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Original Article

Retrospective Review of COVID-19 Polymerase Chain Reaction Test Results of a Children's Hospital According to Person and Time Characteristics

Bir Çocuk Hastanesinde COVID-19 Polimeraz Zincir Reaksiyonu (PCR) Test Sonuçlarının Kişi ve Zaman Özelliklerine Göre Retrospektif İncelemesi

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ABSTRACT

Objective: This study aims to describe the patient and temporal characteristics of the polymerase chain reaction (PCR) test results for children who underwent Coronavirus Disease 2019 (COVID-19) testing at a pediatric hospital between January 1, 2021, and August 31, 2022.

Method: This descriptive archival study was conducted by examining the records of COVID-19 PCR test results (n=36, 102) performed at a pediatric hospital located in the Aegean Region. Demographic data, the time the test performed, and characteristics of the PCR test results obtained from the records. Ethical approval for the study obtained from the relevant ethics committee of the hospital where the research conducted. Statistical analysis of the data performed using the SPSS 27.0 trial version. Statistical significance was considered at $p<0.05$.

Results: The average age of the children included in the study was X=8.25±5.56, with 56.6% being male. The highest proportion of children tested with PCR found to be 1-year-olds, at 11.7%. Of the 36,102 children who were tested, 12.7% had a positive PCR result, with the average age of these children being χ=8.48±5.66 and 52.3% were male. PCR positivity rates vary across different months. A statistically significant difference was found in PCR test results based on the gender of the children ($p<0.05$). The PCR positivity rates varied significantly by season (χ^2=420.323, $p<0.001$). Regression analysis conducted in our study demonstrated that gender and seasonal variables were significant determinants of PCR outcomes.

Conclusion: The PCR test results of children suspected of having COVID-19 found to vary according to gender and season.

Keywords: COVID-19, Severe Acute Respiratory Syndrome Coronavirus 2, child, epidemiological study

ÖZ

Amaç: Bu çalışmanın amacı, 1 Ocak 2021 ile 31 Ağustos 2022 tarihleri arasında bir çocuk hastanesinde Koronavirüs Hastalığı 2019 (COVID-19) testi yapılan çocuklara ait polimeraz zincir reaksiyonu (PCR) test sonuçlarının hasta ve zamana ilişkin özelliklerinin tanımlanması amaçlanmıştır.

Yöntem: Tanımlayıcı nitelikteki bu arşiv çalışması, Ege Bölgesi'nde yer alan bir çocuk hastanesinde gerçekleştirilen COVID-19 PCR test sonuçlarına (n=36.102) ait kayıtların incelenmesiyle yürütülmüştür. Kayıtlardan, demografik bilgiler, testin yapıldığı zaman ve PCR test sonuçlarının özelliklerine ilişkin veriler elde edilmiştir. Bu çalışmanın yürütülebilmesi için ilgili araştırmanın yürütüldüğü hastaneden etik kurul onayı alınmıştır. Verilerin istatistiksel analizleri SPSS paket programı 27.0 deneme sürümünde yapılmıştır. İstatistiksel anlamlılık düzeyi $p<0,05$ olarak kabul edilmiştir.

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Bulgular: Çalışmaya dâhil edilen çocukların yaş ortalaması χ=8,25±5,56 olup, %56,6'sı erkektir. PCR testi yapılan çocuklar arasında en yüksek oran %11,7 ile 1 yaş grubundadır. Test yapılan 36.102 çocuğun %12,7'sinde PCR sonucu pozitif olup, bu çocukların yaş ortalaması χ=8,48±5,66 olup, %52,3'ü erkektir. PCR pozitiflik oranlarının aylara göre değişiklik göstermektedir. Çocukların cinsiyetine göre PCR test sonuçlarında istatistiksel olarak anlamlı bir fark bulunmuştur (p<0.05). PCR pozitiflik oranlarının mevsimlere göre anlamlı farklılık gösterdiği belirlenmiştir (χ^2=420,323, p<0,001). Çalışmamızda regresyon analizinde cinsiyet ve mevsimlerin PCR sonucunda etkili olduğu bulunmuştur.

Sonuç: COVID-19 şüphesiyle test yapılan çocuklara ait PCR test sonuçlarının cinsiyet ve mevsime göre değişkenlik gösterdiği saptanmıştır.

Anahtar kelimeler: COVID-19, Şiddetli Akut Solunum Yolu Sendromu Koronavirüs 2, çocuk, epidemiyolojik çalışma

INTRODUCTION

The Coronavirus Disease 2019 (COVID-19) firstly identified in Wuhan city of China in December 2019, is a new viral respiratory disease characterized by respiratory symptoms of fever, cough, and shortness of breath. It is transmitted through droplets and contact[1]. The COVID-19 pandemic has had the most significant impact on older adults, individuals with chronic health conditions, ethnic minorities, low-income groups, and those experiencing housing insecurity[2]. Although the COVID-19 pandemic tended to have a milder course in children compared to other risk groups, still its clinically significant outcomes in children should not be underestimated[3].

Early diagnosis of COVID-19 disease is crucial for controlling its progression and limiting its spread within the population[4]. Therefore, there is a need for establishing diagnostic methods that provide fast and accurate results at an early stage so as to prevent further spread of COVID-19 disease in the future[4]. Among these tests, the reverse transcription-polymerase chain reaction (rRT-PCR) test, which detects the RNA of the virus, has been recognized as the gold standard in a large-scale study involving 12,270 cases[5]. Consequently, the rRT-PCR test contributes to the early diagnosis of patients, isolation of the patients, treatment, and the reduction of secondary infections among close contacts and health care workers, thereby limiting the transmission of the disease among individuals in the community and aiding in disease prevention[6]. The American Academy of Pediatrics reported that, as of May 11, 2023, more than 15 million children had tested positive for COVID-19 disease, representing 17.9% of all cases, with an incidence rate of 20,718 cases per 100,000 population[7]. In Turkey, due to the lack of published national data illustrating the impact of the COVID-19 pandemic on children, the diagnosis of COVID-19 disease in this population and related clinical and epidemiological characteristics have been limited to findings retrieved from various sample groups[8]. According to a retrospective study involving 10,157 children tested for COVID-19 disease in Turkey, 12.5% of children aged 10 to 18 had received COVID-19 diagnosis[9]. Another study determined that 6.4% of children under the age of 15 in Turkey tested positive for COVID-19[10]. In a study, the researchers retrospectively examined data from 1,156 children who tested positive for COVID-19 in Turkey, and reported that 50.3% of these children were male, with an average age of 10.7 years, and 23.2% of them were over the age of 15. While symptoms of COVID-19 disease , such as fever (50.4%), cough (46.9%), and sore throat (12.4%), were identified in indicated incidence rates[11]. Although there are retrospective studies examining COVID-19 PCR test results in the adult population in Turkey[12-14], studies examining COVID-19 PCR test results in children are limited in number[11,15,16]. Moreover, the retrospective studies cited in the literature regarding children's health conditions during the COVID-19 pandemic have limitations in terms of sample size and the time periods covered by them[17]. In light of these facts, this study aims to describe the COVID-19 PCR test results of children applied to a children's hospital between January 1, 2021, and August 31, 2022, focusing on individual and temporal characteristics.

MATERIALS and METHODS

This study is a descriptive design-based registry investigation. The population of the study includes all children aged 0-18 years (n=36,102) who were suspected of having symptomatic or asymptomatic COVID-19 disease, and underwent PCR testing at Dr. Behçet Uz Pediatric Diseases and Surgery Training and Research Hospital of the Health Sciences University between January 1, 2021, and August 31, 2022, without distinction between hospital wards. The entire study population has been accessed. The research data were obtained from the hospital management system records, and examined in a secure environment provided by the institution. The data was retrieved regarding total number of PCR test samples with negative/positive results, and the number of hospitalized children diagnosed with COVID-19 disease. Demographic characteristics of the children, such as age and gender, as well as the timing of the test and the features of the PCR test results, were extracted from the records.

Real-time PCR tests were performed using the DS Coronex COVID-19 multiplex RT-quantitative-PCR detection kit (DS Bio and Nano Technology, Turkey) on the Montania 4896 (Anatolia Geneworks, Turkey) device.

Statistical Analysis

Statistical analyses were performed using the SPSS software, version 27.0. The data were expressed in terms of frequencies, percentages and means. The chi-square test was used to assess the significance of the correlations between the variables and regression analysis was performed using the significantly relevant parameters. Statistical significance was considered at a level of $p<0.05$. Ethical approval for the conduct of this study was obtained from the Ethics Committee of University of Health Sciences Turkey, Dr. Behçet Uz Children's Diseases and Surgery Training and Research Hospital Clinical Research on November 24, 2022, with protocol number 776 and decision number 2022/20-11.

RESULTS

The average age of children (male: 56.6%, and female: 44.4%) who underwent PCR testing due to suspected COVID-19 disease was 8.25±5.56 years. Small percentage (12.7%) of 36,102 children had positive PCR test results. Male children comprised 52.3% of the study population who had positive PCR test results.

Figure 1 shows the age distribution of children who underwent PCR testing for suspected COVID-19 disease. Upon examination of the distribution diagram, it can be observed that the highest testing rate, (11.7%) is found among children aged one year.

The highest and the lowest PCR test positivity rates for COVID-19 disease among children in the year 2021 were detected in September (15.0%) and June (3.8%) 2021, respectively (Figure 2).

The highest and the lowest PCR test positivity rates for COVID-19 disease among children in the year 2022 were detected in February (25.9%), and May (4.1%), respectively (Figure 3).

Figure 4 presents the age distribution of children who tested positive for PCR. According to this distribution, 14.3% of the children who tested positive for PCR were one year old.

The results of the comparison of PCR test results stratified by sex in 2021 are presented in Table 1. Among the individuals who tested positive for COVID-19, 50.6% of them were male and 49.4% of them were female. Statistical analysis indicated a highly significant difference in PCR test results based on the gender of the children, as evidenced by a chi-square statistic of $X^2=38.775$ ($p<0.001$).

The comparison of PCR test results categorized by sex in 2022 is illustrated in Table 2. Among the individuals who tested positive for COVID-19 disease, 53.9% were male and 36.1% were female. The statistical analysis demonstrated a significant difference in PCR test results based on the children's gender, with a chi-square value of $X^2=6.694$ ($p<0.010$).

The distribution of children who had positive PCR test results stratified by seasons is presented in Table 3.

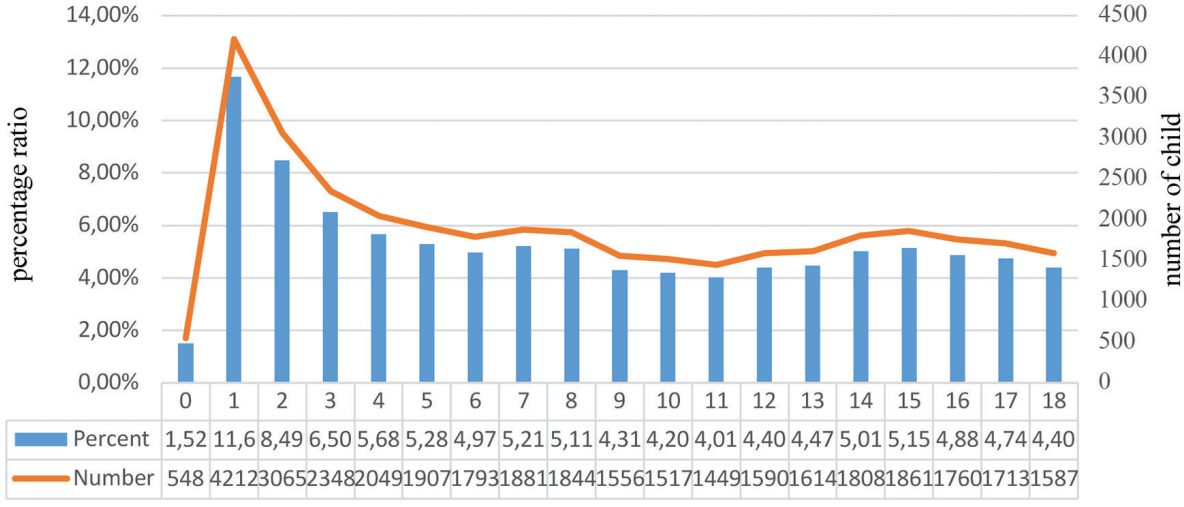

Figure 1. Age distribution of children who underwent PCR testing

PCR: Polymerase chain reaction

A statistically significant difference in PCR positivity rates across the seasons was observed, as indicated by a chi-square statistic of X^2=420.323 (p<0.001).

A multiple regression analysis was conducted to assess the influence of three independent variables i.e. age, gender and season on PCR test results, as illustrated in Table 4. The analysis revealed that the predictive model was statistically significant, with an F statistic of 91.396 (p<0.001). Together, these three variables accounted for 1.3% of the variance in PCR test outcomes. Notably, both gender and season had a statistically significant effect on PCR test results, with t-values of 8.922 (p<0.001) and 10.263 (p<0.001), respectively. The 95% confidence intervals were (1.17-1.25) for gender and (4.48-4.49) for seasons.

DISCUSSION

This study aimed to analyze the descriptive data pertaining to PCR test results of children who underwent

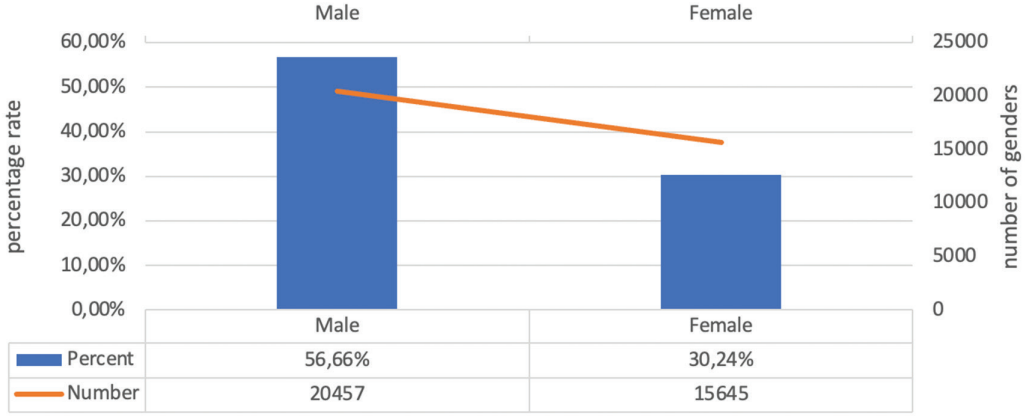

Figure 2. Gender distribution of children underwent PCR testing

In the study, 56.6% of the 36.102 children who underwent PCR testing were male.

PCR: Polymerase chain reaction

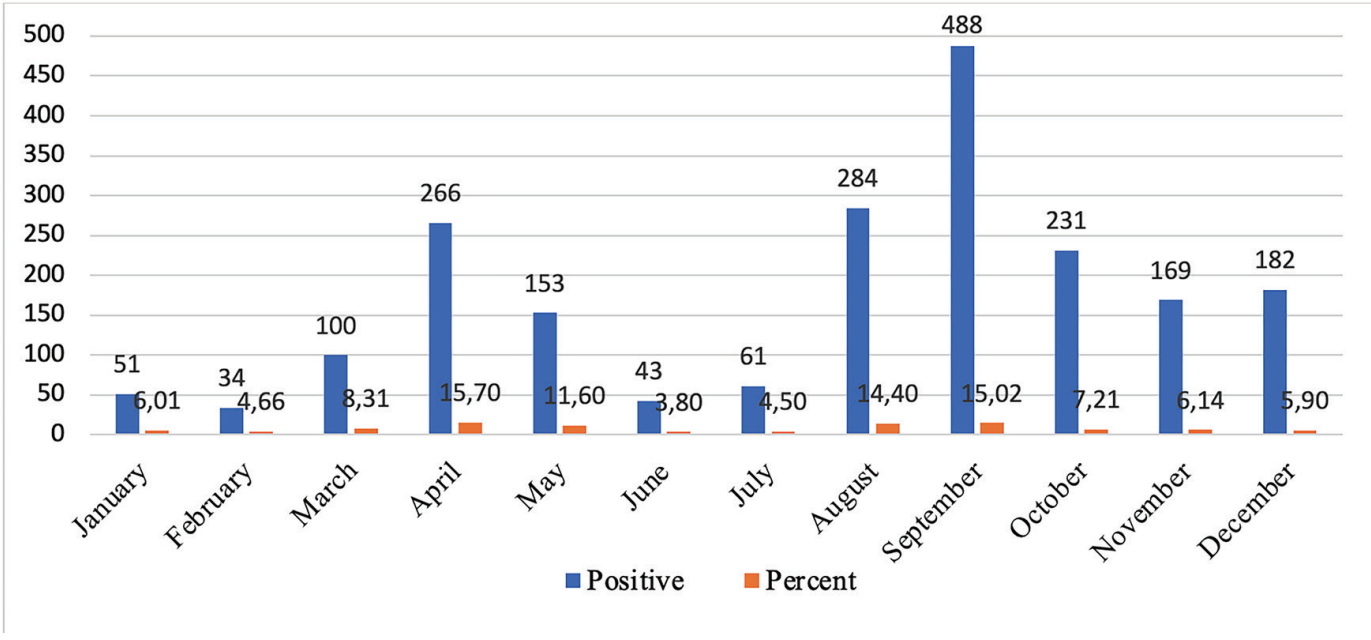

Figure 3. Distribution of children with positive COVID-19 test results by months (2021)

COVID-19: Coronavirus Disease 2019

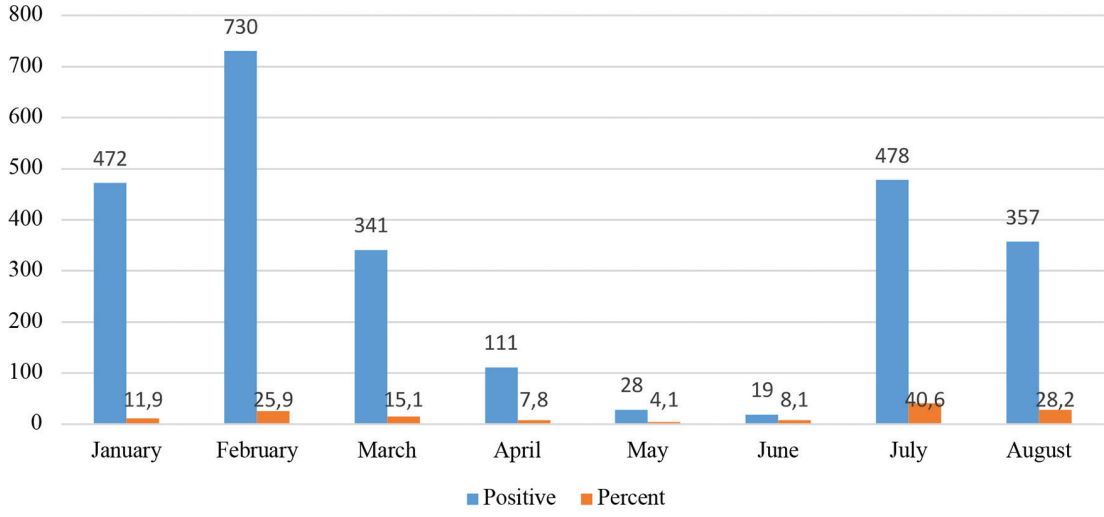

Figure 4. Distribution of children with positive COVID-19 test results by months (2022)
COVID-19: Coronavirus Disease 2019

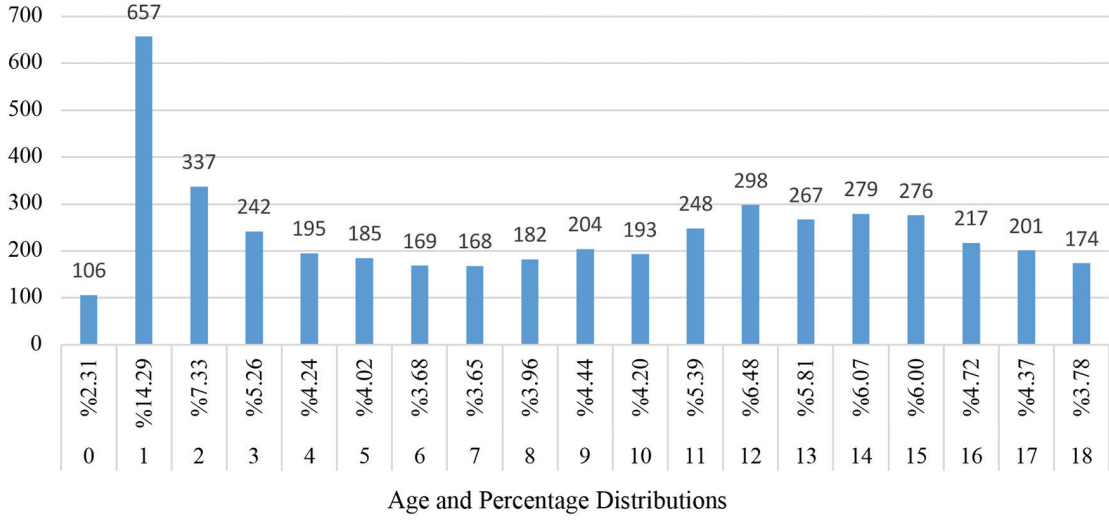

Figure 5. Age distribution of children with positive PCR test results
PCR: Polymerase chain reaction

Table 1. Comparison of PCR test results by gender of children (2021)

	PCR test results				Test value*
	Negative		Positive		
Gender	**n**	**%**	**n**	**%**	
Female	8748	41.9	1022	49.4	X^2=38.775
Male	11864	58.1	1040	50.6	**p<0.001
Total	20612	100.0	2062	100.0	

*: Pearson's chi-squared test **p<0.001, PCR: Polymerase chain reaction

Table 2. Comparison of PCR test results based on the gender of the study participants (2022)					
	PCR test results				Test value*
	Negative		Positive		
Gender	n	%	n	%	
Female	4704	33.2	1167	36.1	X^2 =6,694
Male	6188	56.8	1369	53.9	**p<0.010
Total	10892	100	2536	100	
*: Pearson's chi-squared test **p <0.05, PCR: Polymerase chain reaction					

Table 3. Distribution of children with PCR test positivity by seasons (2021)		
Seasons	PCR (+) number of cases	Test value*
Spring	519	X^2 =420,323 **p<0.010
Summer	388	
Autumn	888	
Winter	267	
Total	2062	
*Pearson's chi-squared test **p <0.05, PCR: Polymerase chain reaction		

Table 4. Multiple regression analysis of PCR test results										
	B	SE	β	t	p	95% Confidence interval		F	Model (p)	Adjusted R square
						Lower limit	Upper limit			
Age	-0.002	0.000	-0.027	-3.954	0.000	-0.003	-0.001	91.396	0.000	0.013
Gender	0.053	0.006	0.063	8.922	0.000	0.042	0.065			
Seasons	0.023	0.002	0.072	10.263	0.000	0.019	0.028			
p=0.001*, SE:Standard error, PCR: Polymerase chain reaction										

testing for COVID-19 at a pediatric hospital between January 1, 2021, and August 31, 2022, with an emphasis on individual and temporal characteristics. Although the COVID-19 pandemic has generally exerted a lesser severity on children in comparison to other high-risk groups, the impacts on this demographic parameter are far from negligible[18]. According to the most recent report issued by the American Academy of Pediatrics since the onset of the pandemic, over 15 million children had undergone PCR testing, with a positivity rate of 17.9%[7]. In the current study, 12.6% of the children assessed for COVID-19 suspicion were PCR positive. While this rate diverges from the figures reported by the European Academy of Pediatrics regarding children diagnosed with COVID-19 disease, a similar investigation conducted earlier during the pandemic indicated an incidence rate of 12.3% among children[19]. These disparities may be attributed to variations in the severity of the pandemic across different countries, as well as the characteristics of the regions where the respective studies were conducted.

In a research analyzing the results of PCR tests conducted on children, the distribution of cases by age group has been extensively examined[20-22]. In the present study, an analysis of the age distribution of children who underwent PCR testing for COVID-19 disease revealed a higher positivity rate among 1- and 2-year-old age groups. Conversely, children under 1 year of age exhibited the lowest positivity rates (Figures 1 and 5). These findings contrast with a study conducted in our country, which reported a higher percentage of positive PCR results in 0-1 year age group relative to other age categories[20]. Similarly, another investigation indicated that children under 1 year of age displayed the highest PCR positivity rate among all age groups[21].

The study conducted by Wali et al.[22] attributed the elevated PCR positivity rate in children under 1 year to an increased likelihood of viral transmission from mothers during pregnancy or postpartum period. In the present study, it is posited that the transmission of COVID-19 disease within the 1-2 year age group may be influenced by exposure to infected family members and

close contacts. The relatively low incidence of positive PCR results in children under 1 year may be indicative of enhanced protective measures provided by their families.

Furthermore, another study found that children aged 15 and older had a higher positivity rate compared to younger cohorts, while the PCR positivity rate within the 1-year-old group was notably low[11]. When interpreting the divergent results reported across these studies, it is imperative to consider variables such as the timing of data collection, sample size, and the geographic context of the research.

When examining the temporal distribution of PCR test results for the children participating in the study, particularly noticeable and higher positivity rates were observed starting from August 2021 (Figure 3 and 4). This finding aligns with the information stated in a report by the American Academy of Pediatrics, which mentioned that "the positivity rate for PCR tests among children steadily increased from August 2021 to May 2022"[7]. These results suggest that the reopening of schools and the commencement of face-to-face education in Turkey as of August 2021 may have contributed to increased interactions among children, particularly in school settings and public transportation, thereby influencing the outcomes.

Several studies have investigated the seasonal variations in the positivity rates of COVID-19 disease among children over time[23-25]. In line with this research, our study also identified distinct seasonal differences in the number of children who tested positive for PCR, revealing a higher incidence of positive cases during the spring and autumn months (Table 3). Consistent with our findings, studies by Abbas et al.[24] and Lota-Salvado et al.[26] also reported an increase in the number of children testing positive for COVID-19 disease during the spring and autumn months. Given that the transmission dynamics of the COVID-19 virus resemble those of the influenza virus, which tends to peak during seasonal transitions, the higher positivity rates observed in spring and autumn can be regarded as a predictable outcome.

In examining the impact of children's gender on PCR test results, this study revealed that both in 2021 and 2022, male children exhibited a higher PCR positivity rate compared to female children ($p<0.05$). This observation aligns with existing literature, which suggests that such differences may be attributable to biological characteristics. Research indicates that girls tend to demonstrate greater adherence to hygiene practices aimed at protecting themselves against COVID-19 disease. Conversely, boys have been observed to comply with preventive behaviors at a lower rate, including frequent handwashing, mask-wearing, and adherence to stay-at-home recommendations[26]. Contrary to our findings, some studies have found no gender-based differences in PCR test results for COVID-19 diagnoses in children[27-29]. These differences in the literature highlight the need for more comprehensive studies with larger sample sizes to conduct gender-based comparisons of COVID-19 test results.

The Centers for Disease Control and Prevention indicated that the reasons for the observed differences in the frequency or severity of COVID-19 disease between genders are not well understood[30].This situation may be attributed to the small sample size of the studies conducted, the course of COVID-19 disease, and non-compliance with individual and societal preventive measures. There is a need for studies that explore the relationship between gender and PCR test results in children in Turkey.

It was determined that gender of the children positively affected PCR test results which may be due to various factors, such as the family environment in which the children are raised, their surroundings, and their attitudes towards hygiene (Table 4). Similarly, Bialek et al.[31] identified gender as a risk factor for testing positive in PCR tests which is consistent with the findings of our study. However, contrarily, Sena et al.[32] reported that gender of the adolescents was not associated with a diagnosis of COVID-19 disease.

It was also found that age did not significantly affect PCR test results of children (Table 4). This may be due to the uniformity of immune system development among children. Consistent with our findings, Güven and Buluş[33] concluded in their study that age was not a determining factor in PCR test results in children. However, other studies have reported conflicting results, indicating that age can be a risk factor in diagnosing COVID-19 disease[32-34]. Furthermore, it was observed that seasonal factors positively influenced PCR test results of children (Table 4). This finding may be explained by the progression of the pandemic, the public health measures implemented at different times and the administration of vaccines to children as a preventive measure. Further studies are needed to explain the seasonal variations in PCR test results among children in Turkey. In line with our findings, Arciniegas et al.[35] reported seasonal

differences in the distributions of PCR test results. They suggested that this variation may be due to fewer tests being conducted and thus lower rates of diagnosis being made during certain seasons.

Study Limitations

The data in this study comprise results of PCR tests of children suspected of having COVID-19 disease, performed at a single hospital over a period of 12 months in 2021 and 8 months in 2022. Consequently, the findings cannot be generalized to all children with COVID-19 disease in Turkey. Additionally, as this study is based on a record review, more detailed inquiries regarding the children's vital signs, chronic illness status, family history of PCR positivity, medication usage, and disease characteristics were not conducted. These limitations should be taken into account when interpreting the results and their implications for broader pediatric populations.

CONCLUSION

We examined the results of PCR tests conducted on children and found that the number of tests and positive results in the 1-year age group were higher than in other age groups. Additionally, the number of children with positive PCR test results increased from August 2021 onwards. A significant relationship was found between gender of the patients and PCR test results, and a seasonal variation in the rates of PCR positivity was identified. In the context of the ongoing uncertainty surrounding the course of future outbreaks of the COVID-19 disease , this study can contribute to implementation of public health measures and health policies. Based on these findings, we recommend conducting further systematic reviews or meta-analyses focusing on children diagnosed with or suspected of having COVID-19 disease .

Ethics

Ethics Committee Approval: Ethical approval for the conduct of this study was obtained from the Ethics Committee of University of Health Sciences Turkey, Dr. Behçet Uz Pediatric Diseases and Surgery Training and Research Hospital Clinical Research on November 24, 2022, with protocol number 776 and decision number 2022/20-11.

Informed Consent: Retrospective study.

Footnotes

Author Contributions

Concept: Ö.K., F.Y.A., A.U.T., F.Z., N.E.,Ş.Ş.,M.Y.Ç., E.C., Design: Ö.K., F.Y.A., A.U.T., Data Collection or Processing: Ö.K., F.Y.A., A.U.T.,N.B., B.C., F.Z., N.E.,Ş.Ş.,M.Y.Ç., E.C., Analysis or Interpretation: Ö.K., F.Y.A., A.U.T., Literature Search: Ö.K., F.Y.A., A.U.T.,N.B., B.C., F.Z., N.E.,Ş.Ş.,M.Y.Ç., E.C., Writing: Ö.K., F.Y.A., A.U.T.,N.B., B.C.

Conflict of Interest: The authors have no conflict of interest to declare.

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