



Article

The Role of IL-5 in Immune Responses to *Enterobius vermicularis* Infection Among Children: A Case control study

Eman Adnan Hadi*¹, Raad Ajam Sayal²

1,2. College of Health and Medical Technology, Kufa, Al-Furat Al-Awsat Technical University

* Correspondence: eman.hadi.chm@student.atu.edu.iq

Abstract: *E. vermicularis* (pinworm) is the most prevalent helminth infection in middle- and high-income nations, especially in school-age children. *E. vermicularis* is found all across the world and is not linked to any specific racial, cultural, or social background. To investigate the role of IL5 in immunity against *E. vermicularis* infection through measuring serum level among infected children and healthy control group. Between August 2024 and January 2025, 45 children—24 boys and 21 girls—from patients who visited AL-Zahraa Teaching Hospital in AL-Najaf province participated in the current study. For hematological parameters and IL5 measurement by ELISA, 5 ml of samples were drawn from the veins of the patients and the control group. The information was entered using SPSS version 22.0. In this study, the relationship between the two variables was analyzed and assessed using the chi-square test. The t-test was used to analyze the differences in serum parameters between the two groups. The threshold for statistical significance was set at $P < 0.05$. Infected children had a significantly lower hemoglobin level than the controls (12.06 vs. 13.46) respectively. Therefore, the mean of hemoglobin was highly significant, as ($P = < 0.001$), while, white blood cells and Eosinophils' showed a highly significant increase ($P = < 0.001$), in patients when compared with control. Interleukin 5 was assessed for both patient and control groups and the mean showed there were a highly significant increase in infected children when compared with control ($P = 0.0001$).

Keywords: Interleukin5 (IL5), *Enterobius Vermicularis*, Infection

Citation: Hadi, E. A., Sayal, R. A. The Role of IL-5 in Immune Responses to *Enterobius vermicularis* Infection Among Children: A Case control study. Central Asian Journal of Medical and Natural Science 2025, 6(3), 1283-1291.

Received: 25th May 2025

Revised: 31st May 2025

Accepted: 11th Jun 2025

Published: 20th Jun 2025



Copyright: © 2025 by the authors. Submitted for open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>)

1. Introduction

Hematopoietic and non-hematopoietic cell lines produce the cytokine dimer interleukin-5, which is mainly involved in the survival, differentiation, and proliferation of eosinophils. T lymphocytes and ILC2s are the primary producers of IL-5, with eosinophils and mast cells contributing little (Price & Kennedy, 2022). IL-5 is constituted of two similar subunits associating non-covalently to a receptor designated the IL-5 receptor. The latter consists of two subunits: a specific α -chain and a common β -chain. Receptor engagement initiates a series of IL-5-dependent intracellular signaling events, predominantly involving the JAK-STAT pathway (Olin & Wechsler, 2014). Among the structural features of IL-5 are receptor binding sites that are critical to the biological activity of the molecule in supporting the survival and activation of eosinophils (Moult et al., 2016). IL-5 has gained considerable attention as a possible therapeutic target due to its importance in eosinophilic disorders. Monoclonal antibodies against IL-5 or its receptor are some of the most effective drugs in the clinic today, offering new hope for the treatment of severe asthma and other eosinophil-associated conditions (Pelaia et al., 2019). Studies

have shown that inhibition of IL-5 has significant therapeutic benefits in the treatment of asthma patients, particularly those severe phenotypes with elevated eosinophil numbers (Barnes, 2018). A distinct type 2 cytokine response is triggered by infection with big, multicellular parasitic helminths that live in and on host tissues (Sorobetea et al., 2018). Innate immune cells and polarized CD4+ T helper type 2 (Th2) cells produce type 2 cytokines, such as IL-4, -5, -9, and -13, to coordinate tissue responses, such as increased mucin production, smooth muscle contractility, goblet cell hyperplasia, and increased turnover of epithelial cells (Harris, 2017). Together, these activities drive worm expulsion and wound healing responses that control worm-induced tissue damage (Shimokawa et al., 2017). Interleukin-5 (IL-5) concentrations are increased in *E. vermicularis* infections, suggesting a strong immunological response. In order to activate and mobilize eosinophils, considered vital for fighting parasitic infections, IL-5 is a key player (Gazzinelli-Guimaraes et al., 2024). The present study aimed to investigate the role of IL5 in immunity against *E. vermicularis* infection through measuring serum level among infected children and healthy control group.

2. Materials and Methods

Subjects:

Between August 2024 and January 2025, 45 children—24 boys and 21 girls—from patients who attended AL-Zahraa Teaching Hospital in AL-Najaf AL-Ashraf province participated in the current study. Scotland tape identified the illness and the child's age, which ranged from 1 to 10 years. Additionally, 40 healthy kids who were matched in age and sex with the sick group were chosen as the control group. For every participating kid in the research, a unique questionnaire form was created, and moms were interviewed to complete it.

Sample collection:

Samples were collected 5 ml from vein by using disposable syringes and transfer 2ml of sample to EDTA tube detect the hematological parameters (Using Sysmex automated blood analyzer) and the rest 3ml transfer to gel tube to collect serum after 5min centrifugation at 3000 r.p.m. to estimate IL5 levels by ELISA kit (Elabscience, USA).

Data entry and statistical analysis:

Statistical Package for Social Sciences (SPSS) version 22.0 was used to input the information obtained. The chi-square test was used to analyze and evaluate the relationship among the two variables in this investigation. Serum parameter differences between the two groups were examined using the t-test. Statistical significance was defined as $P < 0.05$.

3. Results

Table 1 displays the demographic details of the patient and control groups. Patients' mean age was 5.38 ± 2.56 , whereas the control group's was 5.62 ± 2.6 . The difference in mean age between the two groups was not statistically significant ($P=0.925$). The frequency distribution of patients and control participants by age did not differ significantly, according to the results ($P=0.673$). In the group of infected children, there were 27 (60%) men and 18 (40%) girls, while the control group had 33 (73.3%) boys and 12 (26.7%) females. The frequency distribution of patients and control subjects by gender did not vary significantly ($P=0.180$).

Table 1. Comparing the general traits and attributes of the parasite and control groups in children.

Characteristic	Infected children <i>n</i> = 45	Control <i>n</i> = 45	<i>P</i>
Age (years)			
Mean \pm SD	5.38 \pm 2.56	5.62 \pm 2.6	0.925 † NS
1-5, <i>n</i> (%)	24(53.3%)	22(48.9%)	0.673 ¥
6-10, <i>n</i> (%)	21(46.7%)	23(51.1%)	NS
Gender			
Male, <i>n</i> (%)	27(60%)	33(73.3%)	0.180 ¥
Female, <i>n</i> (%)	18(40%)	12(26.7%)	NS
Body mass index (BMI)			
Mean \pm SD	18.28 \pm 1.8	22.19 \pm 5.4	<0.001 †
Residence			
Urban	25(55.6%)	30(66.7%)	0.280 ¥
Rural	20(44.4%)	15(33.3%)	NS

Table (1), concerned on the mean of body mass index among infected children in comparison with control. The results indicated to presence of highly significant decrease in the mean of BMI in patients when compared with control ($P=<0.001$). The results indicated to a most of infected children were in urban 25(55.6%), while 20 (44.4%) in rural residence. The study showed no significant variation between patient and control groups ($P=0.280$).

Table (2), showed that infected children had a significantly lower hemoglobin level than the controls (12.06 vs. 13.46) respectively. Therefore, the mean of hemoglobin was highly significant, as ($P=<0.001$), while, white blood cells and Eosinophils' showed a highly significant increase ($P=<0.001$), in patients when compared with control.

Table 2. Blood parameters among infected children in comparison with control group.

Blood variables	<i>E. vermicularis</i> +ve children <i>n</i> = 45	<i>E. vermicularis</i> -ve children <i>n</i> =45	T. value	P. value
	Mean \pm SD	Mean \pm SD		
Hemoglobin g/dl	12.06 \pm 2.08	13.46 \pm 1.27	3.84	<0.001
WBCs	13.28 \pm 1.35	5.17 \pm 0.62	36.34	<0.001
Eosinophils'	4.09 \pm 0.96	2.74 \pm 0.74	7.44	<0.001

SD: standard deviation; WBCs: white blood cells; t- independent test; P. value less than 0.05 considered significance.

Interleukin 5 was assessed for both patient and control groups and the mean showed there were a highly significant increase in infected children when compared with control ($P=0.0001$) as it shown in Table (3) and Figure (1) respectively.

Table 3. Concentration of IL5 pg/ml among infected children in comparison with control.

IL5 pg/ml	Case control comparison		P. value
	Infected children n=45	Control n=45	
Mean \pm SD	28.51 \pm 4.76	5.14 \pm 1.43	
Range	19-35	3-8	
Median (IQR)	29 (8)	4.9 (3)	<0.0001**
95% CI for the mean	27.07-29.94	4.71-5.57	
Standard error of the mean	0.7104	0.2139	
Test statistic t.	t= 31.49		
SD: Standard deviation, n= number of instances, independent T-test, significant at P. value < 0.05.			

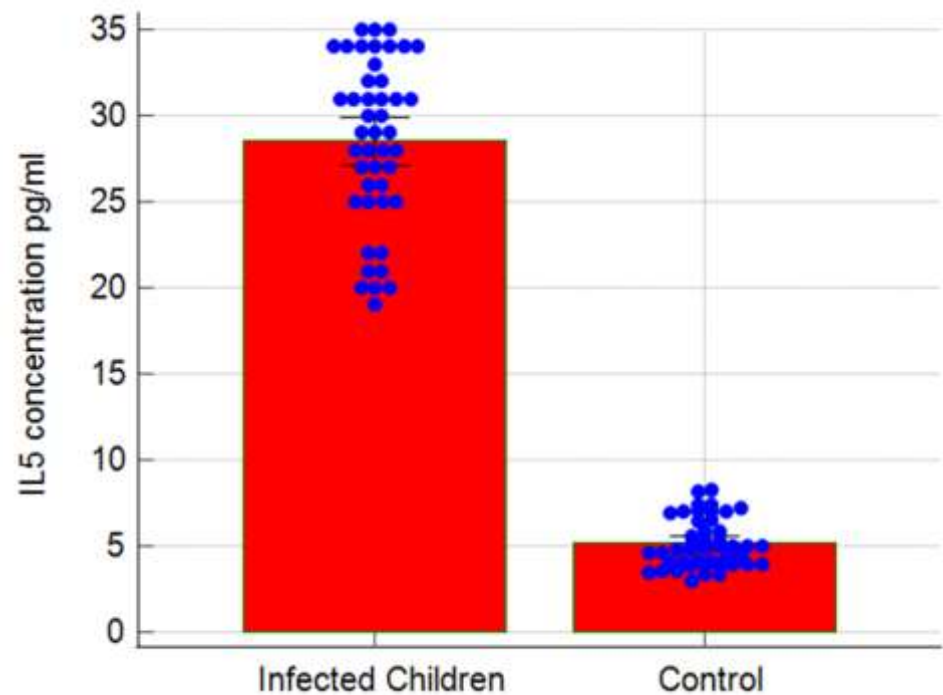
**Figure 1.** Serum level IL5 among infected children in comparison with control (P. value <0.0001).

Table (4), indicated to evaluate the IL5 cutoff value as well as to predict the Enterobius infection as diagnostic tests or adjuvant diagnostic tests, receiver operator characteristic (ROC) curve analysis was carried out across study groups and the results are shown in (4), and figure (2). The IL5 cutoff value was (>8.3), which achieves a sensitivity of 100.00% and specificity of 100.00% with (P=<0.001). According to the table's findings, IL-5 has a high degree of diagnostic accuracy (AUC: 1.000, 100% sensitivity and specificity).

Table 4. IL5 levels analyzed through Receiver Operating Characteristic (ROC) curve among studied groups.

Serum IL5 pg/ml concentration	Studied groups
Area under the ROC curve (AUC)	1.000
95% Confidence interval	0.960 to 1.000
Sensitivity	100.00%
Specificity	100.00%
Cut-off value	>8.3
+PV	100.00
-PV	100.00
Accuracy	1.0000
Significance level P. value	<0.001**

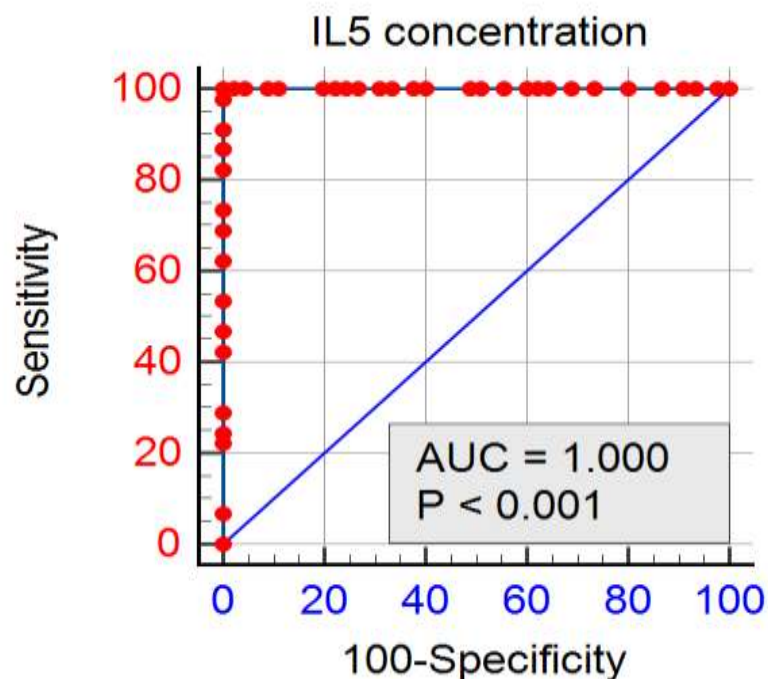


Figure 2. ROC of IL5 among infected children in comparison with control (P. value <0.001).

4. Discussion

Enterobius vermicularis is most common in crowded residences among all ages, but is particularly common in children and affects between 4% and 28% of children worldwide (Altun et al., 2017). This parasite is mostly found in children in kindergartens, institutions or in families with a large number of children. It spreads easily between all family members, with frequent reinfestation (Zouari et al., 2018). The results agrees with Al-Daoudy & Al-Bazzaz, (2020), as they reported that, the highest rate of infection in age group (<6 years), while, lowest rate in group (>7 years). Dohan and Al-Warid, (2022), who reported a significant link between gender and the presence of *E. vermicularis*. Most *E. vermicularis* +ve cases were diagnosed in male individuals. *E. vermicularis* infection is linked to malnutrition and anemia, with infected children showing significantly lower BMI and weight-for-age Z scores compared to non-infected peers (Dohan& Al-Warid, 2022). In a study involving 500 children, a notable percentage (39.5%) were infected with *E. vermicularis*, correlating with lower BMI values (El-Awady & Abed, 2017). In a study demonstrated that, the prevalence of pinworm infection in urban areas was found to be higher than that in rural areas (Fan et al., 2019). Low socioeconomic status was thought to

be a risk factor for pinworm infection, and many studies have highlighted this condition (Chen et al., 2018). It is less well recognized that erythrocyte hemoglobin (Hb), a blood molecule that includes iron and is essential for animals to carry oxygen, is a member of the family of hemoglobin proteins, which have members in all three domains of life: bacteria, eukaryotes, and archaea (Gell, 2018). The intestinal parasites cause vitaminosis, disrupt digestion, release the trophozoite motile feeding stage, and adhere to intestinal villi. Another parasite absorbs roughly 50 milliliters of blood per day (Al-Mousawi & Neamah, 2021). They also feed on the food that is digested in the intestine, which is why some parasites cause anemia by excreting substances that dissolve blood (Bolka & Gebremedhin, 2019). The findings indicate that individuals with parasite infections have higher blood levels of white blood cells (WBCs) because WBCs can destroy parasites by adhering to their walls and secreting granules that can destroy exterior parasite walls (Mohammed et al., 2016). *E. vermicularis* can occasionally result in eosinophilia, despite the fact that it is said to be a virtually innocuous intestinal parasite that may help educate the immune system (Patsantara et al., 2016). Asthma and other allergy disorders are linked to eosinophils' dysregulation of immunological responses. Furthermore, according to Rahimi et al. (2018), this subset of immune cells is frequently thought of as a destructive end-stage effector that is mostly associated with parasitic disorders, particularly helminthic infections including intestinal and tissue nematode infections. The result agrees with Al-Hasheme et al., (2020), as they reported a highly significant increase in IL5 level among infected children when compared with control. As a "eosinophil activator," IL-5 is the most significant cytokine in the generation and transformation of eosinophils (Chen et al., 2023). Elevated IgE, eosinophilia, mastocytosis, and CD4+ T cells that preferentially generate IL-4, IL-5, and IL-13 are all linked to the human immunological response to helminth infections (Ayelign et al., 2020). The host's immune response to intestinal parasites by Th2 cells was the cause of the increase in IL-5 concentration in the sera of children infected with intestinal parasites as compared to children who were not infected. High amounts of the interleukins IL-4, IL-5, IL-9, IL-10, IL-13, IL-21, and IL-33 are produced in response by these cells. These interleukins control the response to acute hypersensitivity, which includes B-lymphocytes switching from producing antibodies to IgG4 and IgM only, a high concentration of mast cells, goblets, and eosinophils, as well as alternative macrophage activation and an influx of inflammatory cells like eosinophils that aid in the death of parasites (Maizels, 2016; Cruz et al., 2017). Increased IL-5 generating is triggered by *E. vermicularis* and is associated with eosinophilia, a disorder marked by an increased blood eosinophil number (Schroeder et al., 2019). Alterations in the intestinal microbiota have been connected to enterobius infection, and they may have an additional impact on IL-5 creation and the body's immune system as a whole (Yang et al., 2017). In accordance with the research on hookworm infections (Loukas et al., 2016), serum IL-5 levels could accurately distinguish between those who were infected and those who were not, with diagnostic accuracy comparable to the stated AUC and prediction values.

5. Conclusion

In conclusion, this study emphasizes the critical function of interleukin-5 (IL-5) in children's immunological responses to *Enterobius vermicularis* infections. IL-5 might be used as a biomarker to identify *E. vermicularis* infections in children and track their immune responses. To clarify the precise processes by which IL-5 affects immunity in helminth infections and investigate its possible use as a target in immunomodulatory treatments, more investigation is necessary.

REFERENCES

- Al-Daoudy, A. A. K., & Al-Bazzaz, E. N. H. (2020). Impact of *Enterobius vermicularis* infection on biochemical parameters in the blood of children in Erbil Province, Iraq. *BMC infectious diseases*, 20, 1-6.
- Al-Hasheme, I. H. M., Al-Tammime, T. A. A. H., & Al-Morshidy, K. A. H. (2020). Study of some hematological and immunological parameters associated with the infection of intestinal parasites in the holy city of Kerbala, Iraq. *Annals of Tropical Medicine and Health*, 23, 207-231.
- Al-Mousawi, A., & Neamah, B. (2021). A study on intestinal parasites among diabetic patients in Najaf governorate of Iraq and its effect on some blood parameters. *Iranian Journal of Ichthyology*, 8, 127-132.
- Altun, E., Avci, V., & Azatçam, M. (2017). Parasitic infestation in appendicitis. A retrospective analysis of 660 patients and brief literature review. *Saudi medical journal*, 38(3), 314
- Ayelnig, B., Akalu, Y., Teferi, B., Molla, M. D., & Shibabaw, T. (2020). Helminth induced immunoregulation and novel therapeutic avenue of allergy. *Journal of asthma and allergy*, 439-451.
- Barnes, P. J. (2018). Targeting cytokines to treat asthma and chronic obstructive pulmonary disease. *Nature Reviews Immunology*, 18(7), 454-466.
- Bolka, A., & Gebremedhin, S. (2019). Prevalence of intestinal parasitic infection and its association with anemia among pregnant women in Wondo Genet district, Southern Ethiopia: a cross-sectional study. *BMC infectious diseases*, 19, 1-8.
- Chen, J., Wang, Y., Shen, L., Xiu, Y., & Wang, B. (2023). Could IL-25 be a potential therapeutic target for intestinal inflammatory diseases?. *Cytokine & Growth Factor Reviews*, 69, 43-50.
- Chen, K. Y., Yen, C. M., Hwang, K. P., & Wang, L. C. (2018). *Enterobius vermicularis* infection and its risk factors among pre-school children in Taipei, Taiwan. *Journal of Microbiology, Immunology and Infection*, 51(4), 559-564.
- Cruz, A. A., Cooper, P. J., Figueiredo, C. A., Alcantara-Neves, N. M., Rodrigues, L. C., & Barreto, M. L. (2017). Global issues in allergy and immunology: parasitic infections and allergy. *Journal of Allergy and Clinical Immunology*, 140(5), 1217-1228.
- Dohan, B. A. M., & Al-Warid, H. S. (2022). Haematological and Demographic Study in Children Infected with Enterobiasis in Al Diwanayah Province, Iraq. *Iraqi Journal of Science*, 107-115.
- El-Awady, M., & Abed, N. (2017). A body shape index versus body mass index in the assessment of nutritional status among Egyptian primary school children infected with intestinal helminthiasis. *Science Journal of Public Health*, 12(2), 13-18.
- Fan, C. K., Chuang, T. W., Huang, Y. C., Yin, A. W., Chou, C. M., Hsu, Y. T., ... & Tu, C. Y. (2019). *Enterobius vermicularis* infection: prevalence and risk factors among preschool children in kindergarten in the capital area, Republic of the Marshall Islands. *BMC infectious diseases*, 19, 1-7.
- Gell, D. A. (2018). Structure and function of haemoglobins. *Blood Cells, Molecules, and Diseases*, 70, 13-42.
- Harris, N. L. (2017). Recent advances in type-2-cell-mediated immunity: insights from helminth infection. *Immunity*, 47(6), 1024-1036.
- Loukas, A., Hotez, P. J., Diemert, D., Yazdanbakhsh, M., McCarthy, J. S., Correa-Oliveira, R., ... & Bethony, J. M. (2016). Hookworm infection. *Nature reviews Disease primers*, 2(1), 1-18.
- Maizels, R. M. (2016). Parasitic helminth infections and the control of human allergic and autoimmune disorders. *Clinical Microbiology and Infection*, 22(6), 481-486.
- Mohammed, K. O., Erzaiq, Z. S., & Azzawi, W. Y. (2016). The changes in blood count among patients with different intestinal parasitic infections at Erbil city. *Tikrit Medical Journal*, 21(1).
- Moult, J., Fidelis, K., Kryshtafovych, A., Schwede, T., & Tramontano, A. (2016). Critical assessment of methods of protein structure prediction: Progress and new directions in round XI. *Proteins: Structure, Function, and Bioinformatics*, 84, 4-14.
- Olin, J. T., & Wechsler, M. E. (2014). Asthma: pathogenesis and novel drugs for treatment. *Bmj*, 349.
- Pelaia, C., Paoletti, G., Puggioni, F., Racca, F., Pelaia, G., Canonica, G. W., & Heffler, E. (2019). Interleukin-5 in the pathophysiology of severe asthma. *Frontiers in physiology*, 10, 1514.

- Price, A. S., & Kennedy, J. L. (2022). T-helper 2 mechanisms involved in human rhinovirus infections and asthma. *Annals of Allergy, Asthma & Immunology*, 129(6), 681-691.
- Patsantara, G. G., Piperaki, E. T., Tzoumaka-Bakoula, C., & Kanariou, M. G. (2016). Immune responses in children infected with the pinworm *Enterobius vermicularis* in central Greece. *Journal of helminthology*, 90(3), 337-341.
- Rahimi, M., Mohammadzadeh, T., & Khanaliha, K. (2018). Eosinophils and parasitic infections. *International Journal of Enteric Pathogens*, 6(4), 108-112.
- Schroeder, J. C., Jones, D., & Maranich, A. (2019). Peripheral eosinophilia found in pediatric *Enterobius vermicularis* infections. *Clinical Pediatrics*, 58(1), 13-16.
- Shimokawa, C., Kanaya, T., Hachisuka, M., Ishiwata, K., Hisaeda, H., Kurashima, Y., ... & Ohno, H. (2017). Mast cells are crucial for induction of group 2 innate lymphoid cells and clearance of helminth infections. *Immunity*, 46(5), 863-874.
- Sorobetea, D., Svensson-Frej, M., & Grecis, R. (2018). Immunity to gastrointestinal nematode infections. *Mucosal Immunology*, 11(2), 304-315.
- Yang, C. A., Liang, C., Lin, C. L., Hsiao, C. T., Peng, C. T., Lin, H. C., & Chang, J. G. (2017). Impact of *Enterobius vermicularis* infection and mebendazole treatment on intestinal microbiota and host immune response. *PLoS neglected tropical diseases*, 11(9), e0005963.
- Zouari, M., Louati, H., Abid, I., Trabelsi, F., Dhaou, M. B., Jallouli, M., & Mhiri, R. (2018). *Enterobius vermicularis*: a cause of abdominal pain mimicking acute appendicitis in children. A retrospective cohort study. *Archives of Iranian Medicine*, 21(2), 67-72.
- Sayal, R.A., 2019. Epidemiological study of *Cryptosporidium* infection in Al-Najaf city. *Int J Pharm Qual Assur*, 10(01), pp.128-131.
- Sayal, R.A., Hameed, S. and Faisal, M.M., 2020. Evaluation of IL-5 concentration level in Irritable Bowel Syndrome patients that suffering from Blastocystis infection in Al-Najaf Province. *Eur. J. Mol. Clin. Med*, 7, pp.3807-3817
- RA Sayal, NMF Alkharasani, [AA Alsadawi](#), [ZHO Alquraishi](#)
Journal of Pharmaceutical Sciences and Research, 2018•chm.atu.edu.iq
- Kadhim, I.A. and Ajam, S.R., 2017. Influence of Toxoplasmosis on Human Personality Among Pregnant Women in Al-Najaf Province. *International Journal of Medical Research & Health Sciences*, 6(12), pp.59-64.
- Sayal, R.A., Ibadi, A.K., Hussein, H.K. and Yasir, A.S., 2019. Obstetrical and medical history of pregnant women with toxoplasmosis in Al-najaf province, case-control study. *Indian Journal of Forensic Medicine & Toxicology*, 13(4), pp.1334-1341.
- Jorany, R.A.S.A., Gassim, Z.A. and Ali, H., 2009. Evaluation of IL-27 Concentration in a Miscarriages Woman Infected with *Toxoplasma gondii*. *Age*, 20(24), pp.38-369.
- Sayal, R.A. and Mohammed, H.M., 2024. Evaluation of TNF- α Concentration Level in Al-Najaf Hospitals Patients Infected with Hydatid Cysts. *Journal La Medihealthico*, 5(5), pp.952-959
- Sayal, R.A. and Mohammed, H.M., 2024. Investigation Epidemiological and Immunological Variable (IL-6) Resulting from Infection with Hydatid Cysts in Al-Najaf Hospitals: Case Control Study. *Journal of Scientific Research in Medical and Biological Sciences*, 5(3), pp.160-167.
- Sayal, R.A. and Mohammed, E.J., 2024. Evaluating the Role of Interleukin-9 in Cholelithiasis patients and Determine Prevalence of *Fasciola Hepatica* among these Patients. *Journal of Scientific Research in Medical and Biological Sciences*, 5(3), pp.129-136.
- Al-Hisnaw, S.A. and Al-Jorany, R.A.S., 2024. Study of The Prevalence of *Trichomonas Vaginalis* Parasite in Females Suffering from Vaginal Inflammations. *Journal of Scientific Research in Medical and Biological Sciences*, 5(1), pp.25-36.
- Ibadi, A.K., Jawad, N.M., Hashim, N.A., Meftah, S.R. and Sayal, R.A., 2023, April. Cesarean section and associated factors in Al Najaf city-Iraq. In *AIP Conference Proceedings* (Vol. 2776, No. 1). AIP Publishing.
- Yasir, A.S., Sayal, R.A. and Tikki, K.A., 2022, January. Immunological and hematological estimation of matrix metalloproteinase-9 (MMP9) level in a serum of female infested through *trichomonas vaginalis*. In *AIP Conference Proceedings* (Vol. 2386, No. 1). AIP Publishing.

-
- Sayl, R.A. and Yahya, I., Immunological Evaluation of IL-10 Concentration Level in Sera of Digestive Disorders Patients Infected with Blastocystis Hominis Infection in Al-Najaf City. *International journal of health sciences*, 6(S4), pp.11497-11505.
- Jorany, R.A.S.A., Gassim, Z.A. and Ali, H., 2009. Evaluation of IL-27 Concentration in a Miscarriages Woman Infected with Toxoplasma gondii. *Age*, 20(24), pp.38-369.
- Sayl, R.A. and Hussien, J.K., 2019. Estimation of interleukin (17, 22) and heat shock protein-20 among leishmaniasis patients in Al-Najaf province. *Biochemical & Cellular Archives*, 19(2).
- Sultan, B.A. and Jorany, R.A.S.A., 2016. Evaluation of Matrix Metalloproteinase-2 (MMP2) in Aborted Women Infected with Toxoplasma gondii. *kufa Journal for Nursing sciences*, 6(2).