

SUMMARY AND CONCLUSION

Background information

In the nineties of the last century data from the National Nutrition Monitoring Bureau showed that even in households where dietary intake of energy was adequate in adults (men and women) energy intake was inadequate in about 40% of preschool children. This was attributed to the poor infant and young child feeding and caring practices. India has entered the dual nutrition burden era: persistent undernutrition especially in children, and an increase in over-nutrition especially in adults are becoming public health problems, especially in urban areas even in low-income families. Data from NFHS 3 indicated that there were substantial intrafamily differences in the nutritional status of mothers and their under-five children. The objective of the present study was to assess the magnitude of differences in the nutritional status of under-five children, their mothers, and other members of the family and explore some of the factors responsible for the observed differences.

Study design

The present study was a community-based cross-sectional observational study. The study was conducted in the Anganwadi's of Neb Sarai, Lado Sarai, and Andheria Mor in South Delhi from 2015 to 2019. A complete door-to-door census had been carried out in 30 Anganwadi of 3 areas in South Delhi namely Neb Sarai, Lado Sarai, and Andheria Mor. Families with under-five children who were likely to stay in the locality for at least one year were identified. The details of the study were explained to these households and the Hindi version of the study information sheet was provided. One week later households were revisited; families who were willing to participate in the study were given the consent form.

Inclusion criteria

Family from the low- middle-income group, have at least one under-five child, are likely to continue to reside in the area for at least 1 year, and is willing to participate in the study.

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Families belonging to the high-income group, families without an under-five child, not likely to stay in the area for 1 year and not willing to participate in the study.

Individual consent was obtained from all adults willing to participate in the study. For all children under seven years consent was obtained from the parents, and for children in the age group, 7-18 years consent from the parent and assent to participate in the study from the child were obtained. All families with at least one under-five child who had consented to participate in the study were enrolled.

Material and methods

Socio-demographic details of the enrolled families with under five children were obtained in a uniform pre coded proforma.

The food security status of the family was assessed in a subsample of the families using the NSSO method and NNMB method

NSSO method: the number of foodstuffs purchased by the family and periodicity of the purchase (daily e.g milk), alternate days, or weekly (e.g fruits, vegetables), once a fortnight, or once a month (cereals, pulses oil, sugar, etc) for each of the major categories of foodstuffs were obtained and recorded. Actual amounts purchased and the period over which they were used were ascertained and consumption for each of the major foodstuffs/CU/Day was computed.

NNMB method: Data on foodstuffs used in cooking the family meals on the previous day using 24-hour dietary recall was collected. Actual amounts of foodstuffs used in cooking the meals for the family were ascertained and consumption for each of the major foodstuffs/CU/Day was computed.

A sub-sample of family data was collected on physical activity adults and school-age children using the 24-hour physical activity recall method. Time spent in various domains of activity duration of activity and intensity of activity (sedentary, moderate, or vigorous) was calculated.

In all enrolled families, anthropometric measurements were carried out on all available and willing under-five children, their mothers, and other family members.

The length was measured using an infantometer in infants and children who cannot stand erect. Height was measured in children and adults using wall mounted stature meter. Weight was measured using a digital balance (with an accuracy of 100g) in all

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family members including infants. BMI (BMI for age in children) was computed for all.

The nutritional status of all available members of the family was assessed and intrafamily differences between different members of the family were assessed.

Sample size An earlier NFI study on morbidity nutrition interactions in the same community showed that the least intra-family difference in nutritional status of 10% was seen in wasting between two under-five children in the same family. The sample size was calculated using a 10% difference in wasting in under-five children, a margin of error of 5% confidence level of 95%, and a design effect of 2. The sample size was 1000 children.

Results

Socio-demographic profile

The total number of households enrolled in the study was 5148. Analysis of data on the socio-demographic profile of households showed that the majority were nuclear families (58.5%). The percentage of fathers who had secondary school education was (74.1%) and mothers (56.3%). had. The majority of the fathers were semi-skilled workers (60.2%); 1/5th worked in white-collar jobs. The majority of women were homemakers (93.6%). Around 81.1 percent of households lived in brick-and-mortar buildings; 45.7% owned their houses; the rest were mostly migrant laborers who lived as tenants in one or two-room tenements. Piped water supply at home was available in 77.8% of households or the near vicinity and access to flush toilets either in their own home or shared with other households. Almost all used Liquefied Petroleum Gas (LPG) and stainless steel utensils for cooking. 96.8% of households owned a color TV, which was their main source of entertainment. The family income was sufficient to meet essential requirements of shelter, household possessions, education of children and health care. These families stated that they had adequate money to purchase food needed for the family and so considered that they were food secure. They lived in one or two room tenements in overcrowded unhygienic localities, because of urban housing constraints.

Composition of family

There were 5148 families with 6539 under-five children (some families had more than one under-five child), 5303 mothers (some mothers had more than one preschool child), 636 under-five fathers, 1288 other women (mostly grandmothers and aunts),

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465 other men (mostly grandfather and uncle). 734 children between the age group of 5-9 years and 376 children of 10-18 years.

Dietary Diversity

Dietary diversity was assessed by the food frequency questionnaire . Cereals were consumed every day(wheat >90% of days and rice on 50% of days). Pulses and legumes were consumed daily in about 50% of the households .Oil , milk and sugar were consumed daily almost by all the families. The data suggest that though cereal, oil sugar consumption of the families was adequate, the consumption of pulse, legume, was low. Roots and tuber (mainly potatoes and onions) were consumed almost daily. Consumption of other vegetables and green leafy vegetables was low both in terms of frequency and in quantity. Fruits except banana were not regularly consumed. Low consumption of the micronutrient rich vegetables and fruits might be reason for the widespread anaemia in this population Animal foods were consumed once or twice a month. The family cooked adequate amounts of animal food on the days when animal foods were cooked, but animal food consumption per capita per day was low because these foods were consumed infrequently.

Food security status of the family

Food frequency data indicated that cereals and roots and tubers (mainly onions and potatoes), other vegetables, milk and milk products, fats and oils, and sugar were consumed every day and that these families were food secure. The food security of the families was assessed using two methods. In the NSSO method, the number of foodstuffs purchased by the family and the frequency of purchase of the food (daily e.g milk), alternate days, weekly (e.g fruits, vegetables), once a fortnight, or once a month (cereals, pulses oil, sugar, etc) for each of the major categories of foodstuffs were obtained and tabulated. Actual amounts purchased and the period over which they were used were ascertained and consumption for each of the major foodstuffs/CU/Day was computed. In the NNMB method data on foodstuffs used in cooking the family meals on the previous day was obtained using 24-hour dietary recall. Actual amounts of foodstuffs used in cooking the meals for the family were ascertained and consumption for each of the major foodstuffs/CU/Day was computed. The data on the consumption of foodstuffs/CU/day calculated using NSSO and NNMB methods were compared with each other and also compared with the

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foodstuffs in a sample balanced diet (for sedentary men) provided in Nutrient requirements for Indians (2020) Indian food composition tables were used to compute the carbohydrate, protein, fat, and energy/CU/day from food group consumption/CU/day (by NSSO and NNMB methods). There was very good concordance between the carbohydrate, protein, fat, and energy consumption computed by NSSO and NNMB methods.

The mean energy consumption by both methods was lower than the EAR for the reference man (wt 65kg EAR 2110 Kcal/day) but higher than the EAR for the average Indian (wt 55kg EAR 1760 Kcal/day). About one-fourth of the families consumed ≥ 2110 Kcal/CU/day (EAR for energy for sedentary reference man); over 75% of the families consumed ≥ 1760 Kcal/CU/day (EAR for energy for sedentary average Indian).

Almost all households had ration cards and purchased subsidized food grain. The mothers stated that the income earned was usually sufficient to take care of their essential food, shelter, education, and health care needs. The families considered that they were food secure.

Physical activity

Physical activity was assessed using the 24-hour physical activity recall method in adults and children between 5-18 years. The 24 hour physical activity method of collecting information about physical activity by a trained nutritionist is time consuming but provided more detailed and accurate information about physical activity as compared to the widely used Across all ages and in both sexes physical activity in all domains was low and the lifestyle of all members was sedentary. Young women with small children spent more time in moderate physical activity as they were looking after household chores as well as looking after their children. Women 35 -40 and beyond, usually have either daughters or daughters-in-law who take care of the household chores and therefore were not physically active during any part of the day. As most transport and occupational domains were mechanized physical activity levels in men were low. Almost all activities were sedentary. None of the family members spent any time on moderate discretionary physical activity.

Nutritional status of children

The majority of the preschool children and their mothers and other women were at home and anthropometric assessment could be carried out during the first or second home visit majority of the children. The 5-18 years aged were not at home during the usual home visit; every effort was made to obtain anthropometric measurements in such children by repeated home visits at such times when they were likely to be at home. However, it was very difficult to get anthropometric measurements of the fathers and other men because they left home early in the morning and did not reach home till late in the evening. Despite repeated efforts, anthropometric measurements of the many fathers and other men in the family could not be obtained.

There was a progressive increase in mean height and weight in the three age groups. Mean BMI was similar in the 0-4 and 5-9 year groups but was substantially higher in the 10-18 year age group. This increase in BMI with age is due to the increase in muscle and fat mass in children as they become older. Similar trends in BMI with age have been reported in AHS CAB and DLHS 4.

Indian children are small-statured; their median height-for-age and weight-for-age are near -2SD of WHO standards for height-for-age and weight-for-age. However median BMI-for-age of Indian children is around -1SD WHO standards for BMI-for-age. This difference is seen in the mean z scores for height, weight, and BMI in children.

In all three age groups the mean HAZ, WAZ and BAZ were in the negative range. The negative mean z scores for height (range -1.5 to 0.9) and weight (-1.1. to -1.0) were higher as compared to the negative mean z scores for the BAZ (range -0.6 to -0.3). The differences in the mean HAZ, WAZ, and BAZ between 0-4 and 5-9 year children were statistically significant. The differences in the mean HAZ and BAZ between 0-4 and 10-18 year children were statistically significant. The difference in the mean HAZ between 5-9 and 10-18 year children was statistically significant.

The stunting rate was lowest in 5 to 9 years of age, lower in 10 to 18 years children, and highest in under five children. The differences in stunting rates between the 0-4 and 5-9 year children and the 0-4 and 10-18 year children were statistically significant, but the difference between the 5-9 and 10-18 year children was not statistically significant. The difference in the underweight rates between 0-4 year children and 5-9 year children was not statistically significant.

In the dual nutrition burden era, BMI for age is the most appropriate indicator for assessing the nutritional status of children, especially in countries like India with high

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stunting rates in children. The differences in wasting rates between 0-4, 5-9, and 10-18 year children as assessed by $BAZ < -2$ SD were not statistically significant. Over 80% of the under five children are normally nourished (BMI z score for age between -2SD and 2SD), about 10% are wasted and 5% are over-nourished.

If the criterion of $BAZ > 2SD$ for under five children and $BAZ > 1SD$ for 5-18 years children, the prevalence of overnutrition was higher in school-age children. When uniform criterion was used across age groups either BAZ of +1 or BAZ +2 ,this trend of substantially higher overnutrition in school-age children is not seen.

Nutritional status of the parents, other men, and women

In these food-secure families, about 10% of young women with young children were undernourished. The mean age of fathers was higher by five years compared to the mothers' age. Fathers were taller by 13.2 cm and heavier by 14.4 kg as compared to the mothers. Fathers had a higher mean BMI as compared to their mothers. The higher body weight and BMI in the fathers might in part be because they were older by five years and many of those whom we measured had sedentary jobs near home or were not working full time. Only 10.8 % of the mothers and 3.9% of the fathers were under-nourished. About half of the mothers and fathers were normally nourished. The prevalence of over-nutrition in fathers and mothers was high. 35.4% of the mothers and 49.8% of the fathers were over-nourished. With increasing age in women and completion of the family, there is a reduction in physical activity and energy requirements; however dietary energy intake remains unaltered, as a result, there was a creeping increase in weight and a steady sustained increase in overnutrition with increases of age in women. The mean BMI of other men and women was 26.1 kg/m² and 25 kg/m² respectively. The prevalence of over-nutrition in other women and other men was high (about 37.2% of the other women and 46.8% of men were over-nourished).

Intra-family differences in nutritional status

a) **Mother and their preschool children (6539 pairs)**- There was a gradient between maternal nutritional status as assessed by BMI and the nutritional status of the under-five child. Stunting, underweight, and wasting rates in children were highest when the mothers were undernourished and least when the mother was over-nourished.

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However, even when the mother was under-nourished less than one-fifth of the preschool children were wasted and over 80% were normally nourished. There was a gradient in stunting rates in children concerning maternal height tertiles suggesting that the height of the mother does have some impact on children's linear growth. Underweight and wasting rates in preschool children showed a clear gradient concerning maternal height.

b) Under-five children and father (636 pairs)- There was a small gradient between paternal BMI tertiles and height tertiles and increasing under-nutrition rates in children. However, even when fathers were in the top tertiles of either BMI or height, some of their children were stunted, underweight, and wasted. The relationship between the nutritional status of other women and men and under five children did not show any clear gradient.

c) Under-five children and other women (2054 pairs) - There were no significant trends in the nutritional status of the under-five children about the nutritional status of the other woman in the family. Irrespective of the fact the other woman was over-nourished or under-nourished majority of the preschool children were normally nourished if BMI for age was used as a method for assessing the nutritional status of the child

d)Under-five children and other men (670 pairs)- There were no significant trends in the nutritional status of the under-five children about the nutritional status of the other men in the family.

e) Elder and younger under-five children (1590 pairs)- In some families, there was more than one under-five child. In these families, the nutritional status of the younger child was compared with the nutritional status of the elder child. If the elder child was stunted, underweight, or wasted, the stunting, underweight, and wasting rates in the younger children were higher. All these differences were significant. However, the majority of the younger siblings of the undernourished elder siblings were normally nourished and the majority of the older siblings of the undernourished younger siblings were normally nourished

f) Under-five and 5-9 aged children (931 pairs)- If the 5-9 year aged child was stunted, underweight, or wasted, the prevalence of underweight, stunting, and wasting was higher in the 0-4 year sibling. These differences were statistically significant for

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WAZ and HAZ but not for BAZ. However, the majority of the younger siblings of the 5-9 year children were normally nourished

g) Under-five and 10-18 aged children (472 pairs)- If the elder sibling was stunted, underweight, or wasted, the prevalence of stunting, underweight, and wasting in the younger sibling was higher.

A comparison of the prevalence of undernutrition between children from the same family showed some interesting findings. Irrespective of the parameter (stunting, underweight, or wasting) or the age group (0-4, 5-9, or 10-18 years), if the elder sibling was stunted, underweight, or wasted, the prevalence of stunting, underweight and wasting in the younger sibling was higher. This is because the siblings share some of the major factors responsible for under-nutrition in children such as small parental stature, low parental weight, low dietary intake, and poor environmental sanitation. However, the majority of the younger siblings of under-nourished elder siblings were normally nourished and the majority of the elder siblings of under-nourished younger siblings were normally nourished.

Comparison of nutritional status of the adults in the family

a) Mother and father (636 pairs)- A comparison of the nutritional status of mothers and fathers (as assessed by BMI) shows that the prevalence of under-nutrition in fathers was higher if the mother was under-nourished. The prevalence of over-nutrition in fathers was higher if the mother was over-nourished. However, even if the mother was undernourished more than one-third of the fathers were over-nourished. Even when the mother was over-nourished about 2% of the fathers were under-nourished

b) Mother and other women (1689 pairs)- A comparison of the nutritional status of mothers and other women shows that under-nutrition rates in the other women were higher when the mother was undernourished; however, even when the mother was undernourished 42.1% of the other women in the family were overnourished. When the mother was normally nourished 45.1% of the other women were normally nourished and 47.9% of the other women were overnourished. If the mother was over-nourished, 62.1% of the other women were over-nourished. All these differences were large and significant

c) **Mother and other men (670 pairs)**- A comparison of the nutritional status of mothers and other Men (as assessed by BMI) shows that the prevalence of under-nutrition in other men was higher if the mother was normal-nourished. The prevalence of over-nutrition in other men was higher if the mother was over-nourished

Intrafamily differences in nutritional status

In almost all families, some members were undernourished, others normally nourished or overnourished in over 60% of families undernutrition, as assessed by one or more indicators of nutritional status, coexisted with overnutrition (as assessed by BMI for age in children and BMI in adults) one or more members of the family. Five decades ago poverty, food insecurity, and low dietary intake were the major factors responsible for the high undernutrition rate in all members of the family from poorer segments of the population. Most of the intervention programs aimed to identify families below the poverty line and

- providing them with employment to improve purchasing power,
- providing subsidized food to improve household food security
- providing health and nutrition services to the vulnerable groups of women and children in these families and
- providing food supplements to bridge the gap between energy intake and requirement to women and children through ICDS and Mid-day meal programs.

Over decades there has been a reduction in poverty and food insecurity at the national and household level. Access to health and nutrition services had improved considerably. To improve household food security, the National Food Security Act 2013 provides two-thirds of all citizens with highly subsidized food grains as an entitlement. In the last three decades, there had been a progressive increase in the mechanization of the activities in occupational, domestic, and transport domains and a concurrent steep decline in physical activity. Unaltered dietary intake and a steep reduction in physical activity had resulted in a substantial increase in overnutrition in adults among all segments of the population including the poor.

India has been undergoing socioeconomic, demographic, nutrition, and health transition. Currently, India is facing a dual nutrition burden of persistent high

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undernutrition rates in children and increasing overnutrition rates in adults, especially in women. As a result of this, there are substantial intrafamily differences in nutritional status between adults and children in the family, children in the family, and adults in the family. The present study was taken up to assess the magnitude of intrafamily differences in nutritional status and explore some of the factors responsible for the differences.

Almost all households had ration cards and purchased subsidized food grain. Income earned was usually sufficient to take care of their essential food, shelter, education, and health care needs. Men and women did not access health care unless they fell ill. Food frequency data indicated that cereals and roots and tubers (mainly onions and potatoes), other vegetables, milk and milk products, fats and oils, and sugar were consumed every day and that these families were food secure. There was good concordance between the NSSO and NNMB methods in terms of computed carbohydrate, protein, fat, and energy consumption/ CU/day. The energy intake/ CU/day computed using 24-hour dietary recall was lower by 210 Kcal as compared to the EAR of the sedentary reference man but higher by 140 Kcal when the EAR for average weight sedentary man was considered. The daily average amount computed from the purchased amount was low. In these food-secure families, continued habitual energy intake across age groups, and concurrent steep fall in physical activity in adults especially older adults is the major factor responsible for the sustained but progressive increase in overnutrition in adults, especially women.

Women tend to accept weight gain with increasing age as normal and seldom seek care. Nutrition and health education to all women on the importance of monitoring weight gain, early detection and effective management of overnutrition, and screening for hypertension and diabetes in women beyond 30 years of age and all overnourished women irrespective of age as a part of essential primary health care for early detection and management of overnutrition and non-communicable diseases can substantially decrease overnutrition and associated risk of NCD.

Maternal and paternal undernutrition and low height are associated with stunting in over 40% of children. As adult height is not alterable, it might not be possible to rapidly reduce stunting rates in preschool children. Even among the children of parents in the highest height tertile about one-fourth were stunted; this might be

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because undetected wasting led to growth retardation in children. Early detection and correction of wasting might bring about a reduction in stunting in children

In children across all the age groups prevalence of stunting and being under weigh was high, perhaps mainly because of the low birth weight and length and low parental stature, wasting rates were lower. Overnutrition rates across all three age groups were low if the same uniform cut-off of BAZ of +2SD was used. This was most probably due to the high nutrient requirements for growth during childhood and adolescence

In the current dual nutrition burden, children's prevalence stunting and underweight rates in preschool children continue to be high and one-fifth of the children were wasted but even now only 3.9 % of the under-five children are overnourished. Screening all under five children to detect those with wasting, providing the family with appropriate nutritional and health education and ensuring that the wasted children get a continued supply of food supplements, early detection and effective treatment of infections in children and monitoring improvement in nutritional status once in three months can result in a substantial reduction in wasting rates in children.

Data from NFHS 3 showed that there are substantial Intra family differences in nutritional status between the mother and her under-five children. Similar trends were seen in AHS CAB and DLHS 4. The mean HAZ was lower in the 5-9 year age group as compared to the 0-4 year and 10-18 year age groups. Rapid linear growth in under-five children and adolescents may be responsible for the observed differences. BMI for age is the most appropriate indicator for assessing the nutritional status of 0-18 year children. Data analysis from the present study using the WHO cut-off for defining overnutrition (BMI z score of $>+2SD$ in preschool and BMI z score of $>+1SD$ school-age children) showed that the prevalence of overnutrition was substantially higher in school-age children as compared to preschool children. However, the uniform criterion was used across age groups either BAZ of $>+1SD$ or BAZ of $>+2SD$, this trend of substantially higher overnutrition in school-age children is not seen.

A comparison of undernutrition rates in children from the same family showed some interesting findings. Irrespective of the parameter (stunting, underweight, or wasting) or the age group (under five, 5-9, or 10-18 years) the prevalence of undernutrition

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was higher in younger siblings of undernourished elder siblings. This is because they share some of the major factors responsible for undernutrition in children such as small parental stature and low dietary intake and poor environmental sanitation. However, the majority of the younger children were normally nourished even when the older sibling was undernourished.

Conclusion

A third of the children have stunted one-fifth were underweight. Stunting and being underweight appear to be mainly related to low birth weight and length and small parental stature. One-tenth of children have wasted prevalence of overnutrition in children is low

In the study families, about half of adults (men and women) are normally nourished; undernutrition rates are low (10%) and over-nutrition is a major problem (affecting nearly half the persons). In these food-secure families, low physical activity appears to be the major factor associated with overnutrition.

Nearly two third of the families had one or more normally nourished, undernourished over-nourished persons. In less than 1 % of the families, all persons of the family were undernourished or over-nourished.

Given the large intrafamily differences in nutritional status between the members of the family (both children and adults), it is essential to screen all members of the family, identify the person with under and overnutrition and initiate appropriate interventions.

The data from the present study showed that there are substantial differences in nutritional status between siblings in the same family .Though prevalence of undernutrition is higher in younger siblings whose elder siblings are undernourished , majority of the younger siblings whose elder siblings are undernourished are normally nourished .

It is imperative that all children in the family should be screened to ensure that under-nourished children are identified and appropriate intervention provided. The Govt of India protocol of community based management of undernutrition in under five

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children (October, 2023) envisages that all children will be screened for undernutrition, undernourished children will be provided with appropriate ICDS supplements and monitored. Effective implementation of this protocol may help in accelerating reduction in undernutrition.

In the context of dual nutrition burden in adults, there is a need screen all adult members of the family to identify and manage both under- and over-nutrition .Hypertension and diabetes occur at a younger age and at a lower BMI in Indians . Non communicable diseases are asymptomatic in their early stages; symptoms appear only when the complications set in.

Early detection of NCD by simple tests is possible in the health and wellness centres. All adults should also be screened for hypertension and diabetes in the health and wellness centres so that those with NCDs are identified in the early in the asymptomatic period and given appropriate care so that complications are prevented.