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Original Research Article

Comparison of COVID-19 antibody levels in school - aged children and healthy adults: evidence from a tertiary care hospital of Bangladesh

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ABSTRACT

Background: The immune response to COVID-19 varies among individuals based on multiple factors, including age, comorbidities and prior exposure to the virus. Understanding these variations is crucial for optimizing vaccination strategies and public health policies. This study was conducted in a tertiary-level hospital in Bangladesh to assess whether age influences COVID-19 antibody levels among school-aged children and healthy adults.
Methods: This cross-sectional observational study was conducted at Central Police Hospital, Dhaka, Bangladesh, between September 2022 and August 2024. Data were collected from two groups: children aged 3-15 years attending the Paediatric Outpatient Department and adults aged 25-76 years attending the Medicine Outpatient Department for routine medical visits. A total of 94 children and 112 adults were included in the study. All statistical analyses were conducted using statistical software SPSS version 26.0.
Results: The mean total antibody levels ranged from 94±14.6 in children aged 3-5 years to 98±15.1 in adults aged 41-60 years, with no significant difference across age groups ($p=0.827$). Regression analysis showed that age was not a significant predictor of antibody levels ($\beta_1=0.015$, $p=0.252$). Comorbidities in adults, including diabetes (96±15.1, $p=0.612$), hypertension (95±13.8, $p=0.529$) and heart disease (93±16.5, $p=0.451$), did not significantly affect antibody responses.
Conclusions: This study found that school-aged children exhibited significant COVID-19 antibody levels despite neither being vaccinated nor having a documented history of infection. In contrast, healthy adults achieved comparable antibody levels primarily through vaccination. Regression analysis confirmed that age was not a significant predictor of antibody levels and comorbidities did not have a notable impact on antibody responses in adults. These findings suggest that children may acquire antibodies through alternative mechanisms, such as asymptomatic exposure or passive immunity, while adults rely on vaccination for immune protection.

Keywords: Age-dependent variation, Adult, COVID antibody, School aged children

INTRODUCTION

The emergence of the novel coronavirus (SARS-CoV-2) in late 2019 led to a global pandemic, causing significant morbidity and mortality worldwide. As of 2022, the virus has infected over 600 million individuals and resulted in more than 6 million deaths globally.[1] Bangladesh, like many other countries, faced multiple waves of COVID-19 infections, with the first case reported in March 2020.[2] The immune response to SARS-CoV-2, particularly the production of antibodies, has been a crucial aspect of understanding immunity and vaccine efficacy. While antibody responses have been studied extensively in adults, there is still debate regarding age-dependent variations in antibody levels, particularly among children and healthy adults.[3]

Antibodies, specifically immunoglobulin G (IgG), serve as indicators of prior infection or vaccine-induced immunity. Several seroprevalence studies have assessed the presence and persistence of SARS-CoV-2 antibodies in different populations, helping to determine exposure rates and immune protection.[4] Some studies have reported age-related variations in antibody levels, suggesting differences in immune response among children and adults.[5] However, recent research from a tertiary-level hospital in Bangladesh indicates that there are no significant age-dependent variations in COVID-19 antibody levels between school-aged children and healthy adults.[6]

Seroprevalence studies from various regions have yielded mixed findings regarding age-dependent differences in antibody responses. A large-scale serological survey in Bangladesh conducted in 2021 reported an overall IgG seropositivity rate of 42%, with no significant difference across age groups.[6,7] Similar findings were observed in other low- and middle-income countries, where children and adults exhibited comparable antibody levels following natural infection or vaccination.[8] Conversely, some studies have suggested that older individuals may exhibit higher antibody titers due to prolonged exposure or repeated antigenic stimulation.[9] A study conducted in Dhaka during the early phase of the pandemic found an overall seroprevalence of 30.4% among the general population, with slightly lower rates in younger individuals.

However, after the vaccination rollout, no significant difference in IgG levels was observed between school-aged children and adults, indicating uniform immune responses across age groups.[10] Similar findings have been reported in sero epidemiological studies from India and Pakistan, further supporting the absence of age-related discrepancies in antibody levels post-infection and post-vaccination.[11,12] The introduction of COVID-19 vaccines has further influenced antibody dynamics across different age groups. Studies have shown that vaccine-induced antibody responses are generally robust across all age groups, though some reports indicate a more rapid decline in older populations.[13] A study in Bangladesh evaluating the persistence of neutralizing antibodies post-vaccination found no significant age-related differences in antibody levels among school-aged children and adults after receiving two doses of an mRNA or adenoviral vector vaccine.[14] This study aimed to evaluate the COVID-19 antibody levels among school-aged children and healthy adults in a tertiary-level hospital in Bangladesh.

METHODS

This cross-sectional observational study was conducted at Central Police Hospital, Dhaka, Bangladesh, between September 2022 and August 2024. Data were collected from two groups: children aged 3-15 years attending the Paediatric Outpatient Department and adults aged 25-76 years attending the Medicine Outpatient Department for routine medical visits. A total of 94 children and 112 adults were included in the study.

Venous blood samples were collected from all participants and transported to the laboratory within 6 hours. Serum aliquots were separated by centrifugation and stored at −20°C until serological analysis. COVID-19 antibodies targeting the receptor binding domain (RBD) of the SARS-CoV-2 structural protein were measured using a commercial semi-quantitative enzyme-linked immunosorbent assay (ELISA), assessing both IgG and IgM levels concomitantly. Inclusion criteria for the children's group were age between 3-15 years, unvaccinated for COVID-19, no known history of COVID-19 infection and no comorbidities.

For the adult group, inclusion criteria were age 25 years and above, vaccinated with at least one dose of COVID-19 vaccine, no known history of symptomatic COVID-19 infection and presence or absence of comorbidities, including diabetes, hypertension and heart disease. Exclusion criteria for both groups included acute or chronic illness at the time of enrollment and a history of symptomatic or severe COVID-19 infection.

Descriptive statistics, including frequency and percentage, were used for demographic and clinical variables. T-tests were conducted to compare antibody levels between different groups and ANOVA was used for multiple-group comparisons. Additionally, a linear regression analysis was performed to evaluate the association between age and total antibody levels. All statistical analyses were conducted using statistical software SPSS version 26.0.

RESULTS

Table 1 presents the distribution of patients according to demographic and clinical characteristics. The study population includes 94 children and 112 adults. Significant differences were observed in age groups, with children primarily falling within the <15 years range,

while adults were distributed across a broader age spectrum, including individuals aged 25-60 years. There were no significant gender differences between the two groups (p=0.812). The occupational status also varied significantly, with all children being students, while adults had diverse occupations including housewives, service holders, unemployed and retired individuals (p<0.001).

Marital status showed a significant difference, as all children were single, while most adults were married (p<0.001). The prevalence of comorbidities, such as diabetes, hypertension, heart disease and kidney disease, was significantly higher in adults compared to children (p<0.001, p<0.001, p=0.018, p=0.302, respectively). Other conditions were more common in adults, but no significant difference was found for malignancies (p=0.568).

Table 2 presents the distribution of patients according to their COVID-19 antibody levels across different age groups. The study shows the mean total antibody levels and mean Ig levels in children and adults. For total antibody levels, children aged 3-5 years had a mean level of 94±14.6, children aged 6-10 years had 96±14.8 and children aged 11-15 years had 97±14.4. In adults, the mean total antibody levels were 97±14.3 for those aged 25-40, 98±15.1 for those aged 41-60 and 96±14.7 for those over 60 years. The mean Ig levels were similarly distributed across age groups, ranging from 44±8.3 in children aged 3-5 years to 47±9.5 in adults aged 41-60 years. An analysis of variance (ANOVA) revealed no significant difference in antibody levels across the age groups (p=0.827), indicating that age did not significantly influence the antibody response in this study population.

Table 3 presents the distribution of patients according to family COVID-19 exposure. Among the children, 34.0% (32) had a family member affected by COVID-19, compared to 40.2% (45) of adults. The difference in family exposure between children and adults was not statistically significant (p=0.378). In the past three months, 19.1% (18) of children and 17.8% (20) of adults had a family member affected by COVID-19, with no significant difference observed (p=0.812).

Table 4 displays the distribution of adult patients according to the presence of comorbidities and their impact on COVID-19 antibody levels. The mean total antibody levels for adults with no comorbidities were 98±14.2, while those with diabetes, hypertension, heart disease, kidney disease and malignancy had slightly lower mean antibody levels of 96±15.1, 95±13.8, 93±16.5, 90±18.2 and 88±17.9, respectively. However, the p-values for each comorbidity group 0.745 for no comorbidity, 0.612 for diabetes, 0.529 for hypertension, 0.451 for heart disease, 0.317 for kidney disease and 0.248 for malignancy indicate that there were no statistically significant differences in antibody levels between these groups.

Table 5 presents the results of the regression analysis assessing the effect of age on COVID-19 antibody levels. The intercept (β_0) is 96.21 with a standard error of 0.55 and the t value is 176.11 (p<0.001), indicating a significant baseline antibody level. However, the coefficient for age (β_1) is 0.015, with a standard error of 0.013, a t value of 1.17 and a p value of 0.252, suggesting that age does not have a statistically significant effect on antibody levels (p>0.05). The 95% confidence interval for age ranges from -0.012 to 0.043.

Table 1: Distribution of patients according to demographic and clinical characteristics.

Variable	Children (n=94)	Adults (n=112)	P value
Age group (in years)			
<1	5 (5.3%)	0 (0%)	
1-3	12 (12.8%)	0 (0%)	
>3-5	20 (21.3%)	0 (0%)	
6-10	30 (31.9%)	0 (0%)	<0.001
11-15	27 (28.7%)	0 (0%)	
25-40	0 (0%)	40 (35.7%)	
41-60	0 (0%)	50 (44.6%)	
>60	0 (0%)	22 (19.7%)	
Gender			
Male	48 (51.1%)	60 (53.6%)	0.812
Female	46 (48.9%)	52 (46.4%)	
Occupation			
Student	94 (100%)	0 (0%)	
Housewife	0 (0%)	40 (35.7%)	
Service holder	0 (0%)	45 (40.2%)	<0.001
Unemployed	0 (0%)	15 (13.4%)	
Retired	0 (0%)	12 (10.7%)	

Continued.

Variable	Children (n=94)	Adults (n=112)	P value
Marital status			
Married	N/A	78 (69.6%)	<0.001
Single	94 (100%)	34 (30.4%)	
Source of patients			
Indoor admission	35 (37.2%)	50 (44.6%)	0.523
Outdoor visit	59 (62.8%)	62 (55.4%)	
Comorbidities			
Diabetes	0 (0%)	30 (26.8%)	<0.001
Hypertension	0 (0%)	40 (35.7%)	<0.001
Heart disease	0 (0%)	12 (10.7%)	0.018
Kidney disease	0 (0%)	5 (4.5%)	0.302
Malignancy	0 (0%)	3 (2.7%)	0.568
Other conditions	0 (0%)	10 (8.9%)	0.097

Table 2: Distribution of patients according to COVID-19 antibody levels across age groups.

Age group (in years)	N	Mean total antibody level±SD	Mean Ig Level±SD	P value (ANOVA)
Children (3-5)	32	94±14.6	44±8.3	0.827 (NS)
Children (6-10)	30	96±14.8	45±8.8	
Children (11-15)	32	97±14.4	46±9.1	
Adults (25-40)	40	97±14.3	46±9.2	
Adults (41-60)	50	98±15.1	47±9.5	
Adults (>60)	22	96±14.7	45±9.0	

NS: non-significant

Table 3: Distribution of patients according to family COVID-19 exposure.

Variable	Children (n=94)	Adults (n=112)	P value
Family member affected	32 (34.0%)	45 (40.2%)	0.378
Family member affected in last 3 months	18 (19.1%)	20 (17.8%)	0.812

Table 4: Distribution of patients according to COVID-19 and comorbidities impact on antibody levels.

Comorbidity	Adults (n=112)	Mean total antibody±SD	P value
No comorbidity	50	98±14.2	0.745
Diabetes	30	96±15.1	0.612
Hypertension	40	95±13.8	0.529
Heart disease	12	93±16.5	0.451
Kidney disease	5	90±18.2	0.317
Malignancy	3	88±17.9	0.248

Table 5: Distribution of patients according to regression analysis-effect of age on antibody levels.

Variable	Coefficient (β)	Standard error	T value	P value	95% confidence interval
Intercept (β_0)	96.21	0.55	176.11	<0.001	(95.07, 97.36)
Age (β_1)	0.015	0.013	1.17	0.252 (NS)	(-0.012, 0.043)

DISCUSSION

This study pursued to observe the existence of age-related inconsistencies in the levels of COVID-19 antibodies among school-aged children compared to healthy adult populations in Bangladesh. Our findings suggest that there were no statistically significant differences detected in the antibody levels across the different age cohorts, thereby implying that age did not exert a considerable influence on the antibody response elicited by COVID-19 vaccination. The analysis of the patient distribution based on various demographic characteristics revealed notable disparities concerning both age and occupational status when comparing the profiles of children to those of

adults. The paediatric population predominantly fell within the age bracket of 3 to 15 years, whereas the adult population was characterized by a more extensive age distribution encompassing a wider range of years. Moreover, significant occupational distinctions were clearly observable, given that all children were identified as students, contrasted with adults who were engaged in a variety of professions, including roles such as housewives, service holders and retirees. The profile of comorbidities exhibited a markedly higher prevalence in the adult population, with chronic conditions such as diabetes, hypertension and heart disease being more commonly observed when contrasted with the paediatric cohort, a finding that is consistent with the outcomes of other studies that similarly highlight a greater prevalence of comorbidities among adult individuals afflicted with COVID-19.

In terms of vaccination status, it is noteworthy that only the adult population demonstrated a high level of vaccination coverage, a situation that is reflective of the national vaccination initiatives implemented in Bangladesh, which have strategically prioritized the achievement of widespread vaccine coverage across the population.[17]

The antibody levels in both children and adults were found to be similar across different age groups, with no significant differences in total antibody or Ig levels. In children, the total antibody levels were 94±14.6 for the 3-5 years age group, 96±14.8 for the 6-10 years group and 97±14.4 for the 11-15 years group. In adults, the antibody levels ranged from 96±14.7 to 98±15.1 across different age groups, including those aged 25-40, 41-60 and >60 years.

These results align with studies conducted in various geographical areas, indicating that immunological responses elicited by COVID-19 vaccination are typically strong across different age demographics.[18,19] Another study indicated that the antibody responses triggered by vaccines do not differ markedly between younger and older groups, which reinforces our conclusions.[20] The minimal differences in antibody levels among various age groups may be due to the ability of COVID-19 vaccines, especially mRNA and adenoviral vector vaccines, to elicit a robust immune response in both children and adults.[21]

The resemblance in antibody levels between children and adults may also indicate the consistency in vaccine administration methods and immune response mechanisms. Notably, our findings also suggested that comorbidities, such as diabetes and hypertension, had no significant effect on antibody levels in adults.

Prior studies have twisted outcomes concerning the influence of comorbidities on COVID-19 antibody responses, with some studies suggesting that pre-existing conditions might diminish vaccine effectiveness, while others report minimal to no impact.[22,23] In the context of our regression analysis, the influence of age on antibody levels was determined to be statistically insignificant (p=0.252), indicating that age did not play a role in the antibody response observed in this inquiry.[24,25]

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

This study found that school-aged children exhibited significant COVID-19 antibody levels despite neither being vaccinated nor having a documented history of infection. In contrast, healthy adults achieved comparable antibody levels primarily through vaccination. Regression analysis confirmed that age was not a significant predictor of antibody levels and comorbidities did not have a notable impact on antibody responses in adults. These findings suggest that children may acquire antibodies through alternative mechanisms, such as asymptomatic exposure or passive immunity, while adults rely on vaccination for immune protection.

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