

The effect of the ectoparasite (*Pediculus humanus capitis*) on immunological and blood parameters in children of different ages in Baquba city

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Abstract

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Website:

<https://djm.uodiyala.edu.iq/index.php/djm>

Received: 23 October 2022

Accepted: 1 November 2022

Published: 30 October 2023

Background: Ectoparasites are predominant parasitic infections among children. Head lice (*Pediculus humanus capitis*) are transmitted parasites, mainly among school-aged children. Although, head lice are not a chief health hazard or a vector for disease, they are a public social problem. The transmitted infections by a parasitic bite, may reach the blood which causes health problems for children and affects their health.

Objective: To investigate the effects of infection with head lice on Immunoglobulin E (IgE), vitamin D3, Zinc, and blood parameters.

Patients and Methods: Samples including skin swabbing and blood samples were collected from 300 children who were examined at AL-Batool Maternity Teaching Hospital (AL-BMTH) and some medical centers. Skin scraping and swabbing were examined microscopically for detection of the parasite. Blood samples were analyzed for immunological and blood parameter estimation, during the period from 1st October 2021 to the end of May 2022. Samples were sent to the parasitology and hematology laboratories in AL-BMTH to identify the parasitic infections and their effects.

Results: The samples include 180 females and 120 males, 90 samples of the 300 were epidemic with lice infection, 48.9% of them were at age 1-5 years, 35.6% were at age 6-10 and 15.6% were at age 11-15, 91% of the infected children were females, while only 9% of the infected children were males. The blood analysis indicated that the levels of vitamin D and the mineral Zinc, were lower in children infected with head lice compared to the control, while IgE was higher. RBC and Hb showed a lower level in infected children than in control, whereas WBC was at a high ratio in most patients.

Conclusion: Parasites cause many diseases in children in particular. They spread in rural and crowded places and affect the activity and vitality of children.

Keywords: Ectoparasite, Head lice, Zinc, Vitamin D, IgE.

Introduction

On 21 June 2017, in New York, the world population was estimated at 7.6 billion and expected to reach 8.6 billion in 2030, according to a new United Nations report.

Such increases in the world population may aggravate many health problems including parasitic infections. The spread of external parasite infection is a health and epidemiological problem due to the increase in the human population, and the challenges of producing healthy food [1,2] Furthermore, the phenomenon of drought that the world has been exposed to in recent years has led to a decrease in the proportion of water suitable for human consumption and use [3,4].

Ectoparasites are the most prevalent in developing countries, particularly in crowded places with poor socio-economic and hygiene conditions [4,5]. The high level of infestation with this parasite is induced by their direct transmission, i.e., head-to-head contact for pediculosis, or through contact with other personal objects for people who were infected with head lice such as combs [7]. Usually, children between the ages of 5 and 12 are the most susceptible group to head lice infestation since they do not practice good hygiene when interacting with other kids and their environment [8,9]. However, there are some factors affecting the relevance of head lice that are more related to the patient family and environment. For instance, [10] and [11] stated that there is a relationship between some socioeconomic status and the incidence of scabies and head pediculosis including, family income, the number of family members, and the mother's education and occupation.

According to [3], head lice can survive on their host for around a month. The female louse feeds on blood and produces 6–10 eggs every day, which adhere to the hair on the surface of the skin and behind the neck and ears. For persistence, they require optimal

conditions of 28–30°C and 70–90% relative humidity.

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In extreme circumstances, a person with head lice may face serious health issues, such as anemia, insomnia, itching, irritation, and skin infections [12,13,14] Due to a hypersensitive reaction to the lice's injected saliva during blood-feeding, itchy papules may form [3]. Head lice can lead to itchy dermatitis on the scalp, crusted sore, and enlarged lymph nodes in the neck but the child can avoid this problem by treating head lice as soon as possible [15,16].

Head lice feed on human blood, so severe chronic injury among children may lead to anemia, which is reflected in fatigue [17,18]. [19,20] reviewed that malnutrition makes children more susceptible to micronutrient deficiency and therefore more affected by parasitic infection. Malnutrition is thought to potentiate the IL-4-dependent polyclonal stimulation of IgE by parasites, and high total serum IgE levels result in decreased resistance because of low levels of specific antiparasite IgE [21].

Vitamin D3 can be obtained from the diet or can be synthesized endogenously from a cholesterol precursor (7-dehydrocholesterol) through the incidence of sun-UVB rays on the skin [22,23]. Vitamin D3 is necessary for calcium homeostasis, cell growth, differentiation, and function in many tissues,

including the immune system, and so for immune defense mechanisms against infections, including parasitic types. Although many studies investigated head lice infection, most of these studies focused on its prevalence and its relationship with some socioeconomic factors e.g., poor hygiene, low education, and other factors [23]. Therefore, the present study proposed to investigate the relationship between head lice infection and some immunological, blood parameters, vitamin D, Zn, and IgE.

Aim of the study investigating the prevalence of head lice infection among children between the ages of 1 and 15 years old, who are outpatients at AL-Batool Maternity Teaching Hospital (AL-BMTH) investigating the relationship between head lice infection and some blood parameters (CBC, WBC count, HB). Examining the relationship between head lice infection and, Vitamin D, Zinc, and level of IgE parameter.

Patients and Methods

The populations of this study included 300 patients of different ages (1-15 years) who were outpatients examined by physicians and send to the parasitology laboratory in Baqubah Teaching Hospital and AL-Batool Maternity Teaching Hospital/Diyala province. The subjects suffered from gastrointestinal complaints with acute diarrhea, one fresh stool samples were collected from the 300 patients and 90 blood samples were 60 blood samples from patients and 30 (controls) to do hematological testes.

The recent research was carried out between the first of October 2021 and the end of May 2022. The presence of at least one development stage (egg, nymph, and adult)

of *Pediculus humanus capitis*, including nits' residues, which can be seen by the necked eye, was classified as a positive infestation. This was determined by carefully inspecting the full head (neck, ears, and hair) and taking skin scraping samples from children with the clinically suspicious infestation. and microscopic examinations were done for each sample of suspicious infestation.

Blood samples were taken from 60 children with head lice infection (39 males and 21 females) and 30 blood samples from uninfected children (18 male and 12 female). Use a sterile disposable 5 ml syringe to draw 5 ml of blood. To examine blood parameters in the parasitology and hematology labs at AL-BMTH, 2 ml of blood were drawn in a specific tube containing EDTA. using the Japanese Sysmex XN-350 apparatus. Whereas, 3 ml were moved into a plastic 6 mL gel tube without anticoagulation and left it in a vertical position for a while. Then they were spun at 5000 cycles per minute for 10 minutes in the centrifuge. The serum was dispensed into Eppendorf tubes and kept at 20 ° C until it was forwarded for immunological tests to another facility using the Cobas Integra system Cobas E 411 auto-electrolysis and Spectrophotometer device, which evaluates Vitamin D and Zinc values.

Statistical Analysis

The data were analyzed using the statistical program SPSS version 25.0. Data were first checked for normality, IgE antibody, hematological parameters, and biochemical parameters using Kolmogorov-Smirnov and Shapiro-Wilk tests. The parameters that did not fit the normality tests (significant difference) were given as median and range, and a significant difference between median

was determined by Mann-Whitney analysis. The parameters that fit both tests (no significant difference) were given as mean standard deviation (SD) (for comparison between two groups). The additional factors were expressed as percentage frequencies, and Pearson's chi-squared test or two-tailed Fisher's Exact Probability were used to seeing whether there were any significant differences in the frequencies (p). To comprehend the link between particular parameters, the Pearson bivariate correlation was used. Additionally, multiple linear regression was used to forecast how a

response variable will behave concerning several explanatory variables. The fully automated CELL - DYN Ruby System, which is used for the analysis and count of hematological parameters, estimated hematological parameters [25].

Results

The results show the relationship between age and the presence of a parasitic infestation. Higher levels of infestation were at ages 1-5 years (48.9%) than the rest of other age groups 6-10 and 11-16, (35.6%) (15.6%) respectively Table (1).

Table (1): The relationship between head lice infections and age groups of participants

		Age groups (years)			Total	P value
		1-5	6-10	11-15		
Lice infection	N	44	32	14	90	<0.01**
	%	48.9%	35.6%	15.6%	100.0%	

Table (2) reviewed that there are significant differences between parasitic infestation and

sex, as the infection rate of females was higher than that of males.

Table (2): Relationship between the prevalence of parasitic infections with the gender of participants

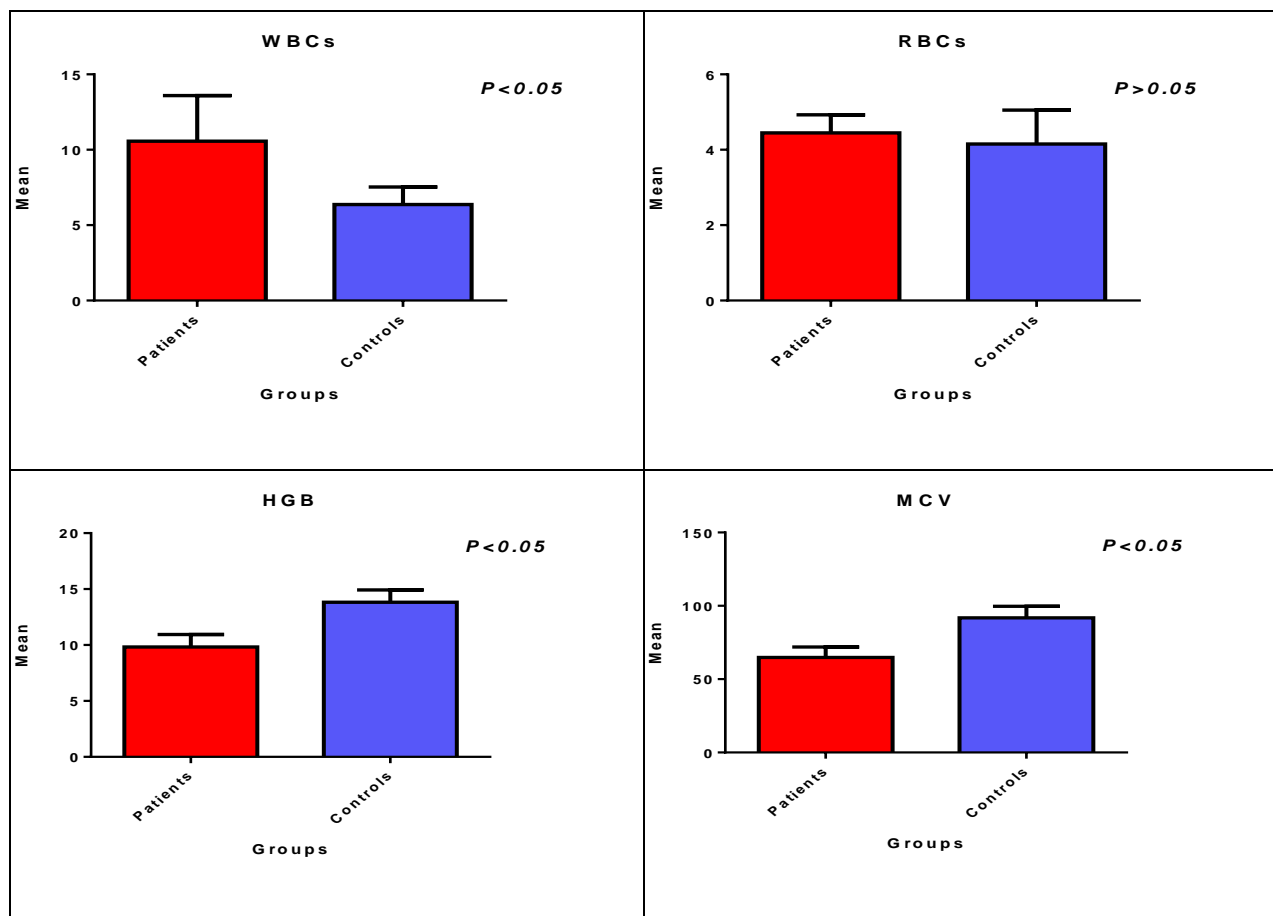
		Gender		Total	P value
		Males	Females		
Lice	n	8	82	90	<0.001***
	%	8.9%	91.1%	100.0%	

The results also show a significant difference (p<0.05) between hematological parameters (WBC, HGB, MCV, MCH, and PLT) in patients and controls. The WBC and PLT parameters were higher in patients (10.57±3.02 and 370.67±84.92) than in

controls. In contrast, the HGB, MCV, and MCH parameters were lower in patients (9.82±1.13, 64.85±7.13, and 21.20±3.04) than in controls. Whereas, there was no significant difference in RBC between patients and controls Table (3), Figure (1).

Table (3): Comparison of hematological parameters between study groups

Groups		N	Mean	SD	P value
WBC	Patients	60	10.57	3.02	<0.01**
	controls	30	6.37	1.16	
RBC	Patients	60	4.45	0.48	>0.05
	controls	30	4.15	0.90	
HGB	Patients	60	9.82	1.13	<0.01**
	controls	30	13.83	1.09	
MCV	Patients	60	64.85	7.13	<0.001***
	Controls	30	91.83	7.38	
MCH	Patients	60	21.20	3.04	<0.01**
	controls	30	30.7	1.95	
PLT	Patients	60	370.67	84.92	<0.001**
	controls	30	293.27	59.71	



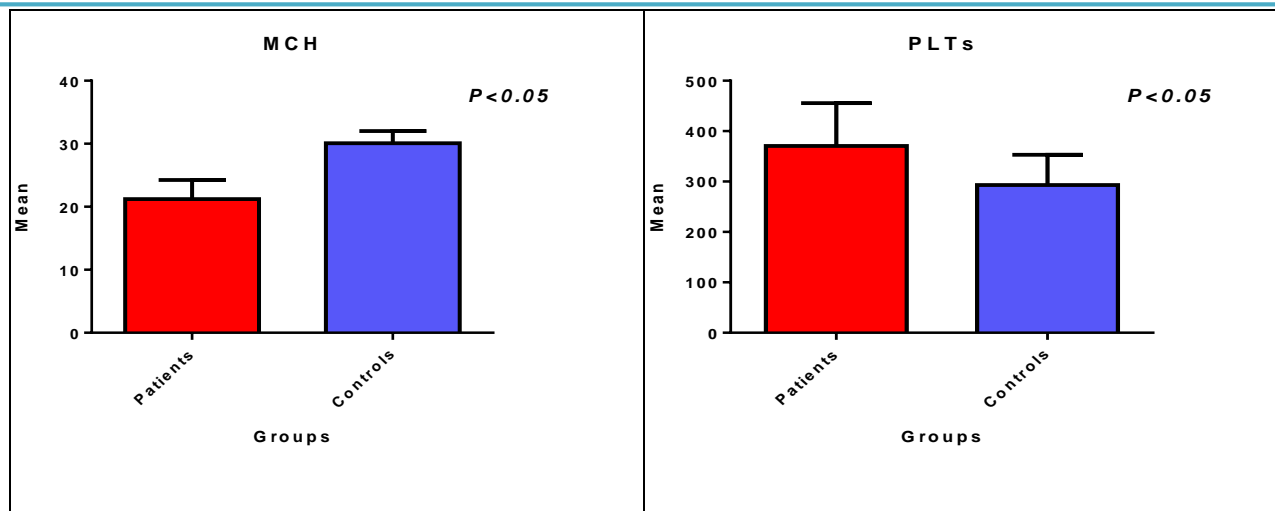


Figure (1): Comparative hematological parameters between study groups

Results show a significantly different ($p < 0.05$) between biochemical (Vit D3 and zinc) and IgE parameters in patients and controls. The Vit D3 (73.68 ± 12.51) and zinc

(24.48 ± 4.24) were lower in patients than in controls. While the IgE (60.55 ± 18.32) was higher in patients than in controls Table (4).

Table (4): Comparison of biochemical and immunological parameters between study

Groups		N	Mean	SD	P value
VitD3	Patients	60	24.48	4.24	<0.001***
	controls	30	70.30	21.87	
Zinc	Patients	60	73.68	12.51	<0.01**
	controls	30	90.17	12.58	
IgE	Patients	60	60.55	18.32	<0.001***
	controls	30	31.23	12.21	

Discussion

The results showed that only 8.9% of males had a head lice infection compared to females 91.1%, which that indicated girls have a higher risk of pediculosis than boys ($p = 0.01$). The results of this study are compatible with many other studies [28,29,30,26,31,32,33]. This can be due to behavioral and lifestyle differences between the two genders [34,35]. should girls usually have longer and thicker hair than boys, which

provides a perfect environment for the growth and presence of head lice. In addition, females are more likely to spend their time in playing areas and have head-to-head contact while they are playing. While males spend more time outdoors engaging in more active sporting activities [4].

Age groups are also affected by the level of head lice infestation. Younger children were more likely to have head lice infestations than older children, 1-5 years old had a two-

fold increased risk of infestation compared to other age groups. This might be explained by older children maintaining better hygiene than younger children [37,35,31]. Thus, children are more likely to get a lice infection due to close contact, poor personal cleanliness, and the constant sharing of hair materials and combs. A study in Kirkuk City, Iraq, reported a relatively high rate (42.7%) among displaced secondary school girls [39]. It may be these groups have a higher incidence since girls, mothers, and children usually have closer physical contact, which makes it easier for the disease to spread. Moreover, other head lice studies have shown a relationship between female sex, overcrowding, and other infested family members [46]. Even though head lice infestation happens during fall months of the year at slightly varying rates, it rises in warmer months due to its influence on gentle seasonal fluctuations in weather temperature. The participants in the present study said that itching of the hair scalp was the most prevalent sign of head lice infestation, which was also reported by [42,43].

As head lice feed on human blood, according to a recent study on blood parameters, severe chronic injury in schoolchildren may result in anemia, which can lower academic performance and cognitive function and manifest as fatigue and drowsiness in class. [44,18]. Previous studies suggested that external parasite infestation could cause iron-deficiency anemia, which lowers hemoglobin levels and other red blood cell components in both people and animals [45,46,47,18]. Due to rivalry between the sponsor and the host for

the blood's food source, hemoglobin levels may have decreased.

The present results indicated a high number of white blood cells and platelets, the reason for these results could be due to the formation of antibodies as a result of the presence of strange materials (e.g., an external infestation that entered the body through lice bite or blood-sucking, or lice saliva). The results are in agreement with [47,48] who reported that parasite-infected humans and animals undergo oxidative stress, in addition to the antioxidant defense mechanism that exists between the parasite and the animal host [49].

Oxidative stress and itch awareness make children nervous and lead to lowered immunity. In allergic inflammatory diseases of humans, such as parasitic infections, efflux associated with citrus is a major source of tissue damage through the production of strong ROS [49].

IgE, its receptors, and particular biological reactions did not evolve to target the safe compounds found in plant pollen, dust mites, or animal dander, it is generally accepted. However, many believe that allergy is actually a misdirected anti-parasite response in hypersensitive people and that the IgE axis originated to fight off metazoan parasites (worms and parasitic arthropods) that are too large to be phagocytosed [50]. Therefore, the high level of immunoglobulin E in The study may be related to the development of antibodies to head lice infection and the high level of histamine, which increases skin infections and hypersensitivity as a result of itching, wounds left by the bite of lice, and the presence of saliva in the blood for lice,

which in turn is related to the formation of antibodies to head lice infection.

In previous studies, plasma from subjects with scabies and lice showed a highly increased specific IgE response to several recombinant proteins from scabies and lice mites [15,50].

Vitamin D3 (Vit D) is a crucial immunological supplement that can be acquired through diet or produced internally from a precursor to cholesterol (7-dehydrocholesterol) by exposure to UVB rays from the sun on the skin. This vitamin and its metabolites regulate cell proliferation, differentiation, and function in numerous tissues, including the immune system [8,10]. Investigation of zinc and vitamin D levels found to be low, this could be due to the nature of nutrition genetic diseases or the presence of other diseases due to weak immunity that results from lack of food quality that encourages the growth of many diseases that makes the body weak and vulnerable to diseases [51]. Also few studies show the relation of parasitic infection in the elevated of IgE. The IL-4-dependent polyclonal activation of IgE by parasites is thought to be exacerbated by malnutrition [52] due to limited amounts of particular antiparasite IgE, a high overall serum IgE level reduces resistance.

Studies that investing the relation between IgE, VitD3, and Zinc are limited so that's references are few that support our research in Baquba city up to appoint. As conclusion, external infection with head lice has a direct or indirect impact on human body such as levels of blood parameters and other parameters including (IgE, Vit D3, Zinc) as a decrease in the levels of antioxidants such

as Vit D3, and Zinc was observed. On the other hand, there was an increase in the level of IgE WBC eosinophils which is the indicator of oxidative stress involved in the pathogenesis of several diseases.

Conclusions

In conclusion, our findings from this report reveal a higher prevalence of *E. histolytica* than *G. lamblia* Endoparasitic infections has a direct or indirect impact on levels blood parameters and immunity parameters (IgE, vit D, zinc) where a decrease in the levels of antioxidants such as vit D3 and zinc was observed. On the other hand, there was an increase in the level of concentration of IgE WBC eosinophils which is the indicator of oxidative stress which involved in the pathogenesis of several diseases.

Recommendations

The findings of this study indicate a high level of intestinal parasitic infection among children especially 5 > which highlighted the need for long term control measures to improve the sanitary and living conditions for these children, especially in regions with high prevalence. The impact of these measures would be further enhanced via an organized health and education programs, which may support and encourage healthy behaviors and lead to decrease of these parasites.

There are several limitations in our research. As this was a single center study, we were unable to rule out the bias of local population specific characteristics which hinder the extrapolation of the results to reference population. The limited numbers of our case and control groups could have affected the power of the study. Therefore, we recommended further investigation using larger samples particular regarding the

relation between the the intestinal parasites and the minerals such as Zinc amd vitamin d.

Source of funding: The current study was funded by our charges with no any other funding sources elsewhere.

Ethical clearance: Ethical approval was obtained from the College of Medicine / University of Diyala ethical committee for this study.

Conflict of interest: Nil

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تأثير الطفيل الخارجي (*Pediculus humanus capitis*) على مقياس المناعة والدم لدى الأطفال من مختلف الأعمار في مدينة بعقوبة

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الملخص

خلفية الدراسة: الطفيليات الخارجية هي العدوى الطفيلية السائدة بين الأطفال. قمل الرأس (*Pediculus humanus capitis*) طفيليات تنتقل بشكل رئيسي بين الأطفال في سن المدرسة. على الرغم من أن قمل الرأس لا يمثل خطرًا رئيسيًا على الصحة أو ناقلاً للأمراض، إلا أنه يمثل مشكلة اجتماعية عامة. قد تصل العدوى المنقولة عن طريق العضة الطفيلية إلى الدم مما يسبب مشاكل صحية للأطفال وتؤثر على صحتهم.

اهداف الدراسة: لمعرفة تأثير الإصابة بقمل الرأس على الغلوبولين المناعي (IgE) وفيتامين D3 والزنك ومعلومات الدم المرضي والطرائق: تم جمع عينات من كشط الجلد وعينات الدم من 300 طفل تم فحصهم في مستشفى البتول التعليمي للولادة وبعض المراكز الطبية. تم فحص تجريف الجلد وتبديله مجهرياً للكشف عن الطفيل. تم تحليل عينات الدم للمناعة وتقدير معامل الدم خلال الفترة من 1 أكتوبر 2021 إلى نهاية مايو 2022. تم إرسال العينات إلى معامل الطفيليات وأمراض الدم في AL-BMTH للتعرف على العدوى الطفيلية وتأثيراتها.

النتائج: شملت العينات 180 من الإناث و120 من الذكور، 90 من أصل 300 مصاب بعدوى القمل، 48.9% منهم في سن 1-5 سنوات، 35.6% في سن 6-10 و15.6% في سن 11-15، 91% من الأطفال المصابين هم من الإناث، بينما 9% فقط من الأطفال المصابين هم من الذكور. وأشار تحليل الدم إلى أن مستويات فيتامين (د) ومعدن الزنك كانت أقل لدى الأطفال المصابين بقمل الرأس مقارنة بالمجموعة الضابطة، بينما كان IgE أعلى. أظهر RBC وHb مستوى أقل في الأطفال المصابين منه في المجموعة الضابطة، في حين كان WBC عند نسبة عالية في معظم المرضى.

الاستنتاجات: تسبب الطفيليات العديد من الأمراض للأطفال بصورة خاصة و تنتشر في الأماكن الريفية و الأماكن المزدحمة و تؤثر على نشاط و حيوية الأطفال.

الكلمات المفتاحية: طفيلي خارجي ، قمل الرأس ، زنك ، فيتامين د ، IgE

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تاريخ استلام البحث: 23 تشرين الأول 2022

تاريخ قبول البحث: 1 تشرين الثاني 2022

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