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To assess epidemiological correlates & growth of infant's cohort residing in urban slum area of western Maharashtra - An observational study

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Abstract

Introduction: Infants in urban slums face significant challenges to growth, including poor nutrition, limited healthcare, and environmental hazards. Despite the large population in these areas, particularly in smaller towns, there is a lack of data on their growth patterns and the epidemiological factors influencing them. This study aims to address this gap by assessing the growth trajectories of infants in urban slums.

Methodology: The study aimed to assess the epidemiological correlates and growth of an infant cohort in an urban slum area of Western Maharashtra, using a prospective cohort design. Conducted at the Urban Health Training Center (UHTC) of Krishna Institute of Medical Sciences, Karad, it provided insights into infant growth in a socio-environmental context. The sample included 60 infants selected through non-probability convenience sampling, with criteria for inclusion being infants born to mothers who are permanent residents of the area and available for one-year follow-up. Exclusion criteria included infants born to mothers visiting parental homes or with congenital malformations or severe diseases. The study tool comprised three sections: demographic profile, anthropometric measurements, and follow-up history. Reliability testing for inter-rater, intra-rater, and test-retest consistency showed good reliability. A pilot study on 10 samples was conducted to refine the methods, with written informed consent obtained from participants and administrative approval from the university and hospital.

Result: The study assessed weight and length growth patterns of male and female infants in an urban slum area of Maharashtra, comparing them to WHO standards. Male infants exhibited consistently lower weights across all percentiles, with the largest deviation observed at the 97th percentile, where the mean weight was 1.2 kg lower than WHO norms. Despite gradual convergence toward WHO standards from the 8th month onward, growth deficits persisted, especially in the 3rd and 97th percentiles. Female infants showed similar trends, with significant weight deficits at the 3rd and 50th percentiles, but some catch-up growth was observed in the 97th percentile from the 8th month. Length measurements for both genders were consistently shorter than WHO standards, particularly in the lower percentiles. Statistical analysis revealed significant differences in weight and length between the study cohort and WHO standards for male infants, while female infants exhibited fewer significant differences.

Conclusion: The findings underscore the need for targeted nutritional interventions.

Keywords: Epidemiological correlates, infant growth, urban slum, cohort study, western Maharashtra

Introduction

Infant growth is a critical determinant of long-term health, cognitive development, and productivity. However, growth disparities are prevalent in resource-constrained settings, such as urban slums, where factors like poor nutrition, frequent infections, and inadequate healthcare access hinder optimal growth. Globally, over 149 million children under five are stunted, and 45 million are wasted, with India contributing significantly to these figures—35.5% of children under five are stunted and 19.3% are wasted, according to the National Family Health Survey (NFHS-5) [1].

Urban slums, marked by poverty, overcrowding, and lack of basic amenities, present unique challenges to infant growth. In these environments, inadequate breastfeeding practices, delayed introduction of complementary foods, and repeated infections, such as diarrhea and respiratory illnesses, exacerbate growth deficiencies. Furthermore, maternal factors like education and nutritional status also impact infant growth outcomes. In India, maternal illiteracy, poor dietary diversity, and low socioeconomic status are strongly linked to

Stunting and wasting among children [2].

The WHO growth standards provide a global benchmark for assessing growth deviations in infants. While these standards are widely used, their applicability in urban slum populations needs further investigation due to the socio-environmental challenges these communities face. Studies in similar settings have revealed that urban slum infants often fail to meet WHO growth norms, with high rates of growth faltering within the first year of life [3].

In India's rapidly expanding urban population, growth monitoring in the first year of life is vital for identifying at-risk infants and implementing timely interventions. However, there is limited longitudinal data on growth patterns in urban slums, especially in smaller cities. This study aims to fill this gap by assessing the growth trajectories of infants in urban slums in Karad, Maharashtra. By comparing these to WHO standards, the study will identify key socio-demographic and health factors contributing to growth faltering, providing valuable insights for improving child health outcomes [4].

Need of the study

The growth and development of infants are crucial for long-term health, cognitive function, and productivity. However, infants residing in urban slum areas often face multiple challenges that hinder optimal growth, including poor nutrition, lack of healthcare access, and environmental hazards. In India, urban slums are home to a significant proportion of the population, with over 65 million people living in these conditions. Despite this large demographic, there is a paucity of data on the growth patterns and the associated epidemiological factors influencing infants in these areas, particularly in smaller towns [5].

Epidemiological studies from similar settings have highlighted that infants living in urban slums are at a higher risk of growth faltering due to factors such as poor maternal nutrition, inadequate breastfeeding practices, and frequent infections like diarrhea and respiratory diseases. A study by Agarwal demonstrated that children in urban slums had a higher prevalence of stunting and wasting compared to their counterparts in rural areas, emphasizing the need for focused interventions in urban slum populations. Furthermore, the socio-economic conditions in these areas, including lower maternal education and limited access to healthcare, contribute significantly to suboptimal growth patterns among infants [6].

Growth monitoring during the first year of life is a critical intervention window, as this period significantly impacts a child's future health and cognitive development. Therefore, assessing the epidemiological correlates and growth of infants in these communities is essential for identifying at-risk children and developing targeted strategies for improving child health outcomes. This study aims to fill the gap in knowledge by examining the growth patterns and associated socio-demographic factors in an infant cohort from an urban slum area of Western Maharashtra, which will provide valuable data for public health interventions aimed at reducing child malnutrition and improving health outcomes in similar urban slum settings [7].

Aim of the study

The aim of this study is to assess the epidemiological correlates and growth patterns of an infant cohort residing in an urban slum area of Western Maharashtra.

Materials and Methods

The study aimed to assess the epidemiological correlates and growth of an infant cohort residing in an urban slum area of Western Maharashtra, using a quantitative research approach with a prospective cohort study design. The study was conducted within the field practice area of the Urban Health Training Center (UHTC) at Krishna Institute of Medical Sciences, Karad, which provided an in-depth understanding of infant growth in this unique socio-environmental setting. The sample comprised 60 infants selected through non-probability convenience sampling, with inclusion criteria including infants born to mothers who are permanent residents of the study area and available for one-year follow-up. Exclusion criteria included infants born to mothers visiting their parental homes for delivery or those with congenital malformations or severe diseases. The study tool was developed with three sections: demographic profile, anthropometric measurements, and follow-up history at six months of age. Reliability testing was conducted using inter-rater reliability (Cohen's kappa for demographic data), inter-rater and intra-rater reliability (intraclass correlation coefficient for anthropometric measurements), and test-retest reliability for follow-up history, with results indicating good reliability across all sections. A pilot study was conducted on 10 samples to assess the feasibility of the study and refine the data collection methods, with administrative permission obtained from the university and hospital, and written informed consent from participants.

Results

The weight-for-age growth chart for male infants in the study cohort (n=28) was plotted against WHO standards across the 3rd, 50th, and 97th percentiles [Figure 1]. The data demonstrated that male infants in the cohort consistently exhibited lower weights compared to WHO standards across all percentiles. The largest differences were observed in the 97th percentile, where the mean weight was 1.2 kg lower than WHO norms during the earlier months. However, a general trend toward convergence with WHO standards was evident as the infants aged, particularly from the 8th month onward. By this time, the gap narrowed, and the 50th percentile aligned more closely with WHO values. Despite this, infants in the 3rd and 97th percentiles continued to show significant deviations, reflecting persistent nutritional challenges within the population.

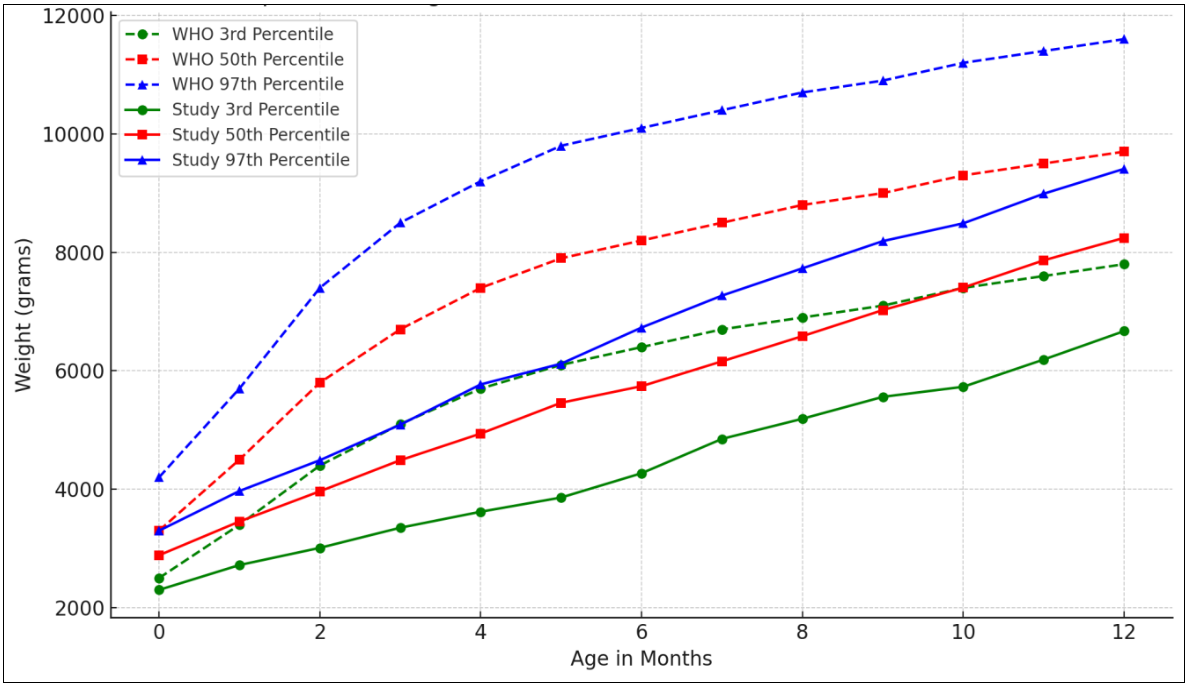

Fig 1: Comparison of weight growth patterns for male infants (N = 28) with WHO standards

The Bland-Altman plot compared the weight of male infants in the study cohort with WHO standards across the 3rd, 50th, and 97th percentiles. The analysis revealed a systematic underperformance in weight, with the cohort consistently falling below WHO standards. The mean differences were most pronounced in the 97th percentile, where infants weighed significantly less than expected. The limits of agreement, particularly during the early months, displayed considerable variability, indicating inconsistencies in growth patterns in the initial stages of life. Over time, the limits of agreement narrowed, especially in the 50th and 97th percentiles, suggesting improved growth trajectories. However, the persistent negative bias across all percentiles underscored the need for targeted nutritional interventions.

Legend

LoA: Limits of Agreement

The length-for-age growth patterns of male infants (n=28) from the study cohort were compared with WHO standards across the 3rd, 50th, and 97th percentiles [Figure 2]. The cohort consistently exhibited shorter lengths than WHO standards across all percentiles, with the largest deviations observed at the 3rd percentile during the first six months. The length discrepancy was most pronounced in the earlier months, with male infants measuring up to 3 cm shorter on average compared to WHO norms at the 3rd percentile. Although there was gradual improvement in length measurements as the infants aged, convergence toward WHO standards remained incomplete by the end of the study, particularly in the lower percentiles, reflecting persistent growth deficits.

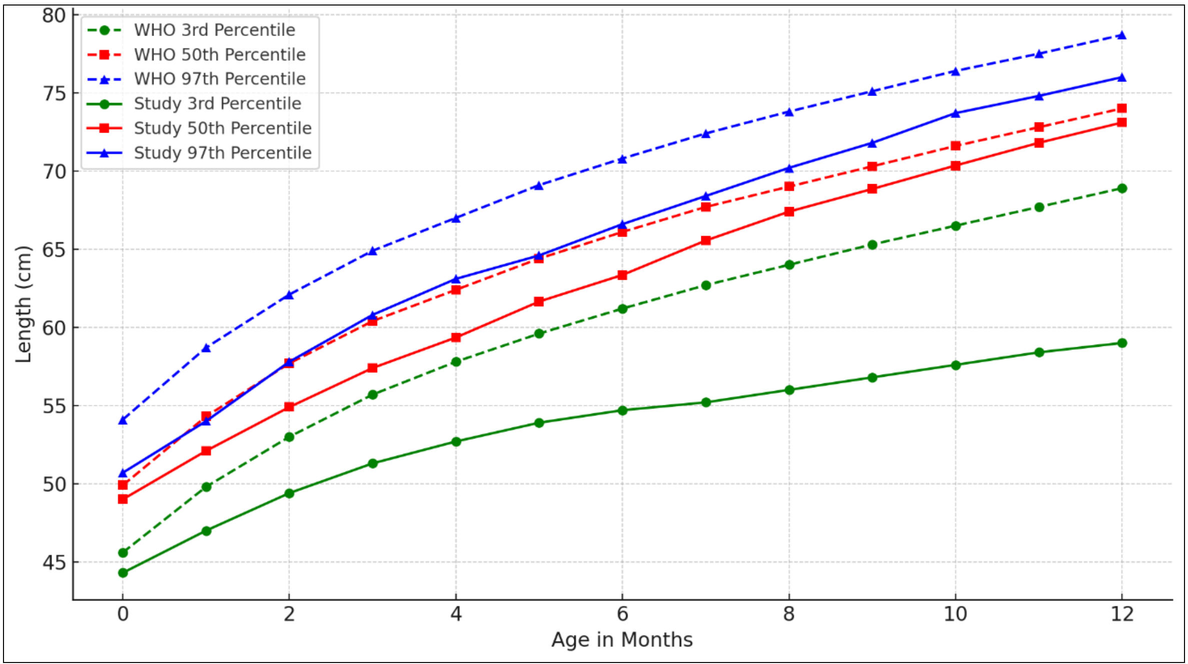

Fig 2: Comparison of length growth patterns for male infants (n = 28) with WHO standards

The Bland-Altman plot compared length differences between male infants in the study cohort and WHO standards across the 3rd, 50th, and 97th percentiles. The analysis demonstrated that the cohort consistently exhibited shorter lengths than WHO standards, with the largest discrepancies observed at the 3rd percentile. The limits of agreement were widest in the lower percentiles, indicating greater variability in growth patterns among infants with lower length-for-age scores. Over time, some convergence toward WHO standards was noted at the 50th and 97th percentiles. However, the overall trend remained one of significant growth retardation, particularly at the 3rd percentile.

Legend
LoA: Limits of Agreement

The weight-for-age growth patterns of female infants (n=32) from the study cohort were compared with WHO standards across the 3rd, 50th, and 97th percentiles. Across all percentiles, the cohort consistently exhibited lower weights than WHO standards, particularly during the earlier months. The deviation was most pronounced in the 3rd percentile, where female infants demonstrated a significant lag compared to WHO norms. However, from the 8th month onward, a noticeable narrowing of the gap was observed, with infants in the 97th percentile even slightly exceeding WHO standards, indicating potential catch-up growth. This pattern suggested a possible improvement in feeding practices or a reduction in early-life morbidity among female infants in the upper percentiles.

The Bland-Altman plot compared weight differences between female infants in the study cohort and WHO standards across the 3rd, 50th, and 97th percentiles. The largest mean difference was observed in the 3rd percentile, where the cohort consistently weighed less than WHO standards. Over time, the difference decreased for the 50th and 97th percentiles, with the latter showing a reversal by the 8th month, as the cohort began to slightly exceed WHO standards. The analysis indicated that while the cohort exhibited significant underperformance in the earlier months, some weight recovery occurred in the higher percentiles as the infants aged. The limits of agreement remained wide for the lower percentiles, reflecting greater variability in weight gain among female infants with lower growth percentiles.

Legend
LoA: Limits of Agreement

The length-for-age growth chart for female infants (n=32) in the study cohort was compared to WHO standards across the 3rd, 50th, and 97th percentiles. The cohort consistently demonstrated shorter lengths than WHO standards across all percentiles, particularly during the earlier months. The largest deviation was observed in the 3rd percentile, where infants were, on average, 2.5 cm shorter than WHO norms during the first six months. Over time, the gap narrowed, with the 50th and 97th percentiles showing gradual improvements toward alignment with WHO standards. However, significant deviations persisted in the lower percentiles, indicating that stunting remained prevalent among infants with suboptimal nutritional intake and health outcomes.

Further the Bland-Altman plot compared the length differences between female infants in the study cohort and WHO standards across the 3rd, 50th, and 97th percentiles. The largest mean difference was observed in the 3rd percentile, where the cohort consistently measured below WHO standards. Over time, variability decreased, particularly in the 50th and 97th percentiles, where convergence toward WHO standards became more evident. The limits of agreement were widest in the earlier months, indicating considerable variability in growth patterns, especially among infants in the lower percentiles. While some convergence was noted, the persistent growth deficit in the 3rd percentile highlighted the ongoing risk of stunting and growth retardation in this population.

Legend
LoA: Limits of Agreement

The study compared weight and length centiles (3rd, 50th, and 97th percentiles) of male and female infants between WHO standards and research data. For weights, male infants in the study had significantly higher weights at the 3rd percentile ($t = 2.53$, $p = 0.009$) and significantly lower weights at the 50th ($t = 2.57$, $p = 0.008$) and 97th percentiles ($t = 3.25$, $p = 0.001$). Female infants showed significantly lower weights at the 3rd ($t = 2.23$, $p = 0.01$) and 50th percentiles ($t = 1.8$, $p = 0.04$) but no significant difference at the 97th percentile ($t = 0.16$, $p = 0.43$). For lengths, male infants were significantly shorter at the 3rd percentile ($t = 2.67$, $p = 0.006$) with no differences at the 50th ($t = 0.66$, $p = 0.25$) or 97th percentiles ($t = 1.2$, $p = 0.11$). Female infants displayed no significant length differences across all centiles (3rd: $t = 0.43$, $p = 0.33$; 50th: $t = 0.7$, $p = 0.24$; 97th: $t = 0.76$, $p = 0.22$), indicating varying growth patterns compared to WHO standards [Table 1].

Table 1: Comparison of weight and length centiles between WHO standards and study data

Parameter	Percentile	WHO Mean (SD)	Study Mean (SD)	t-value	p-value
Weight (Male)	3rd	5931 g (1399)	7585 g (1399)	2.53	0.009
	50th	7585 g (1995)	5709 g (1705)	2.57	0.008
	97th	9315 g (2294)	6581 g (1977)	3.25	0.001
Weight (Female)	3rd	5415 g (1487)	4184 g (1324)	2.23	0.01
	50th	6808 g (1696)	5610 g (1688)	1.8	0.04
	97th	8000 g (1859)	7862 g (2409)	0.16	0.43
Length (Male)	3rd	60 cm (7)	54 cm (4)	2.67	0.006
	50th	65 cm (7)	63 cm (8)	0.66	0.25
	97th	68 cm (8)	66 cm (8)	1.2	0.11
Length (Female)	3rd	60 cm (7)	58 cm (8)	0.43	0.33
	50th	64 cm (7)	62 cm (8)	0.7	0.24
	97th	68 cm (7)	66 cm (9)	0.76	0.22

Discussion

This study reveals notable growth discrepancies between infants in the cohort and WHO growth standards, especially in the lower percentiles (3rd and 50th). The results of this study are consistent with research from resource-limited settings, where growth deficits such as stunting and underweight are commonly observed. Several studies from India and other low- and middle-income countries report similar trends in infant growth. For example, a study by Shrikant S *et al*. (2019) found that infants from socioeconomically disadvantaged backgrounds in India had growth measures consistently below WHO standards, highlighting the impact of nutrition and socioeconomic status on early growth [8]. Similarly, Arup J *et al*. (2023) observed significant stunting in Indian infants, with inadequate nutrition and insufficient healthcare contributing to growth deficits, a trend also reflected in this cohort [9].

As with many studies from sub-Saharan Africa and South Asia, this study observed a gradual convergence toward WHO standards as infants aged, especially in the higher percentiles (50th and 97th), likely reflecting potential improvements in nutrition and care. This is consistent with findings by Grummer-Strawn *et al*. (2004) and Anne M *et al*. (2013), who documented catch-up growth in infants when nutrition was improved or when healthcare interventions reduced early-life morbidity [10,11]. The reversal of the gap in the higher percentiles, particularly the 97th, observed in female infants by 8 months may also indicate a potential for recovery when optimal nutrition and healthcare are provided.

Despite these improvements, significant growth deficits persisted in the lower percentiles, particularly the 3rd, which suggests a continued risk for malnutrition and stunting in this population. This finding is in line with studies showing that early childhood stunting can have long-term consequences, including cognitive and physical developmental delays, as well as an increased risk for non-communicable diseases later in life [12, 13]. Ashraf S *et al*. (2021) and Kathryn G *et al*. (2010) have extensively documented the long-term effects of early growth retardation, underscoring the need for interventions in early childhood to prevent these outcomes [12,13].

The wide limits of agreement in the Bland-Altman plots, particularly in the lower percentiles, reflect the significant variability in growth patterns among infants, which is influenced by environmental factors such as nutrition and healthcare access. These findings are consistent with studies comparing growth patterns in rural and urban populations, which highlight the impact of socio-economic disparities on child growth [14, 15]. Tanvir M *et al*. (2018) found similar variability in growth patterns in populations with different socioeconomic backgrounds, reinforcing the notion that environmental factors play a significant role in early childhood growth [14]. Additionally, the WHO Multicenter Growth Reference Study indicate that growth patterns in low-resource settings often deviate from WHO standards, particularly in the early stages of life [3].

Conclusion

The findings of this study highlight the critical role of early-life nutrition, infection control, and healthcare access in infant growth. As evidenced by this cohort and corroborated by studies from India and other regions, addressing early-life nutritional deficiencies and ensuring proper healthcare interventions can mitigate the long-term effects of malnutrition and growth deficits. Interventions aimed at improving maternal education, promoting breastfeeding, and enhancing access to healthcare could significantly reduce the observed growth discrepancies and support healthier growth trajectories for infants in resource-limited settings. Studies further emphasize the importance of such interventions in achieving optimal growth outcomes globally. Moreover, WHO (2006) continues to emphasize the need for global health strategies to address malnutrition and improve infant growth.

Conflict of Interest: The authors certify that they have no involvement in any organization or entity with any financial or non-financial interest in the subject matter or materials discussed in this paper.

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