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Original article

Epidemiological profile of COVID-19 infection in children during the second and third waves in Diyala Governorate, Iraq: a retrospective cohort study

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ABSTRACT

Background: The COVID-19 pandemic has caused a significant global burden. The paediatric population constituted the least percentage of confirmed cases of COVID-19, However, the distribution of infection cases among children in Iraq is unknown. **Aims:** Exploring the epidemiological profile of COVID-19 infection in children during the second and third waves. **Methods:** Electronic medical records were used to obtain COVID-19 data from January 2021 to December of the same year. The data included samples from positive cases of suspected cases referred to the Coronavirus Screening Centre/Public Health Laboratory, as part of the COVID-19, Hepatitis, AIDS and Syphilis screening programme in Diyala Governorate. The study included 1326 children aged 1-14 years. All suspected cases were examined based on the appearance of symptoms using RT-PCR. **Results:** A total of 907 (68.4%) children were confirmed during the second wave compared to 419 (31.6%) cases in the third wave. In terms of age, young adolescents, aged 10-14 years, showed a significantly higher susceptibility to infection. The distribution of COVID-19 cases by gender shows that the rate of male children with COVID-19 was 60.2% (n=800), significantly higher than female children 39.6% (n=526). The peak increase in COVID-19 cases was observed during March and April with 242 cases (18.2%) and 211 cases (15.9%) during the second wave, while the peak of the third wave was in July with 183 cases (13.8%) reported and confirmed **Conclusion:** We found a significant increase in paediatric infections during the Alpha variant period of the pandemic (March-April / 2021), with another increase during the first outbreak of the delta variant (July / 2021). Adolescents showed an increased susceptibility to COVID-19. Therefore, future preparedness for outbreaks of viral diseases such as COVID-19 and other pandemics requires officials and decision makers in health institutions to include all children in vaccination programs.

Introduction

At the end of 2019, a number of pneumonia cases of unknown origin emerged in Wuhan, China. Within four months of specifying the viral agent the World Health Organization had declared coronavirus disease 2019 as a public health emergency of international concern. The total number of confirmed cases exceeded 60.42 million, while the total number of deaths exceeded 1.42 million worldwide [1]. The COVID-19 pandemic began spreading in Iraq on February 15th, 2020. Al-Najaf Health Department recorded a confirmed case

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of an Iranian student that was regarded as the first case of infection in the governorate [2]. Next, the country witnessed the spread of four waves, which started with the prevalence of the wildtype outbreak during 2020, followed by the second wave during January 2021 characterized by the emergence of the Alpha, Beta, and Gamma variants. After that, there was the spread of the Delta variant in July 2021, which reached its peak of spread as a third wave, accompanied by the outbreak of the fourth wave of the Omicron variant in December 2021 [2,3]. Epidemiological studies indicated that all age groups are susceptible to infection with SARS-CoV-2. However, the elderly and individuals suffering from chronic diseases were the group most affected by the infection [4]. Many global databases, including the COVerAGE-DB which is an open-access database, have identified the burden of COVID-19 infection among adolescents and children. It was recorded 56.9 million cases of infection in these groups under the age of 20 in more than 103 countries. The prevalence ranged from 0% to 37% of the number of cases recorded globally [5]. Most children suffered from an infection that may be asymptomatic, mild or moderate. The recovery period ranged from 1-2 weeks [6,7]. The rates of asymptomatic COVID-19 recorded among children were 15%-65% [8,9]. There are many hypotheses that explain the reason behind the decrease in the infection rates among children, some of them the relation between age and the genetic expression of correlation recipients that the virus used to attach to the host cell (Angiotensin Converting Enzyme 2 (ACE2) and Transmembrane serine protease 2 (TMPRESS2)) [10], Pre-exposure to seasonal coronaviruses [11], and also differences in immune responses compared to adults [12]. The disease severity varied based on the genetic variants of the virus. However, the clinical course of the Alpha variant was more severe among children compared to the omicron variant [13]. The infection of a family member was one of the main ways of transmitting the infection to children. However, it remained unconfirmed whether children contributed significantly to infection transmission among themselves and/or among adults [14]. At the beginning of the pandemic, data concerning the infection of COVID-19 among children were rarely recorded. This has been attributed to some reasons such as the lack of awareness of paediatricians about this disease, the similarity of clinical course of this disease with the flu, the lack of awareness of the severity of the disease in this group, common misinformation, and limited availability of diagnostic tests [15, 16]. Later, many reports indicated an increase in the number of infections among children and infants and most these infections belonged to the Alpha variant that was discovered in UK [17].

Methods:

Study Design and Participants

This retrospective study included children attending centers of coronavirus testing in the Central Health Laboratory / Diyala Governorate / Iraq during the period from January to December of 2021. As part of national screening programs for COVID-19 suspects. The current study was conducted by analyzing available data. The use of data was approved for research purposes only. All positive COVID-19 cases and related data reported between January 2021 and December 2021 were obtained. Through the researchers' survey of electronic medical data, a total of 1326 children with positive nasopharyngeal swab results, aged between 1 and 14 years, were included in this study. All negative cases were excluded from the statistical analysis tables of the current study. The age categories for childhood were defined according to the WHO age classification, which includes the following age groups: <1 year (postnatal/infants), 1-4 years (young children), 5-9 years (toddlers), 10-14 years (young adolescents) [18]. It should be noted that all the children included in the current study were school students from all areas of the governorate.

Data collection

Demographic data such as age, gender (male or female), months, and positive RT-PCR results for all SARS-CoV-2 suspects were collected from the electronic medical database documented in the records of the Central Laboratory/ coronavirus Testing Center.

Ethical Considerations

Ethics Statement: The authors declare that all procedures contributing to this work were in accordance with the ethical standards of the relevant national and institutional committees on human experimentation and the 1975 Declaration of Helsinki, as revised in 2008. The study protocol received prior approval from the Scientific Research Ethics Committee of the Scientific Department of the researchers' college (Ref. No. CEPEC/007-1/12/2023) and the Research Management Unit of

the Diyala Health Department/Ministry of Health (Ref. No. RMU/5878/5/2/2023).

Procedure

The laboratory personnel at the Coronavirus Testing Center/Central Health Laboratory used a global testing protocol approved by the Iraqi Ministry of Health. All suspected cases referred from all health centers in the governorate were examined based on the appearance of symptoms by taking a nasopharyngeal swab to detect the SARS-CoV-2 genome. RT-PCR was used to detect positive cases (TagPath COVID-19 Fast PCR Combo Kit 2.0).

Statistical analysis

After coding, all data were entered into Excel. They were summarized using descriptive statistics. and the study variables were compared using the Chi-square test after representing them as frequencies and percentages. The data were analysed using SPSS version 23. Also, a significance level of P ≤0.05 and P ≤0.01 was considered as having statistical significance.

Results:

Between January and December 2021, 1,326 children were diagnosed with COVID-19 during COVID-19 screening programmes conducted across Iraq. Most of these children are school students who were referred from all health centres in the governorate after they were suspected of acquiring the infection. By monitoring the epidemiological situation of daily new cases in Iraq, since the onset of the pandemic, Iraq has witnessed four waves of escalating virus infections, the most severe of which were the two waves in 2021. The second wave, which witnessed a significant increase in cases of infection with the alpha, beta and gamma variants that lasted until the end of June. The third wave, which was characterized by an outbreak of delta variant that was accompanied by the emergence of the Omicron variant [19, 2, 3].

In the current cohort, 907 (68.4%) of children were confirmed during the second wave of the pandemic compared to 419 (31.6%) cases in the third wave, a statistically significant difference (P<0.05) **(Figure 1)**.

In accordance with (WHO) classification of age groups, PCR results of suspected cases referred from health centres showed that most positive COVID-19 cases were in young adolescents aged 10-14 years, with 62.2% (n=826) compared to the other two age groups **(Table 1)**. The statistical difference was also highly significant (P<0.0001).

Finding from this study revealed that most COVID-19 cases during the second and third wave were in the 10-14 age group, compared to the 1-4 and 5-9 age groups, with a statistically significant difference (P<0.015) **(Figure 2)**.

In terms of gender, nasopharyngeal swab results showed that the rate of positive COVID-19 cases among male during the pandemic was 60.2% (n = 800), significantly higher than females 39.6% (n = 526) and with a statistically significant difference (p < 0.0001**) (Table 2)**.

As illustrated in **Figure 3**, the distribution of COVID-19 cases by age and gender indicates that the frequency of positive cases among males in all three age groups was higher than females, but without a statistically significant difference (P value > 0.05).

A monthly distribution of COVID-19 cases was recorded through daily diagnosis of suspects referred from different health centers in the governorate. Molecular diagnostic results showed that the highest number of confirmed cases were recorded in March and April, 242 (18.2%) and 211 (15.9%), with a statistically significant difference (P value <0.0001), in other words, the peak of the second wave was observed in March and April) **(Figure 4)**. The peak of the third wave was in July reporting 183 (13.8%) confirmed cases. Thereafter, the diagnosed cases gradually decreased during October, November, and December to reach the minimum number of cases **(Table 3)**.

Table (1): Distribution of COVID-19 cases by age according to Cross-tabulation and Pearson Chi-square test.

Age of children	**Results**		**Chi-Squared df**	***P*-Value**
	Frequency	**Percent**		
1-4	137	10.3	558.195 (2)	0.000 ***
5-9	363	27.3		
10-14	826	62.2		
Total	1326	100.0		

Abbreviations: p value=probability value; X2=chi-square test; df=degree of freedom; *= significant if the *p* value <=0.05; ***= highly significant if the *p* value <=0.0001.

Table (2): Distribution of COVID-19 cases by Gender according to Cross-tabulation and Pearson Chi-square test.

Gender of children	Results		Chi-Squared df	*P*-Value
	Frequency	Percent		
Male	800	60.2	56.618 (1)	0.000 ***
Female	526	39.6		
Total	1326	100.0		

Abbreviations: p value=probability value; X2=chi-square test; df=degree of freedom; *= significant if the *p* value <=0.05; ***= highly significant if the *p* value <=0.0001.

Table (3): Distribution of COVID-19 cases by month according to Cross-tabulation and Pearson Chi-square test.

Months	COVID-19 cases		Chi-Squared df	*P*-Value
	Frequency	Percent		
January	89	6.7	578.633 (11)	0.0001 ***
February	155	11.7		
March	242	18.2		
April	211	15.9		
May	110	8.3		
June	100	7.5		
July	183	13.8		
August	92	6.9		
September	104	7.8		
October	16	1.2		
November	15	1.1		
December	9	0.7		
Total	1326	100.0		

Abbreviations: p value=probability value; X2=chi-square test; df=degree of freedom; *= significant if the *p* value <=0.05; ***= highly significant if the *p* value <=0.0001.

Figure (1): SARS-CoV-2 positive cases in second and third waves

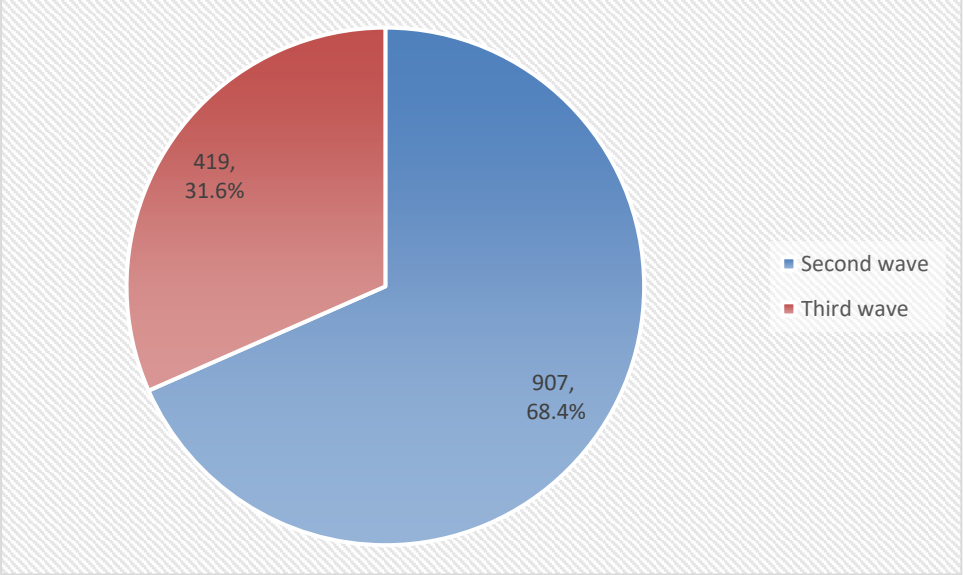


Figure (2): Distribution of age of COVID-19 cases in two waves

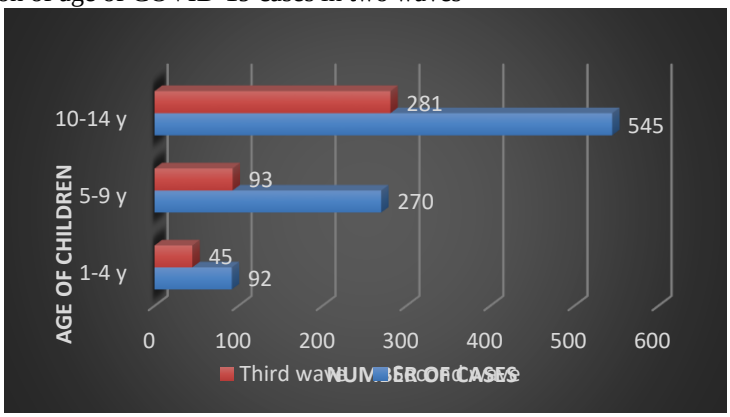


Figure (3): Distribution of COVID-19 cases based on gender and age according to Cross-tabulation and Pearson Chi-square test.

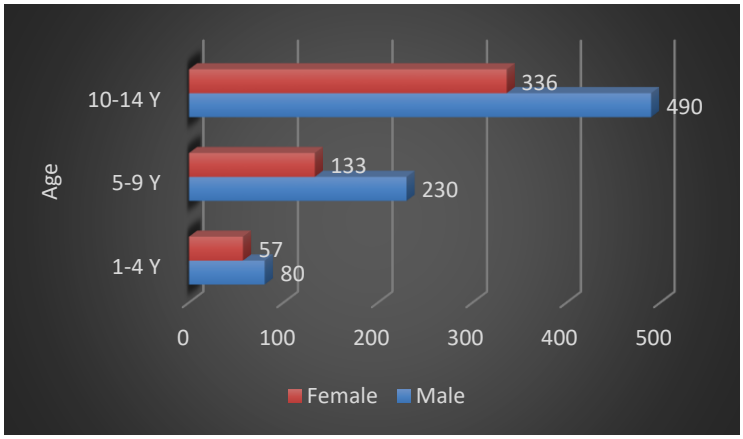
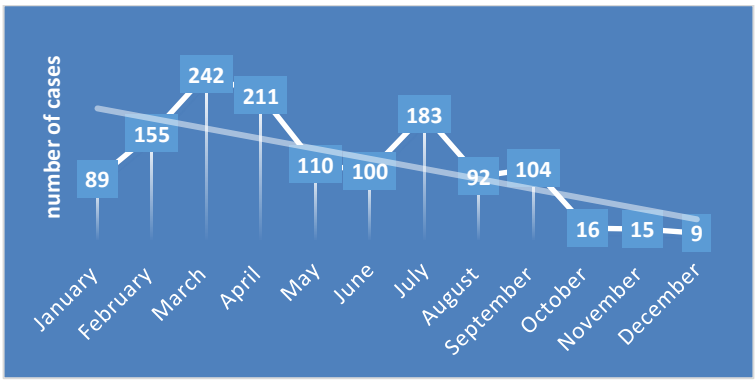


Figure (4): Trend of COVID-19 cases by month



Discussion

The incidence of paediatric COVID-19 cases represents a significant issue in Iraq as well as globally [20, 21]. Testing for COVID-19 in Iraq was initially limited due to financial constraints, mainly relying on rapid tests and to a lesser extent PCR tests of nasopharyngeal swabs [16]. According to a source affiliated to childhood save organization, one of the doctors working there stated, during the peak of infection in March, saying: “We have seen children as young as 10 years old admitted to hospital and there is a higher percentage of children with the virus in primary health care centres and paediatric hospitals than before.” [17], indicating an increase in infections among children during the second wave in Iraq. Few studies have addressed the epidemiological profile of the COVID-19 outbreak among children. Therefore, this retrospective analysis was conducted to shed light on the epidemiological distribution during the second and

third waves of the pandemic. We found significant differences in the numbers of confirmed positive cases during the second and third wave, and our findings are in line with the results of previous studies that showed that high proportions of infections were attributed to the second wave of the pandemic [22, 23]. Possible reasons for this result include the prevalence of more than one new variant and the increased exposure of children during the second wave [24], as well as the start time of the second wave, winter and spring. Adolescent age groups (10-14 years) showed a higher propensity to test positive for COVID-19 than younger groups. This finding is consistent with findings documented in investigation conducted in Sudan during 2020-2021, where 85.9% of cases were in age groups older than 10 years [25]. In the same context, a study conducted in Indonesia recorded the highest fatalities among confirmed cases of COVID-19 in children aged between 10 and 18 years [26]. During the time of the study, vaccines were prioritised for adults over the age of 18 and children were excluded from receiving vaccines, however, it was later strongly recommended to protect children from COVID-19 by offering vaccines to children. After approval by the European Union and the US Food and Drug Administration, the Pfizer-BioNTech vaccine was approved for age groups 5-11, 12-15 and 16 and above [27].

In comparison to our results, which showed that the most infections of the second wave in young adolescents in the age group (10-14 years), the results of the study conducted in Poland showed that the majority of infections during the third wave (which corresponds to the second wave in Iraq, which was characterized by the appearance of the Alpha variant) were among infants and younger children [28]. Other similar studies have recorded a significant increase in COVID-19 cases in children younger than 5 years old [29, 30]. The reason for the difference between the results of the current study and the results of the aforementioned studies is due to the fact that children in the age group (10-14) in Iraq were the least compliant with the preventive measures that were imposed at the time, and the fact that these age groups were not included in the vaccine schedule that reduced the severity of infections in older children, as indicated by Stopyra et al., [28].

Several studies have documented the impact of gender as a risk factor for the prevalence of COVID-19 infection among males and females with COVID-19. While many different studies from around the world have shown that the incidence of COVID-19 infection is higher in males [31-36], other studies have not documented significant differences in incidence between genders [37-39]. Collectively, these findings support studies confirming higher rates of infection among males and, as pointed out by Henni Borowati et al., [36], the gender disparity in susceptibility to viral infections is likely due to differences in the immune system, with women showing less vulnerability compared to men. In relation to COVID-19 cases by gender and age, the findings of the present study showed that in all age groups, males were more positive for SARS-CoV-2 than females but without statistical difference. These results were consistent with a study conducted in the Punjab province of Pakistan [40]. The monthly distribution of the incidence of confirmed COVID-19 infections among children varied across countries. In this work, the months of March and April were characterised by an increased frequency of infections among children during the prevalence of the alpha variant, while July had the highest rate of infections as the delta variant was prevalent during the third wave. In Mozambique, most paediatric infections and hospitalisations were observed during the delta variant wave [40, 41]. Similar studies in India and Bangladesh reported high levels of COVID-19 cases among children during March and April of the second wave [42, 24].

One of the most important **determinants and constraints** of this study is that the current study did not include clinical features of COVID-19 infection, risk factors and severity of the disease.

Conclusion:

We found a significant increase in pediatric infections during the Alpha variant period of the pandemic (March-April / 2021), with another increase during the first outbreak of the delta variant (July / 2021). Adolescents showed an increased susceptibility to COVID-19. Therefore, it is necessary to involve all children in covid-19 vaccination programs future.

Recommendations:

Future and ongoing studies on COVID-19 among children and adolescents, especially among children with severe respiratory diseases, are necessary due to the possibility of a synergistic role of SARS-CoV-2 with other viruses. Future preparedness for outbreaks of viral diseases such as

COVID-19 and other pandemics requires officials and decision makers in health institutions to include all children in vaccination programs.

Declaration:

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Competing interest:

The researchers state that they do not have any conflicting interests.

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