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Exploring the Determinants of Minimum Dietary Diversity in Infants and Toddlers: Insights from Pakistan's Rural and Urban Populations

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ABSTRACT

Determinants of Minimum Dietary Diversity (MDD) in infants and toddlers in rural and urban populations in Pakistan are explored in this study. MDD (consumption of foods from at least 4 food groups in 24 hours) is a marker of dietary quality and nutritional status. Selected rural and urban areas of Punjab were surveyed in a cross-sectional survey, including 600 infants and toddlers 5-20 months of age, and their primary caregivers. Structured surveys were used to collect data on dietary intake, socioeconomic factors, healthcare access, and food security. A total of 25% of children met the MDD criteria, with a significant difference of 48% in urban areas and 28% in rural areas ($p < 0.001$). Through multivariate logistic regression, it was found that several key determinants of MDD include maternal education (AOR: 2.4), household wealth (AOR: 3.1), market access (AOR: 2.7), healthcare utilization (AOR: 1.9), and food insecurity (AOR: 0.6). There were rural–urban disparities in maternal education and wealth as well as net access to markets. By contrast, rural children had less than half the consumption of fruits and protein-rich foods. The results suggest the importance of socioeconomic and infrastructural factors in explaining dietary diversity. Determinants of minimum dietary diversity (MDD) in Pakistan among infants and toddlers are examined in this study with emphasis on differences in these populations living in rural versus urban areas in Pakistan. Children living in urban areas have greater maternal education, wealth, and more access to healthcare and markets compared to children living in rural areas who suffer from food insecurity and socioeconomic challenges. Maternal education can be strengthened, market access increased, and structural inequalities addressed, contributing to increased dietary diversity and better nutrition and health outcomes for all children.

INTRODUCTION

Minimum Dietary Diversity (MDD) is an important indicator of infant and toddler dietary quality and nutrition status (Ativor & Salu, 2023; Atosona et al., 2024). MDD is defined by Jenkins et al. (2024); Rotella et al. 2024 as the consumption of foods from at least four different food groups within a 24-hour period; it serves a proxy for assessing the adequacy in the child's diet with its proximate link to his general wellbeing and development. Good growth, cognitive development, and reduced risk of malnutrition and micronutrient deficiencies in infancy and toddlerhood are linked to adequate dietary diversity at these ages (Qin et al., 2024; Russell et al., 2022). In low- and middle-income countries (LMICs) like Pakistan, however, a large percentage of infants and toddlers do not achieve the recommended dietary diversity, which is a serious public health concern (Islam, Nayan, Jubayer, Amin, & Nutrition, 2024; Paulo et al., 2024).

The setting in Pakistan with its cultural and socioeconomic diversity provides a realm where the determinants of MDD (Qamar et al) can be explored. The country's rural and urban populations have very large differences in resources accessibility, healthcare, education and potential impact on infant and toddler nutrition (Aqib & Development, 2023). In Pakistan, rural areas are typically afflicted by poverty, poor access to markets and no nutritional education that hampers dietary diversity (Haq et al, 2022). However, while urban populations may have better access to more diverse

foods, they are also exposed to a whole range of new dietary challenges including processed food consumption and changing lifestyle habits (De Bruin & Holleman, 2023).

Various factors have been identified to influence MDD in young children including maternal education, household wealth, food availability, cultural practices and access to healthcare (Haque et al., 2024; Roba et al., 2024). For example, maternal education affects the pattern of intake of infants and toddlers: educated mothers would be more likely to offer meals rich in nutrients (Kawecka and Kostecka, 2024; Kebede et al., 2022). Beyond food, household wealth helps influence MDD because access to a variety of nutritious foods is impacted (Ali, 2023, Ravikumar, Spyreli, Woodside, McKinley, & Kelly, 2022) as food insecurity often leads to monotonous, poor quality diets. In addition, dietary diversity is also influenced by the availability of child health services and nutritional counseling, which is much lower in rural compared to urban areas, and thus healthcare infrastructure (Beressa, Whiting, & Belachew, 2024; Nguyen et al., 2023).

The objective of this study is to understand the determinants of MDD in infants and toddlers residing in Pakistan both in rural and urban populations. This research will examine the factors influencing dietary diversity and suggest appropriate interventions based on nutritional challenge faced by families under different settings. MDD in early life is important for long-term health outcomes, therefore, understanding the barriers and facilitators to achieving adequate dietary diversity in early childhood is crucial to improving the public health in Pakistan and other LMICs.

METHODOLOGY

Study Design

It employed a cross-sectional method using quantitative data collection methods. Thorough assessment of determinants of minimum dietary diversity (MDD) in infants and toddlers in Pakistan across rural and urban settings was enabled by the design.

Study Setting

The study was carried out in the selected rural and urban areas of Pakistan, particularly Punjab. Varying socioeconomic and cultural contexts were captured through two districts. Two metropolitan cities were chosen to represent urban areas and rural districts to capture insights from less developed settings.

Study Population

Infants and toddlers between 5 and 20 months (and those they were most commonly fed by) comprised the study population: mothers, fathers, other family members who were primary caregivers and feed the infant most frequently. Infants and toddlers within the specified age range (1 to 6 years) residing in the study area and with caregivers living in the area for 6 months or more with repeated minimal using informed consent. Infants and toddlers with history of chronic illnesses or conditions that might compromise eating were excluded, and caregivers were excluded if they were unable to provide complete information as a result of cognitive, language, or other barriers.

They collected quantitative data through face to face administered structured surveys conducted by trained data collectors over a period of three months. A 24 hour dietary recall method was used to collect dietary intake data in terms of food groups eaten following the World Health Organization (WHO) guidelines for minimum dietary diversity (MDD) for infants and toddlers. Also collected were socioeconomic factors such as household income, caregiver education levels and employment status, as well as information on access to food and markets. Further, data were collected on healthcare access—child health visits and immunizations. Electronic tools were used to capture all data to reduce errors and avoid data security.

The technique used was multistage sampling which involved the random selection of districts from the rural and urban areas, then stratified random selection of villages (rural) and neighborhoods (urban) followed by systematic sample selection from randomly selected households from selected sites. A sample size was determined using MDD estimated prevalence within similar populations with design effects and non-response rates. Descriptive statistics and multivariate logistic regression were used for data analysis and AORs and 95% confidence intervals were presented to describe key risk factors associated with MDD.

Ethical Considerations

The study adhered to ethical guidelines for human research. Informed consent was secured from all participants, ensuring voluntary participation. Participant confidentiality and data anonymity were strictly maintained.

Limitations

The cross-sectional design captured a snapshot of determinants but did not establish causality. Additionally, caregiver-reported dietary intake may have been subject to recall bias.

RESULTS

A total of 600 infants and toddlers aged 5–20 months and their caregivers were included in the study, with 300 participants each from rural and urban areas of Punjab, Pakistan. The mean age of the children was 12.3 months (SD ± 4.1 months), with 52% being male. Caregivers' mean age was 29.5 years (SD ± 5.8 years), and 63% were mothers.

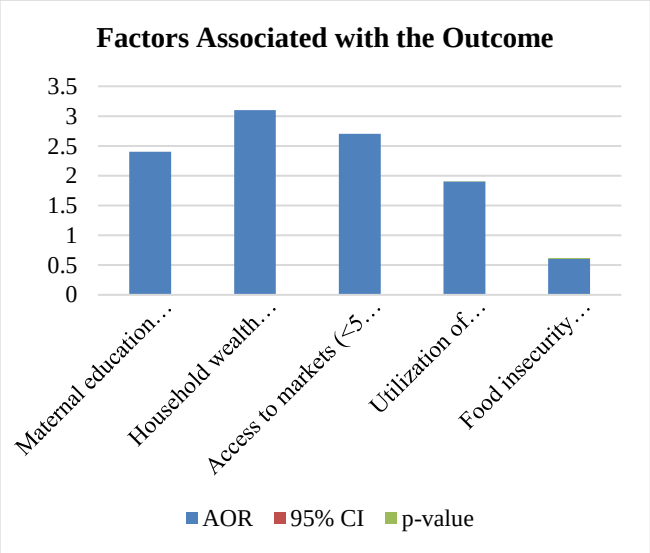
Overall, 38% of the children achieved the minimum dietary diversity (MDD). Urban areas showed a

significantly higher proportion of children meeting MDD (48%) compared to rural areas (28%) ($p < 0.001$).

Multivariate logistic regression analysis identified several significant determinants of achieving MDD:

Variable	AOR	95% CI	p-value
Maternal education (≥Secondary)	2.4	1.8–3.2	<0.001
Household wealth (Quintile 4/5)	3.1	2.1–4.6	<0.001
Access to markets (<5 km)	2.7	1.9–3.8	<0.001
Utilization of healthcare services	1.9	1.4–2.6	0.002
Food insecurity (Moderate/Severe)	0.6	0.4–0.9	0.016

Figure 1



Socioeconomic Disparities

The study revealed notable differences in key socioeconomic factors between urban and rural households. Maternal education levels were higher among urban caregivers, with 68% having completed secondary education, compared to only 34% of rural caregivers. Household wealth also differed significantly, as a higher proportion of urban households fell into the top two wealth quintiles, with 56% in urban areas compared to just 22% in rural areas. Additionally, market access was notably better for urban households, with 74% reporting access to food markets within 5 kilometers of their homes, while only 38% of rural households had similar access. These disparities highlight the impact of socioeconomic factors on the resources and opportunities available to caregivers in different settings.

Food Group Consumption Patterns

Grains (98%) and dairy products (85%) were the most commonly consumed food groups among all participants. However, rural children consumed less fruits (22% vs. 41%, $p < 0.01$) and protein rich foods (18% vs. 37%, $p < 0.01$).

Table 1

Demographic and Socioeconomic Characteristics

Characteristic	Overall (n=600)	Rural (n=300)	Urban (n=300)	p-value
Mean child age (months)	12.3 (±4.1)	12.7 (±4.3)	11.9 (±3.9)	0.042
Male children (%)	52	54	50	0.328
Caregivers with secondary education (%)	51	34	68	<0.001
Households in wealth quintile 4/5 (%)	39	22	56	<0.001
Market access within 5 km (%)	56	38	74	<0.001

Figure 2

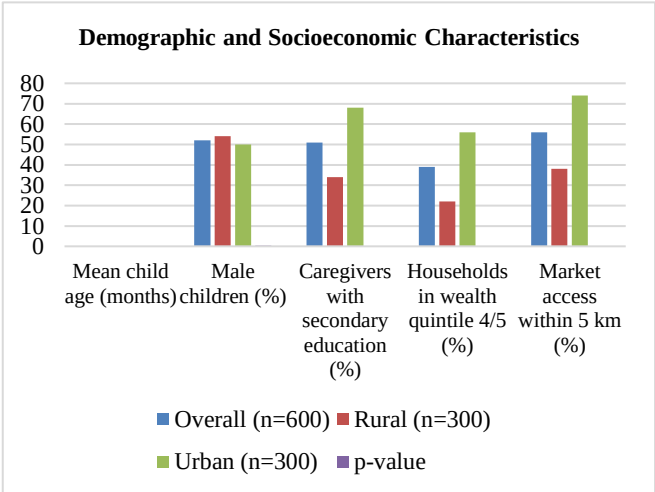


Table 2

Determinants of Minimum Dietary Diversity (Multivariate Logistic Regression)

Variable	AOR	95% CI	p-value
Maternal education (≥Secondary)	2.4	1.8–3.2	<0.001
Household wealth (Quintile 4/5)	3.1	2.1–4.6	<0.001
Access to markets (<5 km)	2.7	1.9–3.8	<0.001
Utilization of healthcare services	1.9	1.4–2.6	0.002
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Figure 3

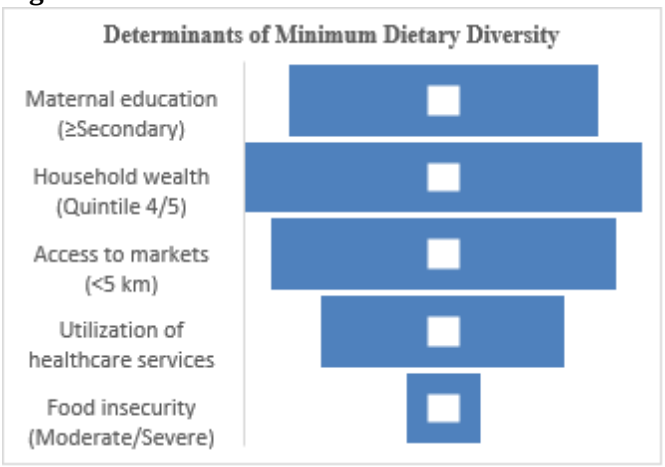
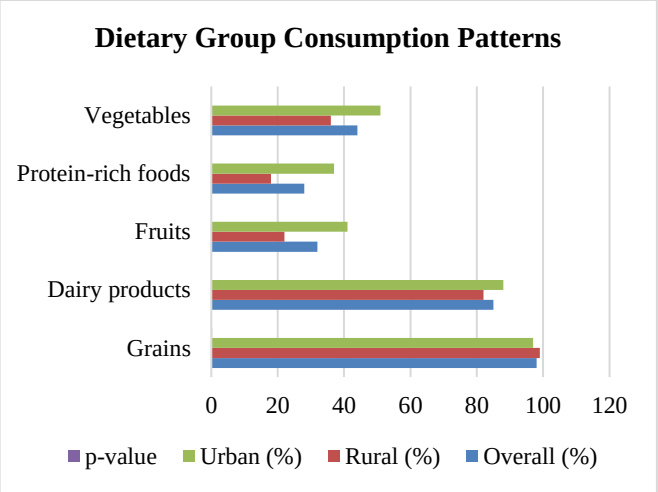


Table 3

Dietary Group Consumption Patterns

Food Group	Overall (%)	Rural (%)	Urban (%)	p-value
Grains	98	99	97	0.256
Dairy products	85	82	88	0.034
Fruits	32	22	41	<0.001
Protein-rich foods	28	18	37	<0.001
Vegetables	44	36	51	0.009

Figure: 4



It finds that depending on their rural-urban residence, the probability of an infant or toddler achieving MDD varies significantly. Better maternal education, household wealth and market access were related to higher MDD achievement in urban areas. In rural settings, the interventions should concentrate more on maternal education and food security.

DISCUSSION

The findings of this study highlight the stark difference in minimum dietary diversity (MDD) between infants and toddlers living in rural and urban Pakistan. Such disparities reflect the larger socioeconomic, educational and infrastructural inequalities present throughout the country.

We found that only 28% of rural children went MDD, compared with 48% of their counterparts living in the city. This stark contrast parallels other studies that demonstrate the advantages of urban areas with respect to resource availability, healthcare access and education (Chaudhry et al., 2019; Khan et al., 2022). Several interrelated factors are likely to contribute to the higher MDD achievement in urban areas:

The strongest predictors of MDD were Maternal Education; AOR 2.4. The educated mother has more chances of being aware of the nutritional needs of the child and adopting diverse feeding practices. In urban areas, 68 percent of mothers had secondary education as compared to 34 percent in rural areas, indicating that targeted educational programmes in rural settings are necessary to enhance dietary diversity.

Household Wealth and Market Access

Urban households were also more likely to make it through the top wealth quintiles (56 percent vs. 22 percent) and have access to better food markets (74 percent vs. 38 percent). Household wealth and proximity to markets increase the availability and affordability of diversified foods, which are significantly important for achieving MDD. On the other hand, rural households often have limited access to nutrient rich foods, e.g., fruits and sources of protein, due to financial constraints and logistical barriers.

Utilization of healthcare services associated with higher odds of achieving MDD (AOR: 1.9). Urban caregivers had more access to child health services which provided nutrition counseling and timely health interventions. Improvements in healthcare delivery systems in rural areas may help caregivers better provide their children's nutrition.

In addition, the analysis of food group consumption further illustrates rural urban nutritional disparities. In both settings, grains and dairy products were consumed widely, but rural children had much lower intake of fruits (22% versus 41%) and foods rich in protein (18% versus 37%). It can exacerbate micronutrient deficiencies and impair optimal growth and development in rural populations. This may also be attributed to the fact that urban children have better access to various food such as fruits and proteins which would contribute to improved dietary diversity.

Moderate to severe food insecurity was the most important barrier to achieving MDD, significantly reducing the odds of achieving dietary diversity, 40% (AOR: 0.6). This finding underscores the importance of Dec logging robust food security programs, especially in rural areas where poverty and market exclusion are more concentrated. The adverse effects of food insecurity on dietary diversity could be mitigated through social safety nets and community-based nutrition programs.

Implications for Policy and Practice Educational Interventions

It is crucial to expand access to maternal education, especially in rural areas. Embedding nutrition education in maternal and child health programs would enable caregivers to learn how to choose diets for their children healthfully.

Access to market will be improved through improved rural infrastructure, such as roads or transportation systems, which increases availability of a wider range of food. Affordability can also be enhanced for low income households through subsidized programs of nutrient rich foods.

Nutritional Counseling and Support Services: Efforts must be made to strengthen healthcare systems to offer nutritional counseling and support services, specifically in areas that are underserved. The knowledge gap of caregivers can be bridged by training healthcare workers

to provide culturally sensitive and practical dietary advice.

Suggested initiatives: For example, policymakers should place priority on subsidies, community gardens and school feeding programs that aim to improve food security by preventing food insecurity through subsidies, community gardens, food security programs in schools, which should include diverse and nutritious food for vulnerable populations.

Study Strengths and Limitations

The strengths of this study include large sample size and robust analysis of food diversity determinants across rural and urban contexts. However, several limitations warrant consideration. Due to the cross-sectional design, causal inference is precluded, and dietary recall methods are subject to caregiver recall bias. The study further contributed to generalizability, as it was also about Punjab and thus limited to other areas in Pakistan with different cultural and socioeconomic context.

CONCLUSION

For example, this study offers critical insights into the determinants of minimum dietary diversity (MDD) of infants and toddlers in Pakistan in comparison to rural and urban populations. The findings highlight that more urban children achieve MDD because of events like elevated maternal education, increased household wealth as well as enhanced access to urban markets and health service. However, rural children have much to contend with, too — lower socioeconomic status, fewer choices in food, and higher food insecurity.

As a key determinant of MDD, maternal education was identified as a critical determinant and a target of upcoming educational initiative focusing on empowering caregivers. Just as critically, interventions that reduce food insecurity and expand market accessibility in rural areas can greatly improve dietary diversity. The results also point to the importance of policies rooting out broader structural inequalities in healthcare infrastructure and socioeconomic development, especially in underserved areas.

This study lays a foundation for designing context specific strategies to improve the nutritional outcomes of children by identifying key barriers to achieve MDD. Future research is needed to determine the causality and the long-term effects of interventions on diet diversity and child health using longitudinal approaches. It is important to address these gaps for equitable child nutrition and healthier communities in Pakistan.

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