
3 or more food groups=2	4 or more food groups=2	4 or more food groups=2

Anthropometric Measurements

Weight and height measurements of all children were taken using the World Health Organization standard techniques [9]. Children were weighed on a digital weighing scale (Sknol T299) that was calibrated to the nearest 0.1 kg. Height was measured using a non-extensible, flexible measuring tape which was calibrated against a standard anthropometric rod, to a least count of 0.1 cm. Both measurements were taken 3 times, and the average of the three readings was calculated and used for further analysis. DD data were collected for all 823 children, but anthropometric measurements were available for only 461 children. Based on these measurements, Z scores for weight-for-age (WAZ), height-for-age (HAZ), and weight-for-height (WHZ) were calculated for 461 children to determine their nutritional status using the WHO's Anthro Plus software (2006 Version 1.0.4) [10].

Data were analyzed using the Statistical Package for the Social Sciences version 20, 2011. ANOVA, Student's *t*-test and Pearson's Chi-square test were performed, and significance was established at $p<0.05$.

RESULTS

Profile of Sample

Among 823 children, 53.9% were boys. More than half of the children (55.5%) were in the age group of 12–23.99 months, 41.9% of children belonging to the age group of 6–11.99 months, and 2.3% of children were in the age group of 24–36 months. Majority of the mothers (65.8%) were in the age group of 22–29 years. About 42.5% of mothers had completed their secondary school education. About 19.2% had completed their 10th standard, and a small percentage of mothers were graduates or postgraduates (Table 1).

Nutritional Status

A small percentage of the children (5.4%) were severely wasted, and about 10.2% were severely underweight. However, 24.7% children were severely stunted (Table 2). Almost 3.3% children were overweight and obese.

Table 1: Profile of sample

Profile of sample	n (%)
Maternal age (years)	
17–21	110 (13.3)
22–29	542 (65.8)
30–40	171 (20.7)
Age of child (months)	
6–11.99	344 (41.9)
12–23.99	456 (55.5)
24–36	19 (2.31)
Gender of child	
Male	444 (53.9)
Female	379 (46.1)
Breastfed children	
6–11.99 months	312 (45.4)
12–23.99 months	365 (53.1)
24–36 months	11 (1.5)
Non-breastfed children	
6–11.99 months	32 (24.4)
12–23.99 months	91 (69.5)
24–36 months	8 (6.1)

The percentage of boys with normal weight and height was more as compared to girls. Almost half (46.4%) of children had normal HAZ, with more boys than girls having normal HAZ.

More than half of children (60%) in the age group of 12–23.99 months were severely stunted and a slightly higher percentage of 6–11-month-old children were severely wasted. Although the number of 24–36-month-old children was very small, a higher percentage among them were severely malnourished, i.e., wasted, stunted, or underweight (Table 3).

DD Scores

The food groups consumed by the children and their DD scores are shown in Table 4. About 92.9% children consumed grains/roots and tubers and only 7.1% of the children were not given as they were not able to eat solid foods. About 16.2% children were not given legumes/nuts, and almost 28.4% children were not given dairy products including milk. Meat, fish, and eggs were given to approximately 5% of the children and vitamin A rich fruits or vegetables were given to only 2.4% children. About 66.5% children were not fed other vegetables.

About 22.1% children had low DD scores, 41.3% children had scores indicating medium diversity, and 36.6% children had scores indicating high DD. When examined by age group, although mean scores did not differ significantly between the three age groups (F=0.92, p=0.91), a significant difference was observed between the percentage of children in the three age groups with low, medium, and high DD scores (χ^2=18.951, p=0.01) (Table 5).

The mean DD score for boys did not differ (1.16±0.85) from that of girls (1.15±0.88). Furthermore, the percentage of children in the three categories of DD scores did not differ by gender (χ^2=3.470, p=0.841). Comparison of the percent distribution showed that 37.4% boys had high DD scores compared to 35.6% of girls. Approximately 21.6% had low DD scores, and 40.9% had medium DD scores. Among girls, 22.9% had low scores, and 19.1% and 41.4% had medium DD scores (Table 5).

Comparison by breastfeeding status indicated that breastfed children had higher DD scores than non-breastfed children in all three age groups, although it was statistically significant only in the 12–23.99 months age group. In the entire sample, 38.1% children aged 6–11.99 months were breastfed. Among these two-fifths (40.7%) of the children had high DD scores. In this age group, only 3.9% were not breastfed (Table 6).

In the 12–23.99 months age group, 80% (n=365) of the children were breastfed whereas the remaining 20% (n=91) were not. In this age group, a significantly higher percentage of non-breastfed children (42.9%) had DD score of 2, i.e., high DD compared to 30.7% of the breastfed children. The percentage of children with low DD scores was 22.5% for the breastfed children compared to only 8.8% of the non-breastfed children (χ^2=34.311, p=0.014). Among the oldest age group of 24–36 months, 11 children were breastfed and eight were not. There was a significant difference in the distribution of children with low, medium, and high DD scores in this age group (χ^2=45.371, p=0.134).

Table 2: Distribution of children by weight for height, height for age, and weight for age categories

Wasting: Weight for height (WHZ) (n=461)	Boys	Girls	Total
WHZ	**n (%)**	**n (%)**	**n (%)**
<−3 (Severely stunted)	16 (3.4)	9 (1.9)	25 (5.4)
−3 to−2 (Moderately stunted)	27 (5.8)	16 (3.4)	43 (9.3)
−1.99 to 1.99 (Mildly stunted)	183 (39.7)	174 (37.7)	357 (77.4)
>2 (Normal)	21 (4.5)	15 (3.2)	36 (7.8)
Stunting: Height for age (HAZ) (n=461)	**Boys**	**Girls**	**Total**
HAZ	**n (%)**	**n (%)**	**n (%)**
<−3 (Severely wasted)	62 (13.4)	52 (11.3)	114 (24.7)
−3 to−2 (Moderately wasted)	54 (11.7)	47 (10.2)	101 (21.9)
−1.99 to 1.99 (Mildly wasted)	116 (25.1)	98 (21.2)	214 (46.4)
>2 (Normal)	15 (3.2)	17 (3.7)	32 (6.9)
Underweight: Weight for age (WAZ) (n=461)	**Boys**	**Girls**	**Total**
WAZ	**n (%)**	**n (%)**	**n (%)**
<−3 (Severely underweight)	25 (24.7)	22 (4.8)	47 (10.2)
−3 to−2 (Moderately underweight)	61 (13.2)	35 (7.6)	96 (20.8)
−1.99 to 1.99 (Mildly underweight)	152 (33.8)	151 (32.7)	303 (65.7)
>2 (Normal)	9 (1.9)	6 (1.3)	15 (3.3)

Nutritional Status and DD scores

Mean Z scores for WAZ, HAZ, and WHZ were compared for children with low, medium, and high DD scores in the three age groups (Table 7).

Mean Z scores for WHZ did not differ among the three DD score categories in all three age groups. Similarly, mean Z scores for HAZ and WAZ did not differ significantly between the three DD score categories. However, Z scores for HAZ improved as DD scores increased in all three age groups, particularly in the 12–23.99 months and 24–36 months age groups. Likewise, this was seen in the mean Z scores for WAZ in the 12–23.99 months and 24–36-month-old age groups (Table 7).

Mean DD scores were also calculated by nutritional status Z score categories. Although there was no statistically significant difference, those with Z scores <3 had slightly lower mean DD scores as compared to those with Z scores >2. Children who were severely undernourished, i.e. those whose Z scores were ≤3 tended to have lower DD scores than their better-nourished counterparts for all three nutritional status indicators - WHZ, WAZ, and HAZ.

Multiple regression analysis was done using height as the dependent variable. Two models were tested: Model 1 - total DD scores as the constant and Model 2 - DD scores, vitamin A rich

Table 3: Comparison of nutritional status by age group (percent distribution)

Nutritional status (Z score categories)	Number of children	Age group (months)		
		6–11.99	12–23.99	24–36
Weight for height				
<−3	25	6.8 (11)	4.3 (12)	15.7 (3)
−2.99 to −2.0	43	12.3 (20)	7.1 (20)	15.7 (3)
−1.99 to 1.99	316	73.4 (119)	80.3 (225)	68.4 (13)
>2	41	7.4 (12)	8.2 (23)	0
All children	461	35.1 (162)	60.7 (280)	4.1 (19)
Height for age				
<–3	114	21.0 (34)	27.1 (76)	21.0 (4)
–2.99 to –2.0	101	19.1 (31)	24.3 (68)	10.5 (2)
–1.99 to 1.99	197	17.1 (79)	43.6 (122)	68.4 (13)
>2	17	11.1 (18)	5.0 (14)	0
All children	461	35.1 (162)	60.7 (280)	4.1 (19)
Weight for age				
<–3	47	9.9 (16)	10.0 (28)	15.9 (3)
–2.99 to –2.0	96	24.7 (40)	17.5 (49)	36.8 (7)
–1.99 to 1.99	289	62.3 (101)	69.3 (194)	42.1 (8)
>2	14	3.1 (5)	3.2 (9)	5.3 (1)
All children	461	35.1 (162)	60.7 (280)	4.1 (19)

( ) Numbers in parentheses represent number of children

Table 4: Percent children receiving different food groups and distribution by dietary diversity scores

	n (%)
Food groups consumed by children	
Grains/roots/tubers	761 (92.9)
Legumes/nuts	686 (83.8)
Dairy products	586 (71.6)
Flesh foods	33 (4.0)
Eggs	49 (6.1)
Vitamin A rich fruits and vegetables	20 (2.4)
Other fruits and vegetables	274 (33.5)
Dietary diversity	
0 (low dietary diversity)	181 (22.1)
1 (medium dietary diversity)	338 (41.3)
2–3 (high dietary diversity)	300 (36.6)

fruits and vegetables, flesh foods, eggs, grains roots and tubers, dairy, legumes and nuts, other fruits, and vegetable, as the constant. In the first model, the r value was 0.146, F=9.948, p=0.002. For the second model, the r value was 0.310, F=6.005, p=0.000. In the second model, grains, roots, and tubers were not significantly correlated (t=0.771, p=0.441). Similarly, there was no significant correlation with consumption of eggs (t=1.024, p=0.306) and vitamin A rich fruits and vegetables (t=0.497, p=0.620). However, legumes/nuts, flesh foods, dairy and other fruits, and vegetables were significantly correlated with height (legumes/nuts: T=3.082, p=0.002; dairy – t=5.232, p=0.000; flesh foods – t=2.147, p=0.032; other fruits and vegetables – t=4.536, p=0.000) (Table 8).

Table 5: Percent dietary diversity scores by gender

Dietary diversity score	Male (n=444) n (%)	Female (n=379) n (%)	n	χ^2, p value
Low	96 (11.7)	87 (10.6)	183	3.470
Medium	182 (22)	157 (19.1)	339	0.841
High	166 (20.2)	135 (16.4)	301	

Table 6: Dietary diversity scores by age group and breastfeeding status

Dietary diversity score	Age group (months)		
	6–11.99 (n=344)	12–23.99 (n=452)	24–36 (n=23)
0	48.1 (87)	49.7 (90)	48.3 (143)
1	33.7 (114)	63.6 (215)	31.8 (147)
2	48.3 (143)	2.7 (9)	2.1 (10)
Mean±SD	1.17±0.81	1.15±0.75	1.11±0.73
Min–Max	0–2	0–2	0–2
Breastfeeding status			
Breastfed	1.81±0.58 (312)	1.60±0.86 (365)	1.16±1.01 (11)
Non-breastfed	1.68±0.88 (32)	1.32±1.12 (91)	0.95±1.21 (8)
F value, *P* value	2.478, 0.116	1.691, 0.003	0.924, 0.090

SD: Standard deviation

Table 7: Mean Z scores for weight for age, height for age, and weight for height vis-à-vis DD scores

Age group	DD score	n	WHZ	HAZ	WAZ
6–11.99 months	Low	61	−0.2±1.9	−1.3±2.3	−1.0±2.2
	Medium	55	−0.8±2.7	−1.0±2.8	−1.4±1.8
	High	46	−0.3±1.8	−1.2±2.3	−1.0±1.4
F value, p value			1.220, 0.298	0.266, 0.767	0.776, 0.462
12–23.99 months	Low	61	−0.4±1.5	−2.2±1.9	−1.4±1.5
	Medium	126	−0.2±2.1	−1.9±2.0	−1.2±1.4
	High	93	−0.3±1.9	−1.6±2.4	−1.1±1.6
F, p value			0.164, 0.849	1.393, 0.250	0.851, 0.428
24–36 months	Low	4	−0.7±0.4	−2.8±1.4	−2.0±1.0
	Medium	9	−0.7±2.9	−1.8±0.9	−1.4±2.1
	High	6	−1.4±1.3	−1.1±1.9	−1.6±1.3
F value, p value			0.213, 0.810	1.640, 0.224	0.156, 0.857

DISCUSSION

Dietary indices enable a holistic evaluation of diets and are fairly easy to interpret [11]. In the present study, we observed that DD of a large proportion of children residing in the slums of Mumbai was poor. Furthermore, children who were undernourished especially those who had low HAZ tended to have lower DD scores. We also observed that diversity scores were lower for older children aged 12–23.99 months and that breastfed children tended to have better DD scores. HAZ Z scores showed a strong correlation with DD scores; however, mean Z scores did differ

Table 8: Mean DD scores by nutritional status category for the three indicators of nutritional status (WHZ, WAZ, HAZ)

Nutritional status indicator	Nutritional status category				F, p value
	<−3	−2.99 to −2.0	−1.99 to 1.99	>2	
Weight for height (WHZ)	1.04±0.79 (n=25)	1.05±0.64 (n=43)	1.02±0.76 (n=357)	1.22±0.76 (n=36)	0.740, 0.528
Weight for age (WAZ)	0.85±0.75 (n=47)	1.07±0.75 (n=96)	1.79±0.25 (n=303)	1.20±0.86 (n=15)	1.259, 0.288
Height for age (HAZ)	0.98±0.77 (n=114)	1.03±0.76 (n=101)	1.07±0.76 (n=214)	1.12±0.79 (n=32)	0.428, 0.733

significantly by DD score categories. Our findings are generally in line with the early report by Arimond and Rule [5] that in nine among 11 countries, DD was associated with HAZ Z scores for children aged 6–23 months. Saaka *et al.* [12] reported that among 6–23-month-old children in North Ghana, only one-third of the children received diets with minimum diversity scores, i.e., four or more food groups and that a composite score of more than one indicator was better associated with stunting. Our diet analysis showed that almost all children received grains, i.e., cereals which would provide small amounts of protein were not of good quality and 16.2% were not fed pulses which would complement the poor quality protein from the cereals. Almost 28.4% children did not receive dairy products, and very few, approximately 5% or less received vitamin A rich fruits and vegetables. About 66.5% children were not fed other vegetables. These findings indicate that mothers tend to feed mostly starchy grains with a small amount of dal, a liquid preparation made from pulses and very little of micronutrient containing foods. Similar observations were recently reported by Zhao *et al.* [13]. Recent studies from China showed that among "underserved" populations in developing countries, diets are largely starchy cereal-based and do not contain much animal products or fresh fruits and vegetables. Such diets are likely to be limited to essential amino acids/good quality protein and micronutrients that are vital for infant growth and development.

Kennedy *et al.* [14] had calculated DD scores using a minimum intake of 10 g from each food group for 24–71-month-old non-breastfed Filipino children. They observed that DD scores based on a simple count of food groups consumed, using the minimum 10 g intake as a criterion, were significant predictors of adequacy micronutrient intakes in these young children, although the latter criterion was a better indicator. Subsequently, Daniels *et al.* [15] reported that inclusion of 5–6 food groups in the diets was the best cut off points vis-à-vis achievement of or obtaining at least 50-75% adequate amount of micronutrients.

Further, Busert *et al.* [16] recently reported from their longitudinal study of a cohort of poor Nepalese children under 5 years of age, that DD was associated with conditional growth during the period of 69–89 months. Furthermore, increasing the DD by one food group was associated with a 0.09 cm increased in conditional growth in this period. In the present study, we found that breastfed children tended to have better DD scores as compared to non-breastfed children. Wright *et al.* [17] have observed that in the Cebu longitudinal study in the Philippines, regardless of the DD scores, breastfeeding was significantly associated with infant length as well as WAZ Z scores until the children were about 20 months of age. However, high DD scores did not confer much advantage in terms of Z scores for HAZ or WAZ. They also reported that in these infants, DD scores were only modestly correlated with nutrient intakes. The authors stated that DD scores may be useful as a qualitative measure for describing population trends in timing of introduction of complementary foods. They also highlighted that in the WHO method of calculating diversity scores, the differences in the contribution by certain food groups to infant nutrition are not taken into account, and equal weightage is given to each food group. This is a limitation that is also applicable to our study. Since Vitamin A rich fruits and vegetables are not consumed on a daily basis, this would not be reflected in our Food Frequency Questionnaire that was used to calculate DD scores. However, use of an FFQ with some weightages assigned might help to overcome the limitations of the method we have currently used.

Regression analysis done in the present study showed that height was correlated with intakes of legumes, dairy products, flesh foods, nuts and fruits, and vegetables, indicative of the importance of including good sources of protein and micronutrients as well as sources of non-nutrient bioactive compounds with health benefits. The results highlight the need for educating mothers and motivating them to feed these foods to their young children. Reinbott *et al.* [18] recently reported the results of a nutrition education program that promoted infant and young child feeding behavior in combination with an agriculture intervention on children's DD and nutritional status. Mean DD of children aged 0–23 months improved and particularly the consumption of provitamin A rich foods and other fruits and vegetables increased after the intervention. The authors did not observe much effect on the height-for-age Z-scores and stated that a longer period of intervention may be required to show effects on growth through "sustainable behavior change of age-appropriate infant feeding."

More recently, Kuchenbecker *et al.* [19] reported that nutrition intervention through community-based education had a positive though not statistically significant impact on HAZ Z scores of 6–23-month-old children in Malawi. They noted that child DD improved even in food insecure areas.

CONCLUSION

The results of present study indicate that DD plays an important role in maintaining intake of essential nutrients, especially for growing children. Proper efforts should be made for promotion of nutritional education. In India, nutritional education is provided through programs such as the Integrated Child Development Services and by voluntary agencies who undertake such activities among the urban, rural, and tribal populations.

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