ORIGINAL RESEARCH ARTICLE

Baseline Nutritional Status of Mother-Child Dyads in Urban Slums: Pre-Intervention Analysis for a Nutrition Informatics Intervention

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ABSTRACT

Background: Urban slums are critical for public health intervention due to high population density, poor living conditions, and limited healthcare access. This study examines baseline nutritional and lifestyle patterns among mother-child dyads in the urban slums of Uttar Pradesh. The dyads were recruited for Nutritional Assessment and Intervention Kiosk (NAIK), a Population Health Informatics platform to address double burden of malnutrition.

Methodology: This cross-sectional, pre-intervention study involved 406 mother-child dyads with children aged 2-5 years. Data on socio-demographic variables, anthropometric measurements, nutrient intake and lifestyle patterns were collected. Descriptive statistics summarized baseline characteristics.

Results: The demographic profile showed predominantly low-income mothers with 43.34% without primary education. The mean ages of mothers and children were 33.98 ± 5.9 years and 46.91 ± 10.89 months, respectively. The waist-to-hip ratio was 0.92 ± 0.76 indicating cardiovascular risk factors with significant maternal obesity (47.78%). Education of the mother was found to be significantly associated with Mid Upper Arm Circumference (MUAC) of the child. The findings highlight the overnutrition in mothers and nutrient inadequacy in children, influenced by inadequate dietary intake and unhealthy lifestyle.

Conclusions: This paper will comprehensively overview baseline population status, setting the stage for further analysis and evaluation of the intervention.

Key-words: Double burden of malnutrition, Feeding and Dietary practices, Nutritional Assessment and Intervention Kiosk, Population Health Informatics, Nutrition Informatics

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INTRODUCTION

Urban slum areas are characterized by high population density, substandard housing, and limited access to basic services, which often contribute to poor health outcomes among residents. The nutritional status of mother-child dyads in these environments is particularly concerning, as it has significant implications for both maternal and child health. Malnutrition, encompassing both undernutrition and overnutrition, is a critical issue that affects millions of people worldwide, with urban slums representing a hotspot for such nutritional deficiencies due to socio-economic vulnerabilities.[1]

The district of Gautam Budh Nagar in Uttar Pradesh, India, has experienced rapid urbanization, leading to the proliferation of slum areas. These areas are characterized by poor living environment like inadequate sanitation, limited access to clean water, and poor health services, all of which contribute to adverse health outcomes and compounds to the quality of life of slum dwellers. Mothers and children in these communities are particularly vulnerable to mortality and morbidity specially malnutrition and its associated health risks.[2]

Nutritional status is a critical determinant of health and development in children and their mothers. For children, malnutrition during the early years of life can lead to stunted growth, impaired cognitive development, and increased susceptibility to infectious diseases.[3] For mothers, poor nutrition can result in adverse pregnancy outcomes, including low birth weight, preterm birth, and maternal mortality.[4] In urban slum settings, the diet of both mothers and children is often characterized by insufficient intake of essential nutrients, which exacerbates these health risks.[5]

In addition to nutritional parameters, lifestyle patterns, including physical activity, hygiene practices, and healthcare-seeking behavior, play a crucial role in determining health outcomes. Residents of urban slums often face numerous barriers to adopting healthy lifestyle practices. Limited space and resources can restrict opportunities for physical activity, while crowded living conditions can hinder proper hygiene practices.[6] Moreover, cultural beliefs and lack of awareness can affect healthcare-seeking behavior, further compromising health outcomes.[7]

The concept of the double burden of malnutrition, which refers to the coexistence of undernutrition and overnutrition within the same population, household, or individual, is increasingly recognized as a significant public health challenge globally, particularly in low- and middle-income countries.[8] This phenomenon is especially pronounced in urban slum settings where transitions in diet and lifestyle contribute to these forms of malnutrition.

Globally, the double burden of malnutrition has been observed in numerous countries undergoing rapid economic and nutritional transitions. For instance, in countries such as Brazil and Mexico, rising rates of obesity and non-communicable diseases (NCDs) coexist with persistent undernutrition in certain population groups.[9] In Sub-Saharan Africa, similar patterns have been documented, with urbanization driving shifts towards energy-dense diets and sedentary lifestyles, leading to an increase in overweight and obesity alongside undernutrition.[10]

India exemplifies the double burden of malnutrition, where traditional issues of undernutrition persist alongside a growing epidemic of overweight and obesity, particularly in urban areas.[11] Studies have highlighted that urban slum populations are particularly affected, with children and mothers showing high rates of stunting and wasting, as well as rising incidences of overweight and obesity.[12] For example, a study conducted in urban slums of Delhi found significant prevalence of both undernutrition and overnutrition among children and adults, indicating the complex interplay of socio-economic, environmental, and behavioral factors driving this dual burden.[13]

This study aims to provide a comprehensive analysis of the baseline nutritional status and lifestyle patterns of mother-child dyads in the urban slum areas of Gautam Budh Nagar District. By identifying the key nutritional needs and lifestyle challenges faced by these populations, this research will provide a comprehensive understanding of the recruited population to be enrolled in implementing a nutrition informatics intervention named NAIK (Nutritional Assessment and Intervention Kiosk). Pre-intervention analyses are essential for establishing a benchmark against which the effectiveness of the intervention in focus can be measured.[14]

The present baseline study assesses the nutritional status of mother-child dyads in the urban slum areas of Gautam Budh Nagar District. The study conducts the evaluation of lifestyle patterns related to diet, physical activity, and behavioural risk factors among the study population. Apart from identification of socio-economic factors that influence nutritional and lifestyle outcomes, the study also focusses on the developing recommendations for targeted interventions to address identified nutritional and lifestyle challenges.

METHODOLOGY

The study used a mixed-methods approach between April 2023 and January 2024. The qualitative study was done through semi-structured, face-to-face interviews with mothers. For the quantitative component, data was collected at baseline and after every 2 months for 6 months. The study is a pre–post quasi-experimental design study in urban slum areas of Gautam Budh Nagar District of Uttar Pradesh. The study was approved by the University Research Ethics Committee of DIT University, Uttarakhand, India (Protocol Number – DITU/UREC/2022/04/11) and

conducted in accordance with the ethical principles of the Declaration of Helsinki.[15]

Detailed sampling plans and data collection information are available in the study protocol paper on "Designing and evaluating a Nutritional Assessment and Intervention Kiosk for mother-child dyad to combat double burden of malnutrition".[16]

Recruitment of subjects: The samples were purposively selected to include children aged 2–5 years and their mothers living in urban slum areas of Gautam Budh Nagar District of Uttar Pradesh. Critically ill mother and child, pregnant women, lactating women, women with children (less than 2 Years; More than 5 Years), or women who did not give consent were excluded from the study. Including the safety margin of 25%, a final sample size of 406 child-mother pairs were recruited.

Tools and techniques: Data was collected from mothers (primary caregivers) in the selected locality through the online-based NAIK to assess and offer intervention. 406 subjects were included in the study who were explained about the objective of the study and informed consent (translated in Hindi) were taken from them before conducting a detailed personal interview.

An adapted questionnaire for this survey was developed using steps I and II of WHO STEPS questionnaire.[17]

All the core components of the questionnaire were incorporated. The questionnaire was designed in English, translated into the local language- Hindi, and was pre-tested for any translation errors.

Figure 1 depicts the different variables and parameters assessed in the baseline sample enrolled in NAIK. The core components of the questionnaire included the following key study variables:

Study Variables and Data Collection Method Summary

Socio-demographic Profile: Data on age, ethnicity, education level, marital and work status, household structure, and income were collected for mother-child pairs at enrolment.

Nutritional Status: Anthropometric assessments of child and mother pairs were conducted bi-monthly. Children's weight, height, and mid-upper arm circumference (MUAC) were measured; BMI and nutritional classifications (normal, moderate, severe malnutrition) were determined based on WHO standards. Mothers' height, weight, BMI, waist-hip ratio, and abdominal obesity status were also calculated.

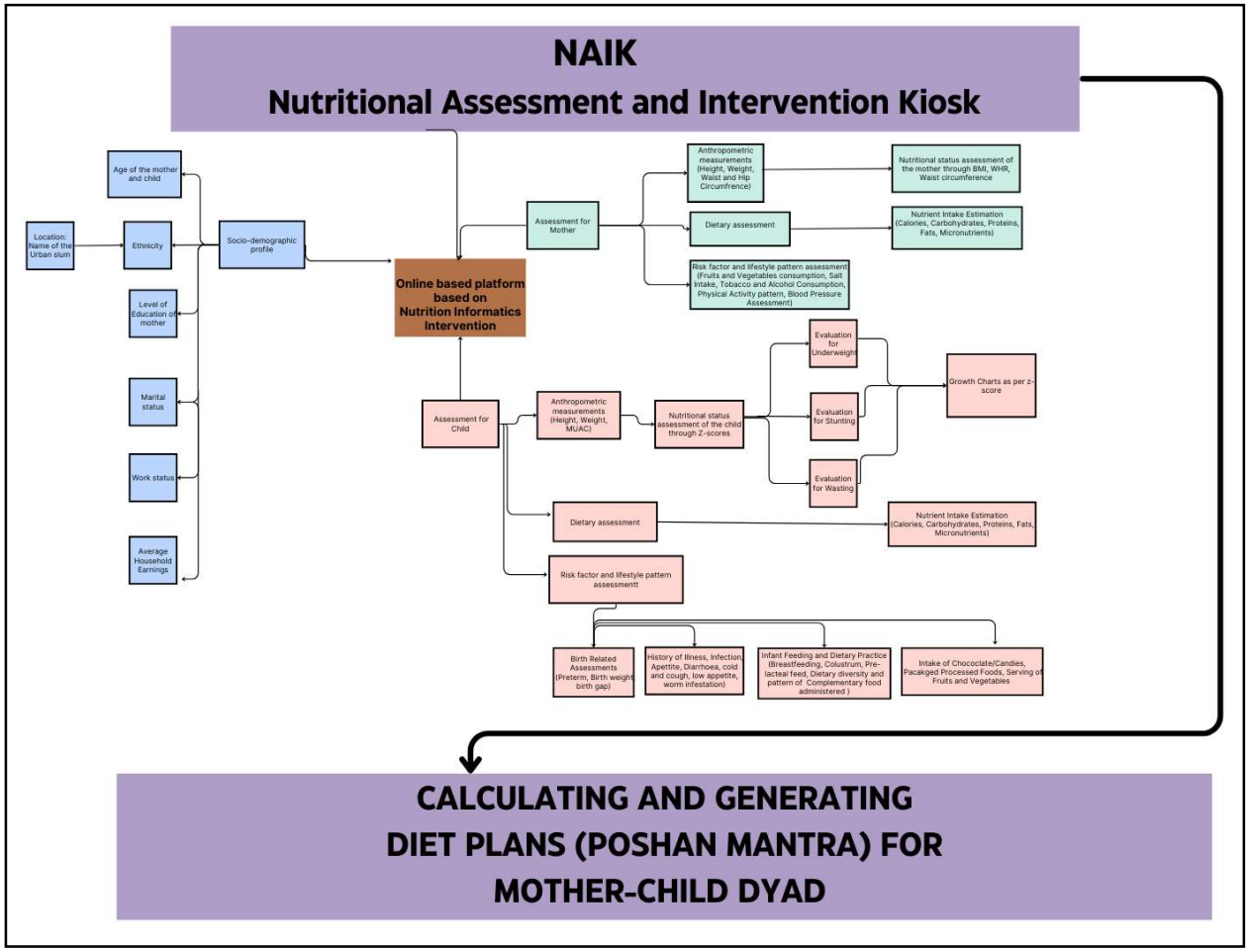

Figure 1: depicts the different variables and parameters assessed in the baseline sample enrolled in NAIK (Nutritional Assessment and Intervention Kiosk)

Nutrient and Food Intake Estimation: Using a 24-hour dietary recall over three non-consecutive days, nutrient intakes were computed via the NAIK software against Indian Food Composition standards. Daily intake was compared to the Recommended Dietary Allowances (2020) for both mother and child.

Risk Factor and Lifestyle Pattern Assessment: Behavioral and biological risk factors, such as tobacco and alcohol use, fruit and vegetable consumption, physical activity, and blood pressure, were recorded for mothers, with additional malnutrition risk factors noted for children.

Fruits and Vegetables Intake: Weekly intake frequency and servings of fruits and vegetables were measured, using specific serving sizes to standardize responses.

Physical Activity: The total time spent in physical activity per week was recorded based on WHO guidelines, assisting in activity factor calculation.

Blood Pressure Assessment: Blood pressure readings were taken using a digital device and compared with the Joint National Committee guidelines for adult classification.

Each of these variables was systematically recorded in the NAIK dashboard for ongoing assessment and intervention adjustments.

Data collection and management: Data were collected through structured questionnaires, anthropometric measurements, and nutrient intake assessments through the computer-based NAIK.

All the recorded data was stored in the maintained database required for monitoring and real-time planning purposes.

Statistical analysis: Statistical software SPSS was used. Continuous variables were summarised using means, medians, standard deviations, and ranges. For categorical variables, frequencies and percentages were calculated. Analysis was done using descriptive statistics and multivariate techniques.

Descriptive analysis was conducted to report the means and standard deviation of the continuous variables and frequency analysis on the categorical variables. The t-test were performed to compare means between the continuous variables and a categorical dependent variable, while chi-square analysis was performed for the categorical variables. All analyses were performed using SPSS, and the results were reported at 95% CI and $p < 0.05$.

RESULTS

The results of the study are tabulated in line with the objective of the study.

Demographic Profile of Mothers: Complete demographic detail of the target population i.e. mothers are presented in Table 1

Table 1: Demographic Details of Mothers (N=406)

Demographic Characteristics	Mothers (%)
Age Group (Years) (mean ± SD)	33.9±5.9
(20-30)	143 (35.22)
(31-40)	194 (47.78)
(41-50)	69 (16.99)
Education	
No formal schooling	56 (13.79)
Less than primary school	120 (29.55)
Primary school completed	127 (31.28)
Secondary school completed	38 (9.35)
High school completed	57 (14.03)
Graduated and above	8 (1.96)
Marital Status	
Divorced	4 (0.99)
Married	362 (89.2)
Separated	40 (9.85)
Main work Status	
Child care worker	33 (8.12)
Cook	92 (22.66)
Domestic worker	56 (13.79)
Others**	100 (24.62)
School maid	86 (21.18)
Vegetable & Fruit vendor	39 (9.6)
Adults In Household	
1	25 (6.16)
2	200 (49.3)
3	134 (33)
4	32 (7.88)
5-6	15 (3.69)
Socio economic status	
Lower Middle	292 (71.9)
Upper Middle	114 (28.1)

*In Table 1 under Ethnicity, Others includes the following Ethnicity (Frequency): Punjabi (4)

**In Table 1 under Main work Status, Others includes the following Work status (Frequency): Butcher (8), Engaged in animal husbandry (8), Fishmonger (4), Sweeper (9) and Others (71).

Table 2: Behavioural Risk Factor Measurement of Mothers (N=406)

Behavioural Measurement	Mothers (%)
Tobacco Consumption	
Currently smoking tobacco	38 (9.4)
Used tobacco in last 30 days	38 (9.4)
Used tobacco in past 12 months	43 (10.6)
Alcohol Use	
Ever consumed alcohol	21 (5.2)
Alcohol consumption in past 30 days	0 (0)
Alcohol consumption in past 12 months	9 (2.2)
Unhealthy Fruit & Veg. Consumption	
0-3 Servings	200 (49.26)
4 Servings	97 (23.89)
≥5 Servings	109 (26.84)
Salt Consumption	
Always	25 (6.16)
Never	138 (33.99)
Often	50 (12.32)
Rarely	87 (21.43)
Sometimes	106 (26.11)

Among 406 sample size, a total of 86.20% (n=350) mothers attended school. The mean age of the subjects was 33.9±5.9 years with most women being in 31-40 years category (47.78%). This study had a majority of population who belonged to Bihar (47.29%). Majority had attended primary school (31.28%) and 89.52% were married. The main work status of most of the subjects was that of a cook (22.66%). Majority of the subjects (49.3%) had 2 adult members in their household.

Behavioural Risk Factor of Mothers

Complete behavioural risk factor measurement of the target population is presented in Table 2

Table 2 depicts the behavioural risk factor measurement of mothers. It suggests that among the subjects 9.4% were currently smoking tobacco products and all of them used tobacco in the past 30 days whereas 10.6% consumed tobacco products in the past 12 months. Whereas 5.2% have consumed alcohol in their lifetime. Out of which 2.2% had it within the past 12 months but none of them consumed it within past 30 days. Hence no one was involved in heavy episodic drinking.

In a typical week on an average the study population were consuming fruits for 3.54 ± 1.64 days with range of 0 to 7 days. Regarding vegetables intake, all were having vegetables in a week. In a typical week, on an average they were having vegetables for 6.12 ± 1.0 days with range of 3 to 7 days.

All of the respondents were having unhealthy consumption of fruits and vegetables (less than 5 servings per day). The Mean ± SD intake of fruits and vegetables servings per day for the subjects was 3.33 ± 0.78.

Both moderate and vigorous intensity activities were recorded if done for at least 10 minutes continuously. None of the mothers were involved in any vigorous activities. Table 3 depicts the amount of time spent by subjects in moderate activities per week.

Whereas majority of the subjects i.e. 53.2% of them have spent the recommended 150 minutes per week doing moderate activities. Percentage of subjects engaged in moderate activities is more than those involved in vigorous activities.

As per data recorded as in Table 4 the mean total time in minutes per week spent by the subjects in doing moderate activities is 385 min per week which is more than twice the recommended time for moderate activity per week. Whereas the mean total time spent by subjects in vigorous activities is far less than recommended time for vigorous activities per week. Hence, the subjects of the study were leading a moderate lifestyle.

Anthropometric assessment of Mothers: Table 5 depicts the anthropometric measurements which were recorded. The table depicts Mean ± SD of height, weight, Body Mass Index (BMI) and Waist Hip Ratio (WHR) of the mothers.

Table 3: Distribution of sample based on time spent in moderate activities per week in their work (N=406)

Time Spent per Week for Moderate Activities	Mothers (%)
No time spent	190 (46.79)
1-149 minutes	0 (0)
150 and more minutes	216 (53.2)

Table 4: Mean time (min) spent in moderate and vigorous activities per week (N=406)

Activity	Mean time (min) spent by Subjects ± S.D.
Vigorous Activities	
Work	0
Recreational	3.54 ± 26.42
Total	3.54
Moderate Activities	
Work	112.90 ± 277.35
Recreational	30.29 ± 83.93
Travel: Walking/Cycling	242.58 ± 314.46
Total	385.77

Table 5: Mean ± SD of the Anthropometric measurements of mothers (N=406)

Variables	Mean ± SD
Height (cm)	158.64 ± 6.21
Weight (kg)	62.19 ± 9.48
BMI (Kg/m^2)	24.72 ± 3.58
WHR	0.92 ± 0.07
Blood Pressure (mmHg)	
Systolic Blood Pressure	127.30 ± 9.67
Diastolic Blood Pressure	86.24 ± 6.99

Nutritional Status Assessment of Mothers

Obesity and Overweight

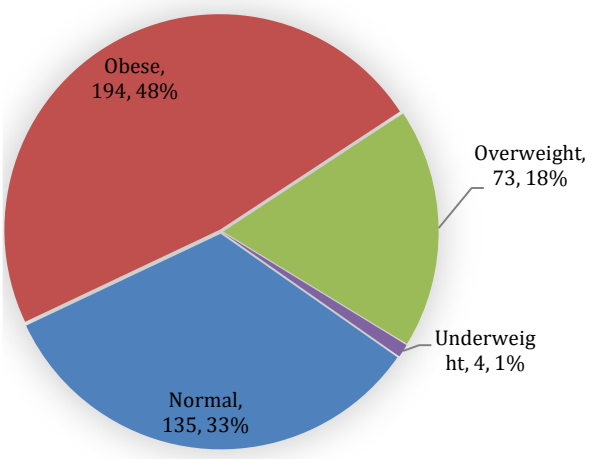

Figure 2: Nutritional Status of the mothers classified as per consensus guidelines for diagnosis of obesity in Asian Indians

Figure 2 depicts that among the subjects, 17.98% and 47.78% of the mothers were classified as overweight and obese with BMI as (23.0-24.9kg/m^2) and (≥ 25kg/m^2) respectively as per Consensus Guidelines for Diagnosis of Obesity in Asian Indians[18].

Maximum number of subjects of the target population were found to be in obese category. Mean BMI of the study population was 24.72 ± 3.58 kg/m^2 with range between 17.78 to 34.78 kg/m^2.

Abdominal Obesity: 82.75% of respondents were classified as having abdominal obesity with Waist–hip ratio ≥0.85 cm as per World Health Organization cut-off points.

Blood Pressure Assessment of Mothers: Table 5 represents the mean systolic and diastolic blood pressure. The values in the table indicates values higher than the standards given by Joint National Committee (JNC-8) for systolic as well as diastolic blood pressure. The classification of subjects as is depicted in Fig 3 is based on blood pressure assessment was compared by the standards given by JNC-8[19].

In Figure 3 Blood pressure assessment of the subjects revealed that majority of the subjects were into prehypertensive stage. (78.81% prehypertensive stage) and it was also found that 18 subjects (4.43%) were getting treated for hypertension.

Nutrient Intake Estimation: The study population was leading a moderate lifestyle as the physical activity assessment revealed that the mean total time taken by the subjects engaged in moderate activities was more than the WHO recommended 150 minutes per week. Daily nutrient intake by taking 24-hour dietary recall was analyzed and the Mean ± SD and adequacy of macronutrients and micronutrients consumed by the mothers have been presented in Table 6.

Mean ± SD for energy intake was 1786.48 ± 936.9 kcal/d which met adequacy of 83.8%. Also, upon recording the corelation coefficient between total energy intake by the mother and the waist circumference -the marker of abdominal obesity, it was found that p-value is 0.033 and Pearson correlation is 0.106 thus suggesting a strong positive relationship between waist circumference and energy intake by the mother.

The nutrient intake revealed inadequacy of iron, calcium and vitamin A meeting adequacy of only 38.62%, 31.03% and 23.17% respectively. 40.96 ± 36.75 g/d was the mean ± SD for protein which met adequacy of 89%. The dietary fibre average for the subjects was 24.96 ± 11.6 /d which was less than the recommended amount and met adequacy of 83.2 %.

The Wilcoxon Signed Rank Test indicated a significant difference in daily calories intake between mother and children (Z= -17.37, p<0.05) Similarly, Wilcoxon Signed Rank Test indicated a significant difference in carbohydrates (Z= -17.37, p<0.05) consumption and protein consumption (Z= -17.20, p<0.05) between mother and children.

As the p-value of Wilcoxon Signed Rank Test is 0.000 which is less than 5 % level of significance which means that median difference is positive and there is definite positive change between calories, carbohydrates and protein intake of mother and child with mother consuming more calories, carbohydrates and protein intake than their children.

Demographic Profile of Children: Complete demographic detail of the target population i.e. children are presented in Table 7.

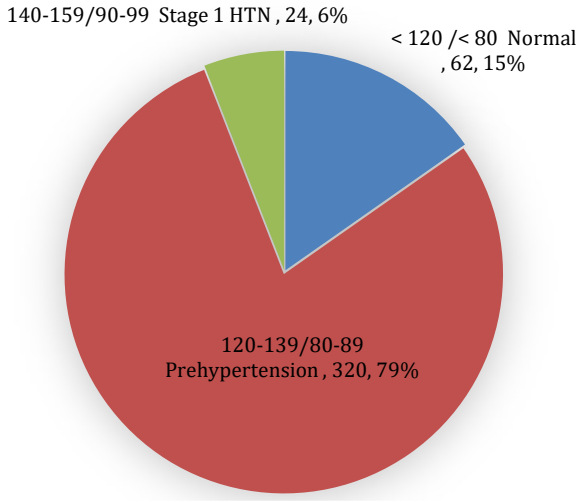

Figure 3: Classification of mothers based on Blood Pressure Assessment

Table 6: Mean ± SD and % adequacy of nutrient intake of the subjects (N=406)

Nutrient	RDA (ICMR-2020)	Mean±SD	% Adequacy
Energy (Kcal/d)**	2130	1786.48 ± 936.9	83.8
Proteins(g/d)*	46	40.96 ± 36.75	89.0
Total Fat (g/d)**	25	83.1 ± 48.8	332.4
Carbohydrate(g/d)**	(50-60%)	214.2 ± 106.7	-
%Calorie from CHO		(47.96%)	
Dietary Fibre(g/d)**	30	24.96 ± 11.6	83.2
Iron(mg/d)**	29	11.2 ± 6.07	38.62
Calcium(mg/d)**	1000	310.3 ± 199.3	31.03
Vitamin A(µg/d)**	840	194.7 ± 181.4	23.17

*Protein expressed as 0.83g protein per kg body weight of reference body weight per day
**Dietary Guidelines for Indians-ICMR 2020. Balanced diet for moderate adult women

Table 7: Demographic profile and risk factor related to children (N=406)

Demographic Characteristics	Frequency (%)
Age Group (Months)	(46.91 ± 10.89)
24-35 months	57 (14.03)
36-47 months	97 (23.89)
48-60 months	252 (62.06)
Gender of the child	
Boys	282 (69.46)
Girls	124 (30.54)
Pre-mature delivered children	
Yes	59 (14.53)
Birth weight in grams	
<2000	50 (12.32)
2000-2500	100 (24.63)
>2500	256 (63.05)
Order of the child	
1st born	294 (72.41)
2st born	95 (23.4)
3st born	17 (4.187)
Birth Gap	
1st Born	294 (72.41)
1 to 2 years	49 (12.07)
2 to 3 years	59 (14.53)
Less than 1 year	4 (0.98)
Colostrum Intake	369 (90.89)
Pre-Lacteal Feed Administered	175 (43.1)
Exclusive breastfeeding	
6 and more than 6 months	176 (43.35)
Less than 6 months	45 (11.08)
Upto 6 months	185 (45.57)
Recurrent Diarrhoea	12 (2.956)
Recurring cold & cough	20 (4.92)
Reduced appetite	20 (4.92)

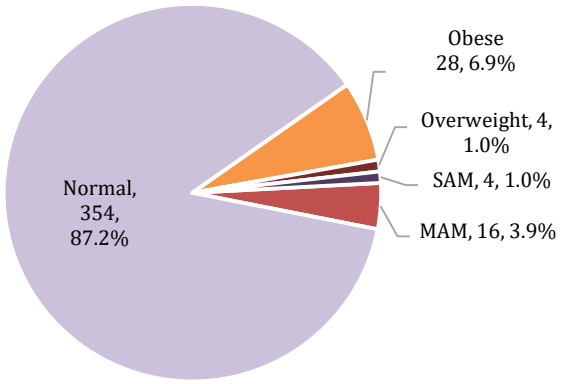

Figure 4: Nutritional Status as per weight-for-length/height of the children recruited in the study

Nutritional Status Assessment of Children: Out of 406 children, only 2.71% were found to be moderately malnourished. Whereas, to assess the nutritional status in the most accurate and sensitive method, growth monitoring was done. Thus, the risk of malnutrition was identified, providing scope for early prevention and action. While studying the WHO Growth Charts, children were classified as stunted, wasted, and underweight if the mean values were more than two standard deviations (SD).

While assessing the Length/height-for-age for children's nutritional status assessment it was recorded that only 1.23 % were stunted (n=5). In Weight-for-age assessment 2.71% (n=11) were underweight children.

Whereas as per figure 4, Weight-for-length/height 3.94% (n=16) were Moderate acute malnourished (MAM-Weight-for-length/height ≤–2 SD and ≥–3 SD of the median), 6.9% were obese (Weight-for-length/height >3 standard deviations (SD) of the median) and both overweight (Weight-for-length/height >2 SD and ≤3 SD of the median) and Severe acute malnourished (SAM-Weight-for-length/height <– 3 SD of the median) cases were found in 4 cases each (0.99%).

Also, as per statistical analysis it was recorded as the p-value of Pearson Chi-square (0.384) is 0.535 is more than 5% level of significance, there is no significant association between socioeconomic status of the mother and MUAC of the child. Out of 395 children having normal MUAC, 72.2% belonged from lower middle class whereas 27.8% hailed from upper-middle class.

Similarly, no significant association was established between weight-for-age, length/height-for-age and weight-for-length/height nutritional status assessment of the child and socioeconomic status of the mother.

But, education of the mother was found to be significantly associated with MUAC of the child as it was recorded that the p-value of Pearson Chi-square (15.23) is 0.018 is more than 5% level of significance. Out of 2.7% (n=11) malnourished children 36.4% belonged to mother with no formal schooling whereas no case of malnourishment was found for postgraduate degree holders and only one child was observed for a university completed mothers.

Feeding and Dietary Assessment of The Child

Breastfeeding Indicators

Exclusive Breastfeeding Under Six Months (EBF): It is advised that infants be breastfed exclusively until they are six months old according to the WHO Global Strategy for Infant and Young Child Feeding.[20] All across the world, exclusive breastfeeding is the safest and healthiest option for children. It ensures that infants have access to a food source that is safe, clean, healthy, and specially tailored to meet their needs. In the study, 185 children were exclusively breastfed for six months.

Continued Breastfeeding 12–23 Months (CBF): Children should continue to be breastfed for at least two years, according to the WHO Global Strategy for Infant and Young Child Feeding [20]. After one year, breast milk can provide a significant amount of the energy that a breastfed child needs for their diet. Breastfeeding should continue while a child is ill because, although they may not be hungry for solid

food, it can help prevent dehydration and provide the nutrients they need to heal.[21]

312 (76.8%) mothers administered breastfeeding along with complementary food items, out of which 248 mothers offered breastfeed, bottle feeds, meals and additional snacks to their child whereas 51 mothers gave breastfeed, bottle feeds and meals and 13 mothers were involved in frequent breastfeeding and meals.

Complementary Feeding Indicators

Introduction of Solid, Semi-Solid or Soft Foods 6–8 Months (ISSSF): The introduction of solid, semi-solid, and soft foods is advised to begin at six months of age, according to the WHO Global Strategy for Infant and Young Child Feeding[20]. The following are guiding principles for providing complementary feedings to a breastfed child:

When the child is six months old (180 days), introduce complementary foods while continuing to breastfeed.[20] After the first six months of life, infants' nutrient demands start to exceed. Unless solid foods are introduced, they will not be able to receive what breast milk alone can supply, making them susceptible to starvation.[22] In the study 271 (66.7%) mothers started the complementary feeding between 6-12 months and 103 (25.3%) mothers started in the range of 12-18 months.

As the p-value of Pearson Chi-square (21.87) is 0.039 which is less than 5% level of confidence which implies that there is significant association between introduction of complementary feeding and weight-for-length/height nutritional status assessment of the child.

Egg and/or Flesh Food Consumption 6–23 Months (EFF): The World Health Organization recommends that "meat, poultry, fish, or eggs should be eaten daily, or as often as possible"[23] in their guidelines for feeding breastfed and non-breastfed children. Research indicates that kids who eat meat and eggs have higher intakes of a number of different nutrients important for optimal linear growth. Egg consumption is linked to higher vitamin B12, vitamin D, phosphorus, selenium, protein, energy, and essential fatty acid intakes, and with a longer recumbent length.[24] Breastfed infants had higher intakes of zinc and protein when meat was introduced as an early complementary food.[25,26] Additionally, research shows that eating meat and eggs is uncommon in many different nations.[27] But, in the study as depicted in Table 8, 222 children (54.6) consumed egg and flesh foods. Following table 9 depicts the consumption pattern in eggs and poultry intake:

Unhealthy Food Consumption 6–23 Months (UFC): Dietary habits in many low- and middle-income nations are changing to include more added sugars, bad fats, salt, and refined carbohydrates. Food items that are prepared commercially are frequently high in salt, sugar, saturated and/or trans fatty acids, low in nutrients, and high in energy.

Table 8: Egg and poultry consumption patterns found in children (N=222)*

Eggs and Poultry Intake Pattern	Children (%)*
Egg	103 (46.4)
Egg, Chicken	70 (31.53)
Egg, Chicken, Fish	29 (13.06)
Egg, Chicken, Fish, Mutton	8 (3.60)
Egg, Chicken, Mutton	4 (1.80)
Egg, Fish	4 (1.80)
Mutton	4 (1.80)

*Out of 222 egg and poultry eating children

Table 9: Consumption of chocolate, junk food, fruits and vegetables found in children (N=406)

Intake of	Frequencies of intake by the child (%)
Chocolate/ candy	
Once a day	28 (6.9)
Twice a day	130 (32)
More than twice a day	62 (15.3)
Once a week	48 (11.8)
Twice a week	109 (26.8)
More than twice a week	20 (4.93)
Once a month	4 (0.99)
Rare	5 (1.23)
Packaged and Junk food	
Once a day	37 (9.11)
Twice a day	89 (21.9)
More than twice a day	49 (12.1)
Once a week	58 (14.3)
Twice a week	107 (26.4)
More than twice a week	49 (12.1)
Once a month	4 (0.99)
Twice a month	9 (2.22)
Never	4 (0.99)
Fruit	
Once a day	126 (31)
Twice a day	51 (12.6)
More than twice a day	16 (3.9)
Once a week	68 (16.7)
Twice a week	91 (22.4)
More than twice a week	45 (11.1)
Twice a month	9 (2.2)
Vegetable	
Once a day	23 (5.67)
Twice a day	275 (67.7)
More than twice a day	96 (23.6)
Once a week	4 (0.99)
Twice a week	4 (0.99)
More than twice a week	4 (0.99)

Table 10: Bottle feeding patterns found in children (N=406)

Bottle feeding age	Count of Bottle feed till which age (%)
Less than 6 months	26 (6.40)
6-12 months	91 (22.4)
12-18 months	168 (41.3)
18-24 months	68 (16.7)
More than 24 months	53 (13.05)

Eating habits that develop early in life continue into later childhood and adolescence. Throughout childhood, frequent exposure to sugary drinks and foods may strengthen the natural preference for sweetness

and subsequently lead to a rise in the intake of sweet-tasting drinks and food items as a potential acquired preference.[28,29] Such practices, if continued throughout. The risk of being overweight or obese can increase during adolescence and adulthood, as well as of associated long-term illnesses in later life. The indicator definition below refers to "sentinel unhealthy foods" like sweets, candies, chips, crisps, cheese puffs,) that are likely to be consumed by IYC and are high in sugar, salt and/or unhealthy fats.[30]

Following table i.e. table 9 depicts the consumption of chocolate and candies and about the frequency of using packaged and junk food.

Zero Vegetable or Fruit Consumption 6–23 Months (ZVF): According to the World Health Organization, consuming fewer fruits and vegetables is linked to a higher risk of noncommunicable diseases (NCDs). In 2017, 3.9 million deaths worldwide were attributed to low fruit and vegetable consumption, making it one of the top 10 risk factors for mortality worldwide.[31] While the majority of the data used in these statistics comes from adult populations, there is evidence that a child's early intake of fruits and vegetables is associated with a later low intake.[32] For every meal, the target age group should have one serving of vegetables, according to the American Academy of Paediatrics.[32] Although there is not a single, accepted recommendation for how many servings of fruits and vegetables should be consumed daily by infants older than six months, consuming none at all the day before symbolizes an unhealthy habit. Table 9 depicts the fruits and vegetable consumption among the children.

As the p-value of Pearson Chi-square (16.33) is 0.012 which is less than 5% level of confidence which implies that there is significant association between intake of fruits servings by the child and nutritional status assessment of the child via MUAC record.

Similarly, there is a significant association between weight-for-age, length/height-for-age and weight-for-length/height nutritional status assessment of the child and intake of fruits servings by the child.

Other Indicators

Bottle Feeding 0–23 Months (BoF): The World Health Organization advises against using feeding bottles since they can be a major source of pathogen transmission and are difficult to keep clean[23]. The best suckling behavior may be hampered by bottle feeding. The WHO advises against feeding bottles and in favor of cup feeding[23]. Following table 10 depicts the age till which bottle feeding continued:

Discussion

The findings highlight the overnutrition in mothers and inadequacy of nutrients in children, influenced by socio-economic factors, inadequate dietary intake, and unhealthy lifestyle behaviors.

The aim of this study was to assess the baseline nutritional parameters and lifestyle patterns among mother-child dyads in the urban slums of Uttar Pradesh, India, through the developed nutrition intervention which addresses the double burden of malnutrition. This comprehensive analysis provides a critical foundation for effective, context-specific interventions aimed at improving the health and nutritional status of this vulnerable population.

The results of this study demonstrated a high prevalence of overnutrition in mothers and inadequate nutrient intake in children. The high rates of abdominal obesity (82.75%) and prehypertension (78.81%) among mothers indicate significant health risks that warrant immediate public health attention. These conditions are exacerbated by insufficient intake of essential nutrients, such as iron, calcium, and vitamin A, which were well below recommended levels. Additionally, the positive correlation between total energy intake and waist circumference suggests that high-caloric diets consumed by mothers, often lacking essential nutrients, are contributing to abdominal obesity.

Previous research has consistently reported similar findings of malnutrition and poor dietary practices in urban slums, underscoring the need for targeted interventions.[33,34] This study builds on existing knowledge by providing detailed baseline data on the nutritional status and lifestyle patterns of mother-child dyads in urban slums, thus highlighting the critical areas for intervention.

The results from the study emphasize the need for increased awareness and education regarding proper nutrition and healthy lifestyle choices for both mothers and children, particularly in low-income and disadvantaged communities. The study findings also suggest that the prevalence of prolonged breastfeeding beyond 24 months is relatively low, at 13.05%, and may be influenced by factors such as cultural norms, maternal employment, and access to childcare services. Also, the prevalence of bottle feeding among children is a significant concern, particularly among those who are less than six months old. Furthermore, it appears that the duration of bottle feeding is negatively impacted by socio-economic factors, inadequate dietary intake, and unhealthy lifestyle behaviors, which may contribute to the issue of overnutrition in mothers and inadequate nutrient intake in children.

Addressing the double burden of malnutrition in urban slums is vital for improving public health outcomes and reducing healthcare costs, particularly in low-income settings. Effective interventions targeting both overnutrition and undernutrition can significantly enhance the health and wellbeing of these populations. The double burden of malnutrition has far-reaching implications, including increased susceptibility to infectious diseases, impaired cognitive development in children, and a higher risk of chronic diseases in adults.

This study is unique in its focus on the urban slums of Uttar Pradesh, India, and the use of a Population Health Informatics Platform to address the double burden of malnutrition. While other studies have explored malnutrition in urban slums, our study provides a comprehensive analysis using advanced informatics tools to gather and interpret data. This novel approach allows for more precise and actionable insights, which are crucial for designing effective interventions.

The findings of this study contradict the common perception that malnutrition is predominantly a rural issue. Our results clearly indicate that malnutrition is also a significant problem in urban slums, highlighting the need for targeted interventions in these areas. This urban focus is essential as it addresses a gap in the existing literature and provides evidence that urban populations are equally vulnerable to malnutrition-related health issues.

The data collected through structured questionnaires, anthropometric measurements, and nutrient intake assessments provide robust evidence supporting the findings of this study. The significant correlations between maternal education and child nutritional status, as well as the associations between dietary practices and health outcomes, reinforce the necessity for targeted interventions.[35] The comprehensive nature of the data ensures that the findings are reliable and can be used to inform policy and program development.

This study provides crucial insights into the baseline nutritional status and lifestyle patterns of mother-child dyads in urban slums, setting the stage for further analysis and evaluation of targeted interventions. The detailed demographic, dietary, and health data collected form a solid foundation for future research and intervention planning. The study's findings can help in tailoring interventions that are culturally appropriate and context-specific, thereby increasing the likelihood of their success.

The findings of this study have important implications for the development of targeted interventions to address the double burden of malnutrition in urban slums, particularly in low-income settings. Effective interventions should focus on improving access to nutritious foods: Ensuring that affordable and healthy food options are available in urban slums; promoting physical activity: Encouraging regular physical activity through community-based programs; and providing education on healthy feeding practices and lifestyle choices: Empowering mothers with knowledge about nutrition and healthy living.

By addressing these factors, it is possible to improve the overall health and well-being of mother-child dyads in these underserved communities.

Strength and Limitations

The findings of this study should be interpreted with caution due to the limited sample size of 406 mother-child dyads and the fact that the study was conducted only in one district of Uttar Pradesh, India. These limitations may affect the generalizability of the findings to other urban slums or regions. Future research should aim to include larger and more diverse samples to validate and extend these findings.

The use of a Population Health Informatics Platform to address the double burden of malnutrition in urban slums is a novel approach that has not been previously reported in the literature. This innovative method allows for comprehensive data collection and analysis, facilitating targeted and effective intervention planning. The integration of informatics in public health research provides a new dimension to understanding and addressing complex health issues.

The study is limited by the small sample size and the fact that it is conducted only in one district in Uttar Pradesh, India, which limits the generalizability of the findings. Additionally, the cross-sectional nature of the study means that causality cannot be established. Future studies should consider longitudinal designs to better understand the causal relationships between socio-economic factors, dietary practices, and health outcomes.

Conclusion

In conclusion, the findings of this study provide crucial insights into the nutritional status and lifestyle patterns of mother-child dyads in urban slums of Uttar Pradesh, highlighting the need for targeted interventions to address the double burden of malnutrition. The study's findings reveal a complex scenario of malnutrition and unhealthy lifestyle practices among mother-child dyads in urban slums of Uttar Pradesh. These findings underscore the need for multi-faceted and culturally appropriate interventions to address the overlapping issues of undernutrition and obesity prevalent in this population. Such interventions should aim to improve access to nutritious foods: Enhancing the availability and affordability of healthy food options in urban slums; to promote physical activity: Developing community-based programs to encourage regular exercise; and to provide education on healthy feeding practices and lifestyle choices: Implementing educational programs to empower mothers with knowledge and skills to make healthier choices.

By addressing these factors, it is possible to improve the overall health and well-being of mother-child dyads in these underserved communities.

Recommendations

Future research can explore the effectiveness of interventions aimed at improving nutritional outcomes and reducing malnutrition in this vulnerable popula-

tion. Longitudinal studies could provide more comprehensive insights into the long-term effects of these interventions and help refine strategies to combat the double burden of malnutrition. Additionally, exploring the integration of informatics tools in public health interventions could provide valuable data to further enhance the effectiveness of these programs.

AVAILABILITY OF DATA

The data that support the findings of this study are not openly available due to reasons of sensitivity and are available from the corresponding author upon reasonable request.

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