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Factors of Complicated Measles in Children Less Than 5 Years of Age

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ABSTRACT

Background: Complicated measles remains a significant health concern in children, with various factors contributing to its severity. Identifying the predisposing factors such as malnutrition, non-vaccination, and poor socioeconomic status is critical for improving outcomes, especially in resource-limited areas. **Objective:** To determine the frequency of factors leading to complicated measles in children less than 5 years of age. **Study Design:** Cross-sectional study. **Duration and Place of Study:** The study was conducted from July 2024 to January 2025 in the Department of Pediatrics at Ayub Teaching Hospital, Abbottabad. **Methodology:** A total of 194 children, aged 1 month to 5 years, diagnosed with complicated measles, were included in the study. Demographic information, including age, gender, residential status, parental education, and socioeconomic status, was collected. The study assessed malnutrition using WHO growth standards and vaccination status via parental reports. **Results:** The study included 194 children with a mean age of 3.43 ± 1.46 years and a mean weight of 12.41 ± 4.96 kg. The sample comprised 57.7% males and 42.3% females, with equal representation from rural and urban areas. The study found that 45.9% of children were malnourished, 59.3% were non-vaccinated, and 67.5% had poor socioeconomic status. **Conclusion:** Our study confirmed malnutrition, lack of vaccination, and poor socioeconomic status as key factors for complicated measles in children, aligning with global research. Targeted interventions in nutrition, vaccination, and healthcare access, especially in rural and underprivileged areas, are crucial to reducing disease burden and complications through effective public health initiatives.

INTRODUCTION

Complicated measles among under-five children is a serious health condition, especially in areas with extremely poor access to health facilities and vaccination[1]. Measles, caused by the measles virus, may lead to serious complications; hence, it increases morbidity and mortality in this age group[2]. The aggravating factors of the disease include malnutrition, inadequate vaccination, immune deficiencies, and socioeconomic disadvantages[3]. These, when identified, will be useful in the formulation of effective preventive and management strategies, especially in low- and middle-income countries where measles is still prevalent[3].

One of the major risk factors among children for complicated measles is malnutrition, especially protein-energy malnutrition.[4] Generally, malnourished children have weakened immunity and suffer from the severity of all infections, including measles. Deficiency of Vitamin A is particularly critical and has been directly associated with the severity of infection in measles[5]. This is because vitamin A is essential in maintaining mucosal barriers and immune function. When deficient, the person becomes highly susceptible to complications related to pneumonia, diarrhea, and corneal lesions that may lead to blindness. Indeed, supplementation of vitamin A during measles infection has been associated with significant reductions in complication and mortality rates[6].

Poor vaccination coverage among children under five years is considered one of the major causes of complicated measles[7]. Although there is an effective vaccine against measles, many children, especially those from underserved areas, are not immunized on time. Delayed or missed doses raise the chances of catching measles and its complications like encephalitis, severe dehydration, or secondary bacterial infections[8]. Many times, vaccine hesitancy, logistical challenges, and misinformation have been barriers to vaccination, allowing outbreaks to persist with increasing disease severity among unvaccinated or partially vaccinated children.

Poor living in unhygienic conditions, failing to access proper medical attention on time, constitutes

critical determinants for the complications of measles, especially amongst children[9]. The possible rapid transmission with overcrowded situations, coupled with suboptimal personal hygiene and inadequate availability of clean water and nutritious food, will readily act as a driver for rapid transmission. Besides, any delay in accessing health services due to economic or geographic constraints is certain to create late diagnosis and management that further worsen the outcome.[10] The socioeconomic variables include health infrastructure, education, and focused vaccination efforts that must be addressed in striving to lessen the complicated measles burden among under-five children[11].

A study conducted by Ahmad S, et al. revealed that among children diagnosed with complicated measles, 64% exhibited malnutrition, 78% had not received vaccination, and 56% belonged to households with poor socioeconomic conditions[12].

This study was necessary to identify and analyze the key factors contributing to complicated measles in children, such as malnutrition, non-vaccination, and poor socioeconomic status. Understanding these determinants helped in designing targeted interventions to reduce the disease burden, improve vaccination coverage, and address underlying socioeconomic challenges. The findings provided valuable insights for healthcare policymakers and practitioners to implement effective prevention and management strategies, ultimately aiming to enhance child health outcomes.

METHODOLOGY

This cross-sectional study was conducted from July 2024 to January 2025 in the Department of Pediatrics at Ayub Teaching Hospital, Abbottabad. A total of 194 participants were included, with the sample size calculated using WHO sample size determination software, considering a 95% confidence level, a 7% margin of error, and an anticipated prevalence of poor socioeconomic status at 56% among children with complicated measles.[12] After obtaining ethical approval and informed consent from parents or guardians, demographic data such as age, gender, weight, residential status, parental education level, socioeconomic status, and profession were collected. Participants were selected using a non-probability consecutive sampling technique. The inclusion criteria comprised children aged 1 month to 5 years, of both genders with complicated measles. Complicated measles was defined as the presence of clinical symptoms including high fever (≥101°F or 38.3°C), dry cough, runny nose, redness and irritation of the eyes, Koplik spots on the buccal mucosa, and maculopapular rash (three or more symptoms), along with any one of the following: inability to drink/feed, vomiting, seizures, or unconsciousness. Exclusion criteria included children with co-infections such as malaria or tuberculosis, anatomical defects, chronic diseases, malignancies, or immunocompromised conditions. Malnutrition, defined as a weight-for-height Z score of ≤ -3 SD according to WHO growth standards, and non-vaccinated status, confirmed by parental report or vaccination records, were also assessed. Poor socioeconomic status was defined as a family income of less than Rs. 20,000 per month. Data regarding factors leading to complicated measles, including malnutrition, non-vaccinated status, and poor socioeconomic status, were recorded using a specifically designed proforma. Data analysis was performed using SPSS version 29. Continuous variables such as age and weight were expressed as mean ± standard deviation or median (IQR) for non-normal data, with normality assessed using the Shapiro-Wilk test. Categorical variables were presented as frequencies and percentages. Factors were stratified by age, gender, residential status, parental education level to identify effect modifiers. Statistical significance was determined using the chi-square test or Fisher's exact test, with a p-value of ≤ 0.05 considered significant.

RESULTS

The mean age of the children was 3.43 ± 1.46 years, with a mean weight of 12.41 ± 4.96 kg. The sample comprised 57.7% males and 42.3% females, with an equal distribution between rural (50%) and urban (50%) residential statuses. Parental education levels varied, with 24.7% uneducated, 26.8% having primary education, 42.3% secondary education, and 6.2% higher education (as shown in Table-I).

Table I

Patient Demographics

Demographics		Mean ± SD / n (%)
Age (years)		3.427±1.46
Weight (Kg)		12.412±4.96
Gender	Male	112 (57.7%)
	Female	82 (42.3%)
Residential Status	Rural	97 (50%)
	Urban	97 (50%)
Residential Status	Uneducated	48 (24.7%)
	Primary	52 (26.8%)
	Secondary	82 (42.3%)
	Higher	12 (6.2%)

Figure 1

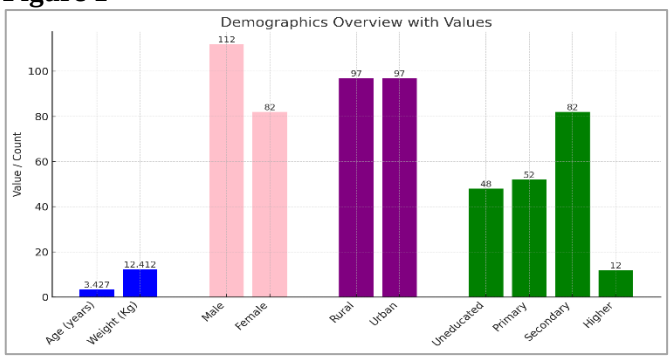


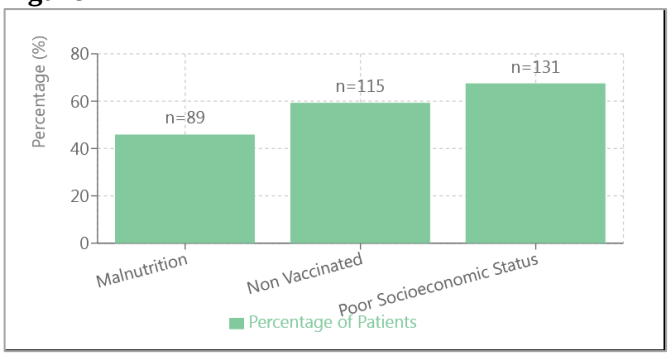
Table-II highlights key factors associated with complicated measles: malnutrition was present in 45.9% of cases, 59.3% of children were non-vaccinated, and 67.5% had poor socioeconomic status.

Table II

Factors associated with complicated measles

Factors associated with complicated measles	Frequency	%age
Malnutrition	89	45.9%
Non-Vaccinated	115	59.3%
Poor Socioeconomic Status	131	67.5%

Figure 2



Graph-I: Factors of complicated measles

Stratified analyses in Table-III revealed significant associations between malnutrition and younger age (78.2% in children aged 1 month to 3 years vs. 3.6% in those >3 years, p<0.001), female gender (67.1% vs. 30.4% in males, p<0.001), rural residence (62.9% vs. 28.9% in urban areas, p<0.001), and lower parental education (68.8% in uneducated parents vs. 25% in higher education, p<0.001). Non-vaccination was more prevalent in males (70.5% vs. 43.9% in females, p<0.001) and those with secondary education (73.2%, p<0.001). Poor socioeconomic status was significantly associated with rural residence (100%, p<0.001), female gender (85.4% vs. 54.5% in males, p<0.001), and lower parental education (100% in uneducated and primary education groups, p<0.001).

Table III

Association of Factors with Demographic Factors

Demographic Factors		Malnutrition		p-value
		Yes n(%)	No n(%)	
Age	1 month to 3 years	86 (78.2%)	24 (21.8%)	<0.001*
	>3 years	3 (3.6%)	81 (96.4%)	
Gender	Male	34 (30.4%)	78 (69.6%)	<0.001
	Female	55 (67.1%)	27 (32.9%)	
Residential Status	Rural	61 (62.9%)	36 (37.1%)	<0.001
	Urban	28 (28.9%)	69 (71.1%)	
Parental Education	Uneducated	33 (68.8%)	15 (31.3%)	<0.001*
	Primary	28 (53.8%)	24 (46.2%)	
	Secondary	25 (30.5%)	57 (69.5%)	
	Higher	3 (25%)	9 (75%)	
Demographic Factors		**Non-Vaccinated**		**p-value**
		Yes n(%)	**No n(%)**	
Age	1 month to 3 years	61 (55.5%)	49 (44.5%)	0.215
	>3 years	54 (64.3%)	30 (35.7%)	
Gender	Male	79 (70.5%)	33 (29.5%)	<0.001
	Female	36 (43.9%)	46 (56.1%)	
Residential Status	Rural	55 (56.7%)	42 (43.3%)	0.465
	Urban	60 (61.9%)	37 (38.1%)	
Parental Education	Uneducated	24 (50%)	24 (50%)	<0.001*
	Primary	31 (59.6%)	21 (40.4%)	
	Secondary	60 (73.2%)	22 (26.8%)	
	Higher	0 (25%)	12 (100%)	
Demographic Factors		**Poor Socioeconomic Status**		**p-value**
		Yes n(%)	**No n(%)**	
Age	1 month to 3 years	80 (72.7%)	30 (27.3%)	0.077
	>3 years	51 (60.7%)	33 (39.3%)	
Gender	Male	61 (54.5%)	51 (45.5%)	<0.001
	Female	70 (85.4%)	12 (14.6%)	
Residential Status	Rural	97 (100%)	0 (0%)	<0.001*
	Urban	34 (35.1%)	63 (64.9%)	
Parental Education	Uneducated	48 (100%)	0 (0%)	<0.001*
	Primary	52 (100%)	0 (0%)	
	Secondary	25 (30.5%)	57 (69.5%)	
	Higher	6 (50%)	6 (50%)	

*Fischer Exact Test

DISCUSSION

The study attempted to establish predisposing factors for complicated measles in children and, in alignment with current studies, exhibited strong correlations with malnutrition, unvaccination, and poor socioeconomic background. Malnutrition, at 45.9%, occurred in a high proportion and, at a significant level, in early age groups (1 month to 3 years) and in rural environments.

Malnutrition in such groups can be explained in terms of susceptibility in early age groups to nutritional deficiencies and compromised access to care and nutritious foods in rural communities, compromising immune function and predisposing to life-threatening complications of measles.[13]

59.3% non-vaccination, seen in males and offspring of parents with secondary school level education, could represent gender-related access to care inequity and cultural bias in certain areas, and gaps in parental intermediate-level educational information regarding care and disease prevention. Poor socioeconomic status, seen in 67.5%, correlated with rural residence and parental level of education, and reflects the role of socioeconomic disadvantage in access to care, vaccination, and general child well-being, in that preventive care and educational access can become restricted in such groups.[14]

We found malnutrition in 45.9% of measles cases in our analysis, in agreement with a number of studies, most prominently in Pakistan and Romania. Afzal and Afzal [15] in a study revealed that malnutrition in children increased susceptibility to measles complications. Similarly, Zahidie et al.[16] stressed malnutrition in Pakistan's city of Karachi, a principal cause of measles in children, in a similar way, in that malnutrition in our analysis revealed a high proportion in less educated parental groups (78.2% in 1-month-old to 3-year-old children) and in less educated parents, similar to Zahidie et al. [16] in a principal role in preventing measles through improvement in nutritional status and in parental education, respectively.

We have observed non-vaccination to be a significant risk factor in our analysis, with 59.3% of cases unvaccinated. That observation supported Afzal and Afzal [15] Hao et al. [17] and Mayxay et al.[18] all of whom stressed lack of vaccination to be a significant contributing cause for developing measles. In detail, Hao et al. [17] have documented a 22.7 times increased risk for measles in unvaccinated children, and Mayxay et al. [18] have documented a significantly smaller proportion of immunized children in the measles group. In our stratified analysis, a significant proportion of males exhibited a high level of non-vaccination (70.5% in contrast with 43.9% in females), supporting observations in Hao et al. [17] that male children have a high susceptibility for measles with a smaller level of vaccination in them. Non-vaccination in our analysis exhibited a significant proportion in less educated groups, supporting Zahidie et al. [16] who have documented less vaccination in less educated groups of children.

Our analysis also revealed a high correlation between rural residence and poor socioeconomic level (100% in rural and 54.5% in urban males), a fact supported in other studies. Afzal et al.[15] noticed that a high proportion of cases of infection with measles included poor socioeconomic level cases, and Zahidie et al. [16] noticed similar trends in Karachi city. Mayxay et al. [18] noticed that poor access to care and poor vaccination in poor communities could cause poor vaccination and poor prognosis, and that observation confirms that specific vaccination in poor communities, and in poor socioeconomic level children, is warranted, a fact concluded in several of the studies mentioned.

From a gender perspective, our analysis showed a high proportion of malnutrition and poor socioeconomic status in female children, with 67.1% of females and 30.4% in males being malnourished. In contrast, in a study performed by Zahidie et al. [16] male children were at high risk for complications of measles, but in a study performed by Hao et al. [17] no gender variation was noticed. In our study, heightened vulnerability in females can possibly represent socioeconomic factors, including less care and nutrition for girls in certain regions, and deserves future investigation in studies.

One of our most striking observations in our work was that secondary-educated children (73.2%) were less likely to have been vaccinated, a result that is counterintuitive to the overall picture in other studies. For example, Afzal, et al [15] concluded that unavailability of vaccines and concurrent disease, but not educational level, were significant factors, and Hao et al. [17] stressed missed opportunities for vaccination. What our observation may imply is that secondary-educated children in a family may have access to medical care but lack vaccination for logistic reasons, such as variable availability of vaccines or a break in the system in the mechanism of care delivery. What it highlights is that educational level cannot necessarily secure vaccine coverage alone.

Lastly, our investigation showed malnutrition to occur more in younger children (78.2% in the 1 month to 3 years age group compared with 3.6% in the >3 years age group), in agreement with Afzal et al.[15] and Hao et al. [17] both of whom have determined that a younger age group is a risk for complications in measles. Yet, in a study conducted by Hao et al. [17] a larger proportion of cases of measles in the 8-14 years age group, in contrast with our observation of a larger proportion in a younger age group, could have been seen, and such a variation could have been due to changing vaccine coverage over a period of years or geographical variation in vaccination trends.

From these observations, it is clear that intervention in malnutrition, improvement in vaccination, and overcoming socioeconomic inequality must be part of any intervention in an attempt to counteract the burden of measles. That such trends have been experienced in parts of the world worldwide signifies that coordinated

worldwide interventions, such as strengthening immunization programs and access to care, could effectively counteract the burden. Nevertheless, our study's specific variation between regions reveals a role for localized interventions with consideration of regional, educational, and cultural factors in an attempt at controlling measles with greater success.

Some of the factors concerning the limitations of our study have to be kept in mind. First, our study was a single-center one, and its generalizability to larger groups cannot therefore be assured. Even when our sample fairly represented our region's population, it cannot represent all regions and settings in terms of diversity in terms of factors of risk. Recall bias could have contaminated parental recall in terms of accuracy concerning vaccination and other factors in our study. Finally, in an observational study, inferences concerning causality cannot necessarily be drawn, and multi-center studies in larger settings will serve to validate our observations and evaluate the factors in a larger variety of settings.

CONCLUSION

Our study confirmed malnutrition, lack of vaccination, and poor socioeconomic status to be significant causative factors for complicated measles in children. All these observations agree with previous studies in most regions of the globe, and it re-emphasizes the need for specific interventions for nutrition improvement, vaccination, and access to care, particularly in rural and underprivileged communities. Intervention in these factors through overall public interventions can effectively restrict disease burden and complications.

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Authors' Contributions

Bibi Tayyaba Swati led the study, managed manuscript preparation, and oversaw hospital data collection. Saima Bibi refined the study design, analyzed data, and contributed to manuscript clarity. All authors reviewed and approved the study.

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