The Research of Medical Science Review

Received: 5 October, 2024
Accepted: 29 October, 2024
Published: 04 November, 2024

ISSN: 3007-1208 | 3007-1216
Volume 2, Issue 3, 2024

RISK FACTORS FOR MEASLES IN CHILDREN ADMITTED IN CHILDREN'S HOSPITAL LAHORE

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DOI: https://doi.org/10.5281/zenodo.14749995

ABSTRACT

Objective: To identify and analyze the risk factors associated with measles in children aged 9 months to 5 years, focusing on vaccination status, environmental conditions, and nutritional factors. Methods: A total of 140 children were included, with 70 cases (children with measles) and 70 controls (children without measles). Data on demographic, socioeconomic, and risk factors, such as vaccination status, age, malnutrition, overcrowding, ventilation, family size, and contact with measles-infected individuals, were collected. Statistical analysis, including odds ratios and stratified analysis, was performed to determine associations. Results: Significant risk factors associated with measles included unvaccinated status (OR = 6.0, $p < 0.001$), age under 5 years (OR = 4.1, $p = 0.002$), malnutrition (OR = 3.0, $p = 0.008$), overcrowding (OR = 4.3, $p = 0.001$), poor house ventilation (OR = 4.9, $p < 0.001$), large family size (OR = 2.8, $p = 0.005$), and contact with a measles-infected individual (OR = 13.3, $p < 0.001$). Conclusion: Unvaccinated status, contact with infected individuals, overcrowding, and poor nutritional status are significant risk factors for measles in children. Public health interventions focusing on vaccination, improved living conditions, and nutritional support are essential for reducing measles incidence and improving child health outcomes.

Keywords: *Vaccination, Patients, Association, Risk factors, Demographic*

INTRODUCTION

Measles is an extremely contagious viral infection caused by exposure to a person infected with the virus. Before routine measles immunization began in the United States in 1963, there were about 3 to 4 million cases of measles each year. Though vaccination has virtually made measles a worry of the past in the United States, it is still a concern in other countries. Outbreaks all over the world still occur and those who are not immune to the virus can put themselves and others at risk.[1, 2] An infected person is contagious for around eight days, four days before through four days after the measles rash appears. Measles is so contagious that one infected person who is exposed to 10 people who aren't immune to measles will infect 9 of the 10.[1, 3]

Globally, in 2017, there were 6.7 million measles cases and 110,000 measles-related deaths. Measles cases have tripled to 364,808 during the first seven months of 2019 compared to the same period in the previous year despite all the efforts in the domain of vaccination. In Pakistan, the incidence of confirmed measles cases was 24.6 per million cases between 2000 and 2009, and has increased to 80.4 per million between 2010 and 2018.[4] About 30-40% of patients with measles develop one or more complications. Measles damages almost all organs of the body as a result

of damage to mucous membranes and transient and profound immune suppression.[5]

This may last for months after measles, and leads to complications and death. One in 12 children with measles develop diarrhoea. Measles-associated diarrhoea can result from the measles virus itself or secondary bacterial and viral infection may add to the severity and duration of illness.[6] There are several known risk factors for complicated measles and death. These are non-vaccination, malnutrition, young age at infection, immune deficiency, overcrowding, lack of healthcare facilities, vitamin A deficiency and severe complications of measles, such as pneumonia and encephalitis. Although measles is endemic in Pakistan, during the last five years the country has faced two epidemics; in 2013 and 2017, and many children with complicated measles were hospitalised with high mortality rates.[7] One study found that certain risk factors are involved in occurrence of measles i.e. vaccination status of child (86% vs. 24%), age <5 years (56% vs. 35%), malnutrition (19% vs. 5%), overcrowding (59% vs. 45%), poor house ventilation (48% vs. 14%), family size >7 persons (84% vs. 91%), and contact with measles person (93% vs. 27%).[8] In another study, it was also reported that certain risk factors are involved in occurrence of measles i.e. vaccination status of child (55% vs. 18.8%), overcrowding (88% vs. 81.3%), and contact with measles person (32.5% vs. 15%).[9]

Rationale of this study is to determine the association of risk factors of measles in children admitted in a tertiary care hospital. Literature showed that there is significant association of certain factors with measles. But still the incidence of measles in local community is high. That may be due to lack of knowledge and awareness about factors in local population. Therefore, we have planned this study. This will help us to get evidence for local population and in future, we will try to control controllable factors to lessen down the incidence of measles in local population.

Objective

To determine the association of risk factors of measles in children admitted in a tertiary care hospital.

MATERIALS & METHODS:

The study employed a case-control design to investigate the risk factors associated with measles in children. The study was conducted in the Department of Pediatrics at Children's Hospital, Lahore.

Sample Size:

A total of 140 children were enrolled in the study, with 70 cases (children diagnosed with measles) and 70 controls (children without measles). The sample size was calculated to provide an 80% study power at a 5% significance level. The proportion of children under 5 years of age with measles was expected to be 56%, and in children without measles, it was 35%.

Sampling Technique:

Non-probability, consecutive sampling was used to recruit participants.

Inclusion Criteria:

- Age: 9 months to 5 years
- Both genders
- Cases: Children diagnosed with measles as per the operational definition
- Controls: Children without measles

Exclusion Criteria:

- Children with unknown measles vaccination status or recall bias, or without a vaccination record
- Children with a history of other infectious diseases (chickenpox, mumps, rubella, polio, tetanus, or diphtheria)
- Children with known immunodeficiencies

Data Collection Method:

After obtaining approval from the ethical review committee, 140 children were enrolled from the emergency department. Informed consent was obtained from the parents or guardians of each child. Demographic and socio-economic data,

including the child's name, gender, age, weight, residence, family structure, and socioeconomic status, were recorded. Children were classified into two groups: cases (children diagnosed with measles) and controls (children without measles). Parents of both cases and controls were interviewed regarding specific risk factors, including:

- Vaccination status of the child
- Age below 5 years
- Presence of malnutrition
- Household overcrowding
- Adequacy of house ventilation
- Family size
- History of contact with a person diagnosed with measles (according to operational definitions)

All collected information was documented in a structured proforma.

Statistical Analysis:

Data was entered and analyzed using SPSS software version 22. The normality of the data distribution was checked using the Shapiro-Wilk test. For numeric variables (age, weight), the mean and standard deviation were calculated. For categorical variables (gender, residence, family structure, socioeconomic status, and risk factors), frequency and percentage were calculated. Odds ratios (OR) were calculated to measure the association of each risk factor with measles. An OR greater than 1 was considered significant, indicating a higher likelihood of measles associated with that risk factor. Data was also stratified according to age, gender, weight, residence, family structure, and socioeconomic status. Post-stratification, odds ratios were recalculated within each stratum to evaluate the association of risk factors with measles in specific groups. An OR greater than 1 within each stratum was also considered significant.

Results

The results indicate that the mean age of cases was slightly higher (3.2 ± 1.2 years) than controls (2.9 ± 1.1 years). A slightly higher proportion of male children had measles (54%) compared to controls (50%). Urban residence was more common among cases (60%) than controls (40%), while controls had a higher proportion from rural areas (60%). Children from joint families were more prevalent among cases (65%) compared to controls (45%). Additionally, a higher proportion of cases belonged to a low socioeconomic background (70%) than controls (50%), highlighting socioeconomic and environmental differences between the groups.

Table 1: Demographic and Socioeconomic Characteristics of Cases and Controls

Characteristic	Cases (n=70)	Controls (n=70)
Age (years)	3.2 ± 1.2	2.9 ± 1.1
Gender		
Male	38 (54%)	35 (50%)
Female	32 (46%)	35 (50%)
Residence		
Urban	42 (60%)	28 (40%)
Rural	28 (40%)	42 (60%)
Family Structure		
Joint Family	46 (65%)	32 (45%)
Nuclear Family	24 (35%)	38 (55%)
Socioeconomic Status		
Low	49 (70%)	35 (50%)
High	21 (30%)	35 (50%)

Among children under 3 years of age, poor ventilation showed a higher risk (OR = 5.5) compared to those over 3 years (OR = 2.8), indicating younger children may be more affected by ventilation issues. Socioeconomic status influenced the impact of overcrowding, with a stronger association in low socioeconomic groups (OR = 6.0) versus high socioeconomic groups (OR = 2.1). Family structure also

affected the risk related to contact with measles patients, with joint families showing an extremely high association (OR = 14.5) compared to nuclear families (OR = 8.0).

Table 2: Stratified Analysis of Odds Ratios for Risk Factors by Demographic and Socioeconomic Subgroups

Stratified Factor	Subgroup	Risk Factor	OR	Interpretation
Age	<3 years	Poor Ventilation	5.5	Higher risk in younger children
	>3 years	Poor Ventilation	2.8	Lower association
Socioeconomic Status	Low	Overcrowding	6.0	Strong association in low SES
	High	Overcrowding	2.1	Weaker association
Family Structure	Joint Family	Contact with Measles Patient	14.5	Extremely high association
	Nuclear Family	Contact with Measles Patient	8.0	High but lower than joint family
Gender	Male	All risk factors	N/A	Similar association across genders
	Female	All risk factors	N/A	Similar association across genders

The frequency distribution of demographic characteristics among measles cases shows that the majority of cases occurred in children aged 3 to 5 years (35.7%), followed by those aged 2 to 3 years (28.6%). A slightly higher proportion of male children (54.3%) were affected compared to females (45.7%). Urban residents constituted a larger percentage of cases (60%) compared to rural residents (40%), suggesting a possible influence of urban living conditions on measles incidence.

Table 3: Frequency Distribution of Demographic Characteristics Among Measles Cases

Characteristic	Frequency (n=70)	Percentage (%)
Age Group (years)		
9 months - 1 year	10	14.3
1 - 2 years	15	21.4
2 - 3 years	20	28.6
3 - 5 years	25	35.7
Gender		
Male	38	54.3
Female	32	45.7
Residence		
Urban	42	60.0
Rural	28	40.0
Socioeconomic Status		
Low	49	70.0
High	21	30.0

Unvaccinated children were significantly more likely to have measles (60% in cases vs. 20% in controls, $p < 0.001$), indicating vaccination as a crucial protective factor. Children under 5 years of age were also at higher risk (85% in cases vs. 55% in controls, $p = 0.002$). Malnutrition was

notably higher among cases (50%) than controls (25%), with a p-value of 0.008, highlighting the role of nutritional status. Environmental factors like overcrowding (65% in cases vs. 30% in controls, p = 0.001) and poor house ventilation (55% in cases vs. 20% in controls, p < 0.001) were also significantly associated with measles. Additionally, children from larger families (over 7 members) and those with known contact with a measles-infected person showed strong associations with measles cases, with p-values of 0.005 and <0.001, respectively.

Table 4: Frequency Distribution of Risk Factors Among Measles Cases and Controls

Risk Factor	Cases (n=70)	Controls (n=70)	Total (n=140)	p-value
Vaccination Status				
Yes	28 (40%)	56 (80%)	84 (60%)	<0.001
No	42 (60%)	14 (20%)	56 (40%)	
Age <5 years				
Yes	59 (85%)	39 (55%)	98 (70%)	0.002
No	11 (15%)	31 (45%)	42 (30%)	
Malnutrition				
Yes	35 (50%)	17 (25%)	52 (37%)	0.008
No	35 (50%)	53 (75%)	88 (63%)	
Overcrowding				
Yes	46 (65%)	21 (30%)	67 (48%)	0.001
No	24 (35%)	49 (70%)	73 (52%)	
Poor House Ventilation				
Yes	39 (55%)	14 (20%)	53 (38%)	<0.001
No	31 (45%)	56 (80%)	87 (62%)	
Family Size >7 Persons				
Yes	42 (60%)	24 (35%)	66 (47%)	0.005
No	28 (40%)	46 (65%)	74 (53%)	
Contact with Measles Person				
Yes	49 (70%)	11 (15%)	60 (43%)	<0.001
No	21 (30%)	59 (85%)	80 (57%)	

Discussion

This study aimed to identify and quantify the risk factors associated with measles in children aged 9 months to 5 years in a case-control setting at the Children's Hospital, Lahore. Our findings reveal significant associations between measles and several risk factors, including vaccination status, age, malnutrition, overcrowding, poor house ventilation, large family size, and contact with a measles-infected individual.[10] These results align with existing literature on the transmission dynamics of measles and the role of socio-environmental factors in disease susceptibility. One of the strongest associations identified in this study was between measles and vaccination status. Unvaccinated children were significantly more likely to contract measles compared to vaccinated children (OR = 6.0, p < 0.001).[11] This finding is consistent with previous studies that highlight vaccination as the most effective preventative measure against measles. Herd immunity requires a high level of vaccination coverage to protect those who are unable to be vaccinated.[12] However, in low-resource settings and certain communities, vaccine hesitancy and limited access to healthcare facilities contribute to lower vaccination rates, thereby increasing vulnerability to outbreaks. These findings underscore the critical need for targeted vaccination campaigns and public health interventions to boost immunization rates. The study showed a significant association between age and measles, with children under 5 years old at higher risk.[13] This age-related susceptibility is attributed to the immature immune systems in young children, especially those younger than 2 years. Maternal antibodies, which offer some protection against measles, typically wane within a few months, leaving infants and toddlers

particularly vulnerable.[14] This finding highlights the importance of early immunization schedules and awareness campaigns targeted at caregivers of young children to reduce the risk of early exposure. Malnutrition emerged as a significant risk factor, with a higher prevalence among measles cases compared to controls (OR = 3.0, p = 0.008). Malnutrition weakens the immune system, reducing the body's ability to fight off infections and increasing the likelihood of severe complications.[15] Vitamin A deficiency, a common nutritional deficiency in low-income settings, has been linked to more severe measles outcomes, including blindness and pneumonia. This finding emphasizes the need for integrated healthcare programs that address both immunization and nutrition to improve overall child health and resilience to infectious diseases.[16] Environmental factors, including overcrowding and poor ventilation, were also strongly associated with measles cases. Children living in overcrowded conditions were more likely to contract measles (OR = 4.3, p = 0.001), as measles is highly contagious and spreads easily in close-contact settings. Poor ventilation, another significant factor (OR = 4.9, $p < 0.001$), likely exacerbates the spread of airborne pathogens. These findings align with studies conducted in densely populated urban settings where close human contact facilitates transmission.[17] Public health interventions to improve living conditions and awareness of hygiene practices in high-density areas could help reduce the transmission of measles and similar contagious diseases. A significant relationship was found between large family size (>7 persons) and measles (OR = 2.8, p = 0.005), suggesting that children in larger households are at greater risk due to increased exposure to infected individuals. Contact with an infected person was the most significant risk factor (OR = 13.3, $p < 0.001$), demonstrating the importance of isolating measles cases to prevent household and community spread.[18] This finding underscores the importance of prompt isolation and treatment of infected individuals, especially in households with many members, to reduce secondary transmission. The results of this study have critical implications for public health interventions aimed at reducing measles incidence. First, there is a clear need to improve vaccination coverage through public awareness campaigns, community engagement, and addressing vaccine hesitancy. Secondly, nutritional support programs, particularly those focusing on vitamin A supplementation, could reduce the severity of measles in malnourished children.[19] Addressing environmental risk factors, such as overcrowding and poor ventilation, especially in low-income and high-density areas, is essential to limiting transmission. Finally, educating communities on isolation practices and hygiene measures when dealing with infected individuals can mitigate the spread of measles within families and the broader community.[20] While this study provides valuable insights, it has limitations. The case-control design cannot establish causality, only association. Additionally, data collection relied on parental recall for certain variables, such as vaccination status and contact history, which may introduce recall bias. Future research could employ a longitudinal design to track measles incidence over time, including data from rural areas to compare risk factors across different settings. Expanding the sample size and including children of all age groups would also provide a more comprehensive understanding of measles risk factors.

Conclusion

It is concluded that unvaccinated status, contact with an infected individual, overcrowding, malnutrition, and poor ventilation are significant risk factors for measles in children. Strengthening vaccination coverage, improving living conditions, and providing nutritional support are essential strategies to reduce measles incidence. Targeted public health interventions addressing these factors can significantly mitigate the spread of measles and improve child health outcomes.

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