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Original Research Article

An Observational Study Assessing Association between Measles Antibody Titres with Nutritional Status in Children

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Abstract

Aim: The aim of the present study was to find out any association of measles antibody titres with nutritional status in children 1 to 12 years.

Methods: This hospital based cross-sectional study was conducted in the duration of one year on 1–12-year-old children attending the Pediatric O.P.D. of Department of Pediatrics, with the objective of finding out the seroprevalence and anti-measles antibody levels, and studying their association with age, gender, as well as nutritional status of these children.

Results: A significant proportion (66.66%) of the whole sample population has received vaccination for measles. Nevertheless, the statistical analysis did not reveal a significant association between age and vaccination status (p=0.160). There were no statistically significant differences identified in the baseline parameters between the vaccinated and unvaccinated groups, with the exception of the mean weight for age Z score, which was considerably lower in the unvaccinated group. A total of 38.34% of the individuals aged ≤5 years had severe wasting, also known as severe acute malnutrition, while 35% displayed moderate wasting. Among children aged five years and older, 23.34% exhibited extreme thinness, 13.33% displayed thinness, and a mere 0.6% were classified as overweight, with just two cases falling into this category. A significant proportion of the vaccinated individuals aged five years or less, namely 43%, exhibited severe wasting, often known as severe acute malnutrition. Additionally, 35% of the participants had moderate wasting. A strong and statistically significant correlation was found between BMI Z scores in individuals aged 5 years and older and seropositivity. The data revealed that children with higher BMI Z scores had a greater likelihood of being seropositive. In a similar vein, a statistically significant correlation was found between height for age Z scores and seropositivity. Specifically, it was shown that children with greater height for age z scores exhibited higher levels of seropositivity.

Conclusion: The nutritional status of children exhibits a correlation with both measles antibody titres and the geometric mean titre (GMT) of measles-specific IgG antibodies. Specifically, children with improved nutritional status tend to have greater levels of measles antibody titres.

Keywords: Measles, Vaccine, Antibody, Vaccination, Malnourished, Anthropometry.

Introduction

Measles is a highly contagious infectious illness that is prevalent among the pediatric population. The etiology of this condition may be attributed to a viral pathogen classified under the myxoviruses taxonomic category. [1] The Globally, measles stands as the most prevalent illness that may be prevented with vaccination, constituting 38% of the overall disease burden. Measles, despite the availability of safe and cost-effective vaccines, is a significant contributor to mortality rates among young children, particularly in underdeveloped nations. [2,3] According to the World Health Organization (WHO), a total of 145,700 deaths resulting from measles were recorded in the year 2014. This translates to an average of 400 children succumbing to the disease on a daily basis, or almost 16 deaths occurring every hour. [3,4] The worldwide death rate for measles had a significant decline of 75% between 2000 and 2013 as a direct result of widespread vaccination efforts. [5]

Globally, it has been observed that around 84% of children aged 1 year have gotten at least one dose of the measles vaccine, mostly due to regular vaccination efforts. Despite the aforementioned precautions, measles remains a prominent contributor to both illness and death in impoverished nations, mostly owing to the presence of underlying malnutrition and overcrowding. Measles is a prominent etiological factor for morbidity and a substantial contribution to death among children in India. [6] In India, in the year 2011, a total of 33,634 children were affected with measles, resulting in 56 fatalities. In India, measles is responsible for 3% of mortality among children under the age of 5. [7] India accounts for 47% of worldwide measles-related fatalities, mostly attributed to its high population density and inadequate vaccine coverage. [8] The measles immunization is administered to just 71% of children aged 9 to 12 months. With a seroconversion rate of 85% seen with vaccination at 9 months, it is evident that only 60% of children get protection at this age. A significant proportion of youngsters, namely 40%, continue to possess vulnerability to measles, hence contributing to the occurrence of outbreaks. [9]

The seroconversion capacity of a newborn is contingent upon their age, since it is influenced by the quantity and degradation of maternal antibodies, as well as the maturation of their immune system. Additionally, variations in seroprevalence have been noted across different geographic regions. Pregnant women residing in regions with high disease prevalence may exhibit a higher likelihood of having acquired natural measles infection, leading to elevated levels of measles antibodies. Consequently, these antibodies can be transmitted across the placenta to their infants, providing a more durable form of protection compared to expectant mothers who have developed antibodies through vaccination. [10,11] The presence of measles may lead to the occurrence of malnutrition due to factors such as protein-losing enteropathy, heightened metabolic requirements, and reduced dietary consumption. Children who have measles at an early age exhibit a notable decrease in average weight relative to their age-matched counterparts who do not contract the disease.

Therefore, the objective of this research was to investigate if there is any correlation between measles antibody titers and nutritional status in children aged 1 to 12 years.

Material & Methods

This hospital based cross-sectional study was conducted in the duration of one year on 1–12-year-old children attending the Pediatric O.P.D. of Department of Pediatrics, SKMCH, Muzaffarpur, Bihar, India with the objective of finding out the seroprevalence and anti-measles antibody levels, and studying their association with age, gender, as well as nutritional status of these children. A total of 430 patients were evaluated initially. Out of these, 300 patients whose parents consented for the study were enrolled in the study. The procedure of systematic random sampling was used for selection of subjects. Blood samples were tested for presence of measles specific IgG antibodies.

Inclusion criteria

- Children in the age group of 1 to 12 years.

Exclusion criteria

- Refuses to give parental consent,
- Received blood or
- Blood components within last 3 months, received corticosteroid therapy or other immunosuppressive therapy, are HIV positive, are transplant recipients (bone marrow/ solid organ), received of gamma globulins within last 2 months, are on dialysis and are having malignancies.

Clearance was sought from Institutional Ethics Committee of Department of Pediatrics, SKMCH, Muzaffarpur, Bihar, India. The techniques of measurement described in Cogill's (2003). [12] Anthropometric Indicators Measurement Guide were followed to make the following measurements.

Weight was measured using a portable electronic weighing scale with a weighing capacity from 1 kg to 150 kg in 100 g divisions, accuracy +/- 100g.

Height: was measured in centimetres to a precision of 0.1cm by a wall mounted tape measuring up to 2 meters. An infantometer was used to measure the length for children less than 2 years of age.

The following indices & their z scores were calculated:

Body Mass Index (BMI) = $Weight\ (Kg)/\ Height\ (m)^2$.

Weight for age: for children less than 10 years of age by W.H.O standard growth chart and z score was calculated.

Height for age: for all children based on W.H.O standard growth chart and z score was calculated.

Weight for height: for children less than 5 years based on W.H.O standard growth chart and zscore was calculated.

Nutritional status of children was classified on the basis of the WHO Growth Standards, 2006 for 0-60 months; and the WHO Reference, 2007 for 5-19 years.

Children 5-19 Years:

Overweight: >+1SD (equivalent to BMI 25 kg/m2 at 19 years) Obesity: >+2SD (equivalent to BMI 30 kg/m2 at 19 years). Thinness: <- 2SD. Severe thinness: <-3SD.

Children 0-60 months:

Moderate wasting: weight-for length/ height Z - score -2 to -3 Severe wasting (severe acute malnutrition): weight-for length/ height Z –score <- 3.

Overweight: BMI-for-age or weight-for-length/ height Z -score > 2. Obesity: BMI-for-age or weight for- length/ height Z -score>3. Moderate stunting: length/ height for age Z -score -2 to -3. Severe stunting: length/ height for age Z -score < - 3.

Blood samples were collected, and serums were separated by centrifugation and stored at -20 degree Celsius till the time of assay. Measles specific IgG antibodies were detected by using a commercial IgG ELISA kit (Measles Virus IgG ELISA, IBL International GMBH) in accordance with the manufacturer's instructions.

Results

Table 1: Vaccination status of children against measles

Age group (years)	Vaccinated N (%)	Unvaccinated N (%)	Total	P value
1-12	200 (66.66)	100 (33.34)	300	0.160

Majority (66.66%) of the total subjects had been vaccinated against measles. However, the relationship between age and vaccination status was not found to be statistically significant (p=0.160).

Table 2: Baseline characteristics of measles vaccinated and unvaccinated children

Characteristics	Vaccinated mean±SD	Unvaccinated mean±SD	P value
Age (years)	6.4±3.0	5.6±3.4	0.518
Weight (kg)	16.4±7.3	16.2±6.1	0.248
Height (cm)	104.6±20.2	108.2±20.5	0.652
BMI (kg/m^2)	14.4±2.6	14.6±1.7	0.119
Weight for age Z score (1-10 years)	-1.4±1.2	-2.6±1.6	0.024
Height for age Z core	-1.6±0.4	-1.7±1.4	0.0752
Weight for height Z score(1-5 years)	-1.6±1.6	-1.6±1.8	0.422
BMI Z Score	-1.6±2.4	-1.6±1.8	0.645

No statistically significant difference was observed in the baseline characteristics of vaccinated and unvaccinated group except for mean weight for age Z score which was significantly lower in the unvaccinated group.

Table 3: Nutritional status of subjects

Parameter of Nutritional status		Total	(%)	Vaccinated	(%)	cinated N	(%)
t for ageZ Score (age ≤10yrs)	< -3	60	20	44	22	16	16
	-2 to-3	100	33.34	70	35	30	30
	>-2	140	46.66	86	43	54	54
	Total	300	100	200	100	100	100
Veight forHeight Z Score (age≤5yrs)	<-3	80	26.66	60	30	20	20
	-2 to-3	105	35	70	35	35	35
	>-2	115	38.34	70	35	45	45
	Total	300	100	200	100	100	100
Height for Age ZScore	<-3	18	6	10	5	8	8
	-2 to-3	60	20	40	20	20	20
	>-2	222	74	150	75	72	72
	Total	300	100	200	100	100	100
BMI for age Z score (age > 5yrs;	<-3	70	23.34	40	20	30	30
	-2 to-3	40	13.33	20	10	20	20
	>-2 to 1	188	62.66	138	69	50	50
	>1	2	0.6	2	1	0	0
	Total	300	100	200	100	100	100

38.34% of the total subjects ≤5 years old had severe wasting (severe acute malnutrition), while 35% had moderate wasting. In children > 5 years, 23.34% had severe thinness, 13.33% had thinness and only 2 (0.6%) case was overweight. 43% of the vaccinated subjects ≤5 years old had severe wasting (severe acute malnutrition), while 35% had moderate wasting.

Table 4: Relationship of measles antibody status with nutritional status of total subjects

Parameter of nutritional status		Antibody status							P value
		Positive	N (%)	Negative	N (%)	Equivocal	N (%)	Total	
Weight for Age z score (age ≤10yrs)	<-3	40	66.6	15	25	5	8.33	60	0.052
	-2 to-3	72	72	20	20	8	8	100	
	>-2	98	70	20	14.28	22	15.72	140	
Height forAge	<-3	3	50	2	33.33	1	16.66	6	0.026
	-2 to-3	9	45	8	40	3	15	20	
	>-2	50	67.56	17	22.97	7	9.45	74	
Weight for Height z Score (age <5 years)	<-3	45	56.25	24	30	11	13.75	80	0.634
	-2 to-3	65	61.90	25	23.80	15	14.28	105	
	>-2	65	56.52	40	34.78	10	8.69	115	
BMI	<-3	39	54.28	26	37.14	5	7.14	70	0.001
	-2 to-3	24	60	12	30	4	10	40	
	>-2 to 1	150	79.78	28	14.89	10	5.31	188	
	>1	2	100	0	0	0	0	2	

A highly statistically significant relationship was observed between BMI Z scores (in subjects aged ≥5yrs) and seropositivity, with higher seropositivity being noted in children with higher BMI z scores. Similarly, a statistically significant relationship was observed between height for age Z scores and seropositivity, with higher seropositivity being noted in children with higher height for age z scores.

Table 5: Nutritional status wise geometric mean titer (GMT) of measles specific igg antibody of total children

Parameters of nutritional status		GMT (mIU/mL)	P value
W/A z score	> -2SD	932	0.001
	<-2SD to-3SD	669	
	<-3SD	549	
H/A z score	-2SD	1790	0.005
	-2SD to-3SD	680	
	<-3SD	382	
W/H z score	> -2SD	579	0.555
	-2SD to-3SD	569	
	<-3SD	558	

It was not found statistically significant with p value 0.05 for seropositivity but significant with p value for antibody levels. In weight for length/height both seropositivity and GMT were found insignificant in well-nourished, moderately malnourished as well as severely malnourished subject.

Discussion

Measles is a contagious illness that has a high level of transmissibility and is often seen in the pediatric population. The etiology of this condition is attributed to a viral pathogen classified under the myxoviruses taxonomic category. [13] Globally, measles stands as the predominant vaccine-preventable illness, constituting 38% of the overall disease burden. [14] Despite the availability of safe and cost-effective vaccines, measles remains a significant cause of mortality among young children, particularly in underdeveloped nations. [15] According to the World Health Organization (WHO), a total of 145,700 deaths attributed to measles were recorded in the year 2014. This translates to an average of 400 child fatalities each day, or almost 16 deaths occurring every hour. [16,17] Globally, it has been observed that around 84% of children aged one year have gotten at least one dose of the measles vaccine, mostly due to regular vaccination efforts. Despite the aforementioned precautions, measles remains a prominent contributor to both illness and death in impoverished nations, mostly owing to the presence of underlying malnutrition and overcrowding. [18]

A significant proportion (66.66%) of the whole sample population has received vaccination for measles. Nevertheless, the statistical analysis did not reveal a significant association between age and vaccination status (p=0.160). There were no statistically significant differences seen in the baseline characteristics between the vaccinated and unvaccinated groups, with the exception of the mean weight for age Z score, which was found to be considerably lower in the unvaccinated group. A total of 38.34% of the individuals aged ≤5 years had severe wasting, also known as severe acute malnutrition, while 35% displayed moderate wasting. Among children aged five years and older, 23.34% exhibited extreme thinness, 13.33% displayed thinness, and a mere 0.6% were classified as overweight, with just two cases falling into this category. A significant proportion of vaccinated individuals aged ≤5 years had severe wasting (severe acute malnutrition), with 43% presenting this condition. Additionally, 35% of the vaccinated patients showed moderate wasting. The study conducted by McMurray et al. (2019) [19] revealed that there was no significant impact on the nutritional condition of children after immunization. All children have equivalent immune responses in relation to their dietary condition. The hemagglutination-inhibition titres exhibit a small decrease across all dietary groups at the 14-month mark after immunization. Smedman et al. (2020) [20], Halsey et al. (2021) [21], and Ekunwe et al. (2022) [22] saw a favorable antibody response among children who did not exhibit severe malnutrition. In a similar vein, Lyamuya et al. [23] discovered that changes in dietary status did not provide any statistically significant differences in measles antibody levels. Several investigations have shown that the rates of seroconversion in malnourished children are comparable to those in well-nourished children. This is attributed to the suppression of cell-mediated immunity rather than humoral immunity. [24,25] In line with our investigation, separate research has provided evidence indicating a correlation between stunting and diminished antibody response. [26] In the aforementioned research, severe stunting was shown to be correlated with lower antibody response. Additionally, severe wasting was also identified as a factor linked with lower antibody response. However, it is important to note that this particular discovery was not replicated in our own investigation. Idris and colleagues [27] observed a reduction in antibody levels in children diagnosed with Kwashiorkor. Hafez and colleagues [28] discovered a reduction in the humoral response to the measles vaccination.

A strong statistical association was found between BMI Z scores (in individuals aged ≥5 years) and seropositivity, indicating that children with higher BMI Z scores had a greater likelihood of being seropositive. Likewise, a statistically significant correlation was found between height-for-age Z scores and seropositivity, indicating that children with greater height-for-age Z scores exhibited higher levels of seropositivity. The findings of the study indicate that the administration of measles vaccination to malnourished children within the community is both safe and efficacious. However, there are studies that have shown a favorable antibody response, while others have indicated a less satisfactory antibody response. The understanding of the processes behind the immune response remains insufficient. Further investigation is required in this domain in order to reach any definitive conclusions.

Conclusion

There exists a correlation between the nutritional status of children and their measles antibody titres, as well as the geometric mean titre (GMT) of measles-specific IgG antibody. Children with superior nutritional condition tend to exhibit greater measles antibody titres.

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