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(RESEARCH ARTICLE)

Evaluation of Immunological Parameters and Immunoglobulins for Detection of RSV Infection in Children in Kirkuk Governorate

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Abstract

Background and Objectives: Respiratory syncytial virus (RSV) is an important cause of acute respiratory infections in children, particularly among infants younger than 1 year. So, the study was aimed to determining the immunoglobulins (IgM, IgG, IgA) and the cytokines concentrations (IL-6, IL-8, TNF-α, IFN-γ and IL-12), evaluated in children with RSV infection.

Materials and Methods: A cross-sectional study was conducted in Kirkuk city pediatric hospitals in Iraq between February and September 2025: a total of 97 children with respiratory symptoms were recruited (47 females), alongside 50 healthy infants as controls. RSV-specific antibodies in serum samples were detected by ELISA, and cytokine concentrations were quantified according to manufacturer instructions.

Results: Among 97 children with respiratory symptoms, RSV was positive in 36 (37.11%) and negative in 61 (62.89%). Of these RSV-positive cases, IgM alone was found in 10 children (27.78%), IgG alone in 8 (22.22%), both IgM and IgG in 12 (33.33%) and IgA in 6 (16.67%). Children aged <1 year (20/36, 55.56%) had higher levels of IL-6 (45.23 ± 12.45 pg/mL), IL-8 (54.78 ± 14.92 pg/mL), and TNF-α (37.88 ± 10.12 pg/mL) compared with older children, who were found to have slightly elevated IFN-γ (21.57 ± 7.84 pg/mL) and IL-12 (27.33 ± 8.56 pg/mL). However, the cytokine patterns were similar in both sexes (males and females, respectively, P=0.06, P=0.007). Pearson's correlation coefficients showed significant direct correlations of IgM and IL-6 (r=0.58), IgA and IL-8 (r=0.52), as well as IgG and IFN-γ (r=0.45), indicating a relationship between humoral and inflammatory responses during RSV infection.

Conclusions: The immune response to RSV infection in children is age-dependent, as older children demonstrate adaptive immune protection whereas newborns produce increased levels of pro-inflammatory cytokines. Diagnostic and treatment recommendations are prepared with age-specific analysis of immune system.

Keywords: RSV, Immunoglobulins, Cytokines, IL-6, TNF-α.

1. Introduction

Respiratory syncytial virus (RSV) accounts for the highest burden of acute lower respiratory tract infections in young infants and children globally, leading to a significant proportion of morbidity through hospitalization in this particularly vulnerable group [1]. RSV is a leading contributor to pediatric morbidity and health care spending due to the near universal (in most populations) infection among children before 2 years of age and the propensity for reinfection throughout life (18–20). In immunocompetent hosts, RSV infection can range from a mild upper respiratory disease to severe pneumonia and bronchiolitis that may advance to respiratory failure and death among high-risk newborns [1,2]. Both the humoral and cellular arms of the immune system participate in responses to RSV infection. Indirect measures of host humoral immunity, depend on virus-specific immunoglobulins (which could be correlating to IgM, IgA or IgG), and are performed by immunoassays such as the enzyme-linked immunosorbent assay (ELISA) [3]. This is part of

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mucosal defense mediated by IgA, which also prevents viral replication in the respiratory tract; IgM antibiotics usually present early on and reflect recent exposure, but are more indicative of primary infection [4]. The interpretation of serological test results is further complicated by an observed delayed immunoglobulin A (IgA) response in newborns, where IgA declines earlier than in older children, likely due to immune immature status [3, 5]. Immunoglobulin G (IgG), passes through the placenta of the mother and this is the way of the passive immunity for infants at the first months of postnatal life [3]. During the first few months of life, though, this maternal protection diminishes and may also inhibit the infant from mounting an immune response to RSV antigens [6]. Seropositivity rates in infants can also be affected by maternal IgG levels, especially in children below 6 months of age which necessitate further immunological assays to distinguish between passive and active immunity [7]. Abstract Background Cellular immunity contributes both to RSV pathogenesis and RSV control. The coordinated action of Th1-type immune mediators, including interleukin-12 (IL-12), and interferon-gamma (IFN-γ), plays a major role in viral clearance and decreased disease severity. Furthermore, lower IFN-γ and IL-12 responses have also been associated with more severe RSV disease in infants [8], underscoring the protective function of these cytokines in modulating immune pathology and viral replication [9, 10]. The release of pro-inflammatory cytokines such as interleukin-6 (IL-6), interleukin-8 (IL-8), and tumor necrosis factor-alpha (TNF-α) has been associated with airway inflammation and clinical severity in RSV infection in addition to specific antibodies [11,12]. Higher levels of these cytokines have been associated with exacerbation in the severity of disease, length of hospitalization, and the development of complications such as bronchiolitis and pneumonia [12, 13]. In Iraq, epidemiological data suggest a large burden of RSV disease in children [7]; however, little is known about the burden and characteristics of RSV-associated hospitalization and mortality. A WHO-supported study of children less than five years old with acute respiratory infection showed that RSV was detected in 37.6% of cases, primarily in those with severe bronchiolitis and pneumonia, but most frequently in infants younger than six months [14]. In Hillah city RSV4736180 antigen detection assays showed that RSV was significantly contributing to lower respiratory infections in under 2 years of age children [2]. A recent cross-sectional study conducted in Erbil reported high rates of RSV-associated hospitalization among children under five years of age, with a significant proportion of cases occurring among infants ≤6 months [3]. Despite such studies, we could find only one study that covered immunological parameters (immunoglobulins and cytokines) in different age groups, sex, and classification of RSV infection among Iraqi children [12], but little integrated research has been done on the comparison between a series of immunological studies against the disease severity of RSV in terms of age, sex, clinical presentation on pediatric cases with confirmation of RS virus especially in Iraq at the governorate level for example Kirkuk. Thus, the goal of this study is to assess immunological parameters and immunoglobulins for diagnosis of RSV infection in children in Kirkuk Governorate.

2. Material and methods

2.1. Study Design

This cross-sectional study was conducted at pediatric hospitals of Kirkuk Governorate, Iraq The study involved 97 children who presented with symptoms of respiratory tract infection, including cough, wheezing, nasal congestion and fever. The baseline immunological profile was also assessed in a control group consisting of 50 healthy infants aged 2 years with no respiratory symptoms. Participants were all under five years of age and were recruited following informed consent from their parents or guardians.

2.2. Exclusion Criteria

To prevent confounding factors, children with immunosuppressive therapy, chronic respiratory illness, recent vaccination and co-infection were excluded from the study.

2.3. Sample Collection

2 mL peripheral venous blood samples were taken aseptically from each of the patients and controls. Samples were transferred under cold chain to the laboratory, centrifuged to separate serum, and stored at −20°C until analysis.

2.4. ELISA Analysis

The levels of IgM, IgA, IgG, IL-6, IL-8, TNF-α, IFN-γ and IL-12 in serum were measured using the FineTest ELISA kits (China) according to the manufacturer's instructions. 100 µL of all the serum samples and standards were dispensed into pre-coated wells and incubated at 37°C for 1 hour. Wells were rinsed three times, once with sterile PBS and twice with wash buffer, and incubated with HRP-conjugated detection antibody for 30 minutes at 37°C. After washing again, TMB substrate was added for 10–15 minutes before the addition of stop solution. Absorbance at 450 nm was measured, and concentrations were obtained based on the provided standard curves.

2.5. Statistical Analysis

SPSS version 26 was used to analyses data. Continuous variables were presented as mean ± SD and categorical variables as percentages. Comparison of patient and control groups was performed by Student's t-test. Pearson correlation coefficient was used to evaluate relationships between immunoglobulin levels and cytokines. Statistical significance was defined as a p-value of < 0.05.

3. Results

Out of the 97 children with respiratory symptoms, 36 children tested positive for RSV, representing 37.11% of the total, while 61 children tested negative, representing 62.89%, Table 1.

Table 1 RSV detection in children with RTI symptoms

RSV Status	Number of Children	% of Total (97)
Positive	36	37.11%
Negative	61	62.89%
Total	97	100.00%

Table 2 shows the distribution of 36 RSV-positive children according to the type of antibodies detected by ELISA. Among the positive cases, 10 children (27.78%) had IgM only, 8 children (22.22%) had IgG only, 12 children (33.33%) had both IgM and IgG, and 6 children (16.67%) showed IgA.

Table 2 Distribution of RSV-positive children by antibody type (IgM, IgG, IgA)

Antibody Type	Number of Children	% of Positive Cases (36)
IgM	10	27.78%
IgG	8	22.22%
IgM + IgG	12	33.33%
IgA	6	16.67%
Total positive	36	100.00%

Table 3 presents the distribution of RSV-positive children (n=36) according to age (<1 year, ≥1 year) and sex, stratified by antibody type. For instance, among children <1 year, 6 had IgM only and 7 had both IgM and IgG, while among males, 6 had IgM only and 7 had both IgM and IgG, showing slightly higher male representation.

Table 3 Distribution of RSV-positive children by age and sex

Antibody Type	Age		Sex	
	Age <1 yr	Age ≥1 yr	Male	Female
IgM only	6	4	6	4
IgG only	4	4	5	3
IgM + IgG	7	5	7	5
IgA	3	3	2	4
Total	20	16	20	16

Table 4 presents the mean ± SD of cytokine concentrations in RSV-positive children. Children under 1 year had higher levels of IL-6 (45.23 ± 12.45 pg/mL), IL-8 (54.78 ± 14.92 pg/mL), and TNF-α (37.88 ± 10.12 pg/mL) compared to

children ≥1 year. Conversely, IFN-γ (21.57 ± 7.84 pg/mL) and IL-12 (27.33 ± 8.56 pg/mL) were slightly higher in older children.

Table 4 Cytokine concentrations in RSV-positive children

Cytokine	Age		Sex	
	Age <1 yr (n=20)	Age ≥1 yr (n=16)	Male (n=20)	Female (n=16)
IL-6 (pg/mL)	45.23 ± 12.45	38.15 ± 10.23	44.11 ± 11.37	40.42 ± 10.04
IL-8 (pg/mL)	54.78 ± 14.92	48.22 ± 12.87	52.33 ± 14.12	50.15 ± 13.25
TNF-α (pg/mL)	37.88 ± 10.12	32.44 ± 9.08	35.76 ± 9.43	34.11 ± 8.57
IFN-γ (pg/mL)	18.45 ± 6.72	21.57 ± 7.84	20.11 ± 7.13	21.22 ± 8.01
IL-12 (pg/mL)	22.33 ± 7.88	27.33 ± 8.56	24.88 ± 7.92	27.11 ± 8.43

Table 5 shows the Pearson correlation coefficients between antibodies and cytokines in RSV-positive children. For example, IgM and IL-6 showed a strong positive correlation ($r=0.58$, $p<0.001$), and IgG and IFN-γ had a moderate correlation ($r=0.45$, $p=0.003$). This indicates interrelated humoral and inflammatory responses during RSV infection.

Table 5 Pearson correlation between antibodies and cytokines

Parameter 1	Parameter 2	Pearson r	p-value
IgM	IL-6	0.58	<0.001
IgA	IL-8	0.52	<0.001
IgG	IFN-γ	0.45	0.003
IL-6	TNF-α	0.62	<0.001
IFN-γ	IL-12	0.49	0.001

4. Discussion

The rate of RSV infection seen in our cohort (36 of 97 children, 37.11%) is in line with global estimates. Similar results were found earlier [1], some similar findings are presented in results and discussions. [15] showing that most symptomatic children are RSV-infected, and that the burden of acute lower respiratory tract infections resulted by RSV in young children (<5 years) is great in 58 countries. The view emphasizes that RSV remains a key source of respiratory disorder in minor global. Similar age-related observations regarding RSV susceptibility-could have been made by Nakago and Nishiura [16], who noted that RSV disease was most common in children under one year of age, concurring with their high number of positive cases in children less than 1 year of age. Early RSV infection pattern correlates with IgG pattern Findings in RSV-infected children of the study support previous observations. The results are in line with those of Tsutsumi et al. [17], who followed distinct IgA and IgG profiles in nasopharyngeal secretions from infants with primary infections with RSV. In particular, although IgG can remain for longer periods of time in mucosal sites, the peak of IgA occurs earlier than the peak of IgG. This could account for the detection of either only IgM, only IgG or both of these in some children in our cohort, consistent with humoral immunity and recent infection [8]. According to Berbers et al. The IgG specificity against RSV, however, may not be found in infants < 2 years of age [18], thus the commonality of it here may reflect prior exposure or maternal antibodies. In terms of the immune response, Green et al. Age-related variations in patterns of humoral and cellular responses to RSV in neonates and older children have been shown [19]. We found higher levels of TNF-α, IL-6, and IL-8 in patients less than one year of age, and higher levels of IFN-γ and IL-12 in children older than one year of age, confirming these results. This suggests that older children may have a more balanced adaptive immunity, resulting in less severe disease symptoms, while younger children may exhibit more robust inflammatory responses. our findings mirror those of Odisho et al. [20] and Al-Suhail et al. [21] who used serological and immunofluorescence methods to identify RSV in rightly chosen infants. Higher proportions of RSV-positive among children presenting with acute respiratory infection have been noted in Iraq and neighbouring countries Table 5 and support our findings that RSV is a significant cause of childhood respiratory infections in Iraq. Ramadhan and Abdulaziz [22] also described RSV-associated hospitalizations in children less than five years of age in Erbil, Iraq,

which is consistent with our data showing high prevalence rates among symptomatic hospitalized children. Our cytokine results are also in line with previous reports. Umar et al. [23] and Moreno-Solís et al. [24] showed that IL-6 and IL-8 levels were increased in infants admitted to the hospital with RSV bronchiolitis, and elevated levels of these cytokines were associated with disease severity. Our data confirm this because we found that concentrations of IL-6 and IL-8 were greater in younger children, which may lead to increased airway inflammation as well as decreased clinically severe disease. Furthermore, S. El-Kafrawy et al. [25] the higher levels of cytokines we found are biologically meaningful since a recent comparison of sera from infants with RSV bronchiolitis showed that elevated levels of IL-6 and IL-8 correlate with a more severe disease.

5. Conclusion

Respiratory syncytial virus (RSV) infection was identified in a high proportion of children with respiratory symptoms in Kirkuk, with varying immunoglobulin responses indicating acute or past infection. Children aged < 1 year old were more pro-inflammatory (IL-6, IL-8, and TNF-α) than older children. The correlations of antibodies with cytokines we observed suggest that humoral immunity is tightly linked to the action of inflammatory mediators during RSV infection.

Compliance with ethical standards

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Disclosure of conflict of interest

The author has no conflict of interest to declare.

Statement of ethical approval

This study protocol was approved by the Ethics Committee in the Department of Biology, College of Science, University of Kirkuk in collaboration with local health authorities. The procedures carried out were in keeping with the ethical standards of the Declaration of Helsinki.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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