DOI: https://doi.org/10.53350/pjmhs02024181895

ORIGINAL ARTICLE

Impact of Environmental and Biochemical Factors on Recurrent Tonsillitis among School-Age Children: A Community-Based Clinical Study

HAMEEDULLAH ACHAKZAI[1], IQBAL AHMAD[2], FAROOQ AHMAD MALIK[3], RIZWAN SAEED[4], M. FAHEEM SIDDIQUI[5], S. M. QAISAR SAJJAD[6]

[1]Department of ENT, Bolan Medical College, Quetta, Balochistan, Pakistan.
[2]Associate Professor, Department of Pediatric Medicine, Shahida Islam Teaching Hospital, Lodhran, Punjab, Pakistan.
[3]Associate Professor of Biochemistry, DG Khan Medical College, Dera Ghazi Khan, Punjab, Pakistan.
[4]Professor & Head, Department of Community Medicine; Director Students Affairs, Azra Naheed Medical College, Superior University, Lahore, Punjab, Pakistan.
[5]Associate Professor of Biochemistry, Queen Medical College, Kasur, Punjab, Pakistan.
[6]Assistant Professor, Sir Syed College of Medical Sciences for Girls, Karachi, Sindh, Pakistan.
Correspondence to: Dr. Iqbal Ahmad, Email: iqbalswm146@yahoo.com

ABSTRACT

Background: Recurrent tonsillitis is a common childhood disorder characterized by repeated tonsillitis, which is linked to a diminished quality of life, school absence, and increased health care costs. Environmental exposures and biochemical disturbances can play a major role in the recurrence of diseases in school-age children of school age.

Objective: To assess the effect of environmental and biochemical factors on the occurrence of recurrent tonsillitis in a community-based clinical population of school-age children.

Materials and Methods: This community-based cross-sectional clinical study was conducted from June 2022 to June 2023 at the Department of Pediatric Medicine, Shahida Islam Teaching Hospital, Lodhran, Punjab, Pakistan, and Sir Syed College of Medical Sciences for Girls, Karachi, Sindh, Pakistan. The total number of children aged 5-15 years was 120, including 70 children with recurrent tonsillitis and 50 healthy control children. Structured questionnaires were used to evaluate environmental factors such as passive smoking, overcrowding, poor ventilation, biomass fuel exposure, and dust allergen exposure. Biochemical investigations included complete blood count, C-reactive protein (CRP), antistreptolysin O (ASO) titer, eosinophil count, serum vitamin D, serum iron, and serum calcium levels. Data were analyzed statistically with SPSS 25.0.

Results: Children with recurrent tonsillitis had significantly more passive smoking, overcrowding, poor ventilation, and environmental allergens than the controls. High levels of CRP, leucocytosis, eosinophilia, and high ASO titres were significantly correlated with recurrent tonsillitis. Additionally, vitamin D deficiency and low calcium and iron levels in the serum were significantly more prevalent among the affected children. The multivariate analysis revealed that passive smoking, poor ventilation, high ASO levels, and vitamin D deficiency were independent factors for recurrent tonsillitis.

Conclusion: Exposure to the environment and biochemical abnormalities play a major role in the occurrence of recurrent tonsillitis in school-age children. Identification and correction of modifiable risk factors early in life may lead to a decrease in disease recurrence and improve health outcomes in children.

Keywords: Recurrent tonsillitis, school-age children, environmental exposure, vitamin D deficiency, inflammatory biomarkers, pediatric infections, ASO titer

INTRODUCTION

Recurrent tonsillitis is the most prevalent chronic infectious disease in school-aged children globally and a significant public health issue due to its effects on children's health, educational attainment, quality of life, and health care use[1]. The condition is characterized by repeated episodes of inflammation and infection of the palatine tonsils, usually accompanied by sore throat, fever, dysphagia, cervical lymphadenopathy, halitosis, and general malaise[2]. Children and parents may suffer from psychological stress, sleep disturbances, nutritional compromise, school absenteeism, and repeated physician visits and antibiotic exposure as a consequence of repeated tonsillar infections[3]. Despite advances in pediatric healthcare and antimicrobial therapy, recurrent tonsillitis continues to contribute substantially to pediatric morbidity, particularly in developing countries with overcrowded living conditions and environmental pollution[4].

Palatine tonsils are an integral part of Waldeyer's ring and are important immunological structures in childhood, involved in the recognition of antigens and in mucosal immune defense against inhaled and ingested antigens[5]. Chronic inflammatory changes, lymphoid hyperplasia, crypt fibrosis, and chronic microbial colonization of tonsillar tissue may occur after repeated exposure to infectious organisms[6]. Bacterial pathogens, particularly Group A β-hemolytic Streptococcus, Staphylococcus aureus, and polymicrobial biofilm-forming organisms, are commonly implicated in recurrent infections[7]. Viral pathogens and impaired local immune responses may further exacerbate the inflammatory process and predispose children to repeated episodes of tonsillitis[8].

Received on 12-10-2023
Accepted on 29-12-2023

The importance of environmental determinants to recurrent upper respiratory tract infections in children has been increasingly acknowledged[9]. Exposure to passive cigarette smoke, indoor biomass fuel combustion, poor household ventilation, overcrowded residential settings, environmental allergens, airborne dust particles, and urban pollution may promote chronic irritation and inflammation of the upper airway mucosa[10]. Children in crowded neighborhoods and households with limited ventilation are at a higher risk for frequent respiratory infections due to higher exposure to inflammatory environmental triggers and greater spread of infectious agents[11]. School settings also promote close personal contact, and this can enhance the transmission of microbes among young students in the years they are starting to learn in school[12].

Along with environmental factors, biochemical and immunological factors can be important contributors to tonsillitis pathogenesis and recurrence[13]. Several studies have shown that children with recurrent tonsillitis have raised inflammatory markers such as leukocytosis, C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), eosinophilia, and raised antistreptolysin O (ASO) titres, which represent systemic inflammatory activation and recurrent exposure to streptococci[14]. Nutritional and micronutrient deficiencies, including vitamin D deficiency, iron deficiency, and dysregulated calcium metabolism, can diminish innate and adaptive immune function, making individuals more vulnerable to recurrent infections[15]. Vitamin D is especially important because of its immunomodulatory role in enhancing antimicrobial peptide synthesis and regulating inflammatory pathways within the respiratory mucosa[16].

Recent evidence also indicates that allergic predisposition and eosinophilic airway inflammation can occur in combination with recurrent tonsillar disease[2]. Continuous exposure to environmental

allergens may contribute to chronic lymphoid tissue activation, mucosal edema, and recurrent infection susceptibility[18]. Additionally, socioeconomic inequalities, lack of access to healthcare, hygiene, and nutrition could contribute to further disease burden in the community pediatric population[19].

Although numerous studies have independently evaluated infectious, environmental, or immunological contributors to recurrent tonsillitis, limited community-based clinical studies have comprehensively assessed the combined impact of environmental and biochemical factors among school-age children[20]. Understanding these multidimensional risk factors is important for developing preventive strategies, reducing disease recurrence, minimizing unnecessary antibiotic exposure, and improving pediatric respiratory health outcomes[14].

Hence, the present study was carried out to assess the effect of environment and biochemical factors in a community-based clinical population with recurrent tonsillitis.

MATERIALS AND METHODS

This community-based cross-sectional clinical study was conducted from June 2022 to June 2023 at the Department of Pediatric Medicine, Shahida Islam Teaching Hospital, Lodhran, Punjab, Pakistan, and Sir Syed College of Medical Sciences for Girls, Karachi, Sindh, Pakistan. This study aimed to assess the effect of environmental and biochemical factors on Recurrent Tonsillitis in school-going children.

The study involved 120 children aged 5–15 years, selected by a non-probability consecutive sampling technique. Participants were divided into two groups comprising 70 children diagnosed with recurrent tonsillitis and 50 healthy age-matched controls recruited from community schools and pediatric outpatient settings. Recurrent tonsillitis was diagnosed if there were three or more clinically documented episodes of tonsillitis in 1 year, which included the presence of sore throat, fever, dysphagia, enlarged tonsils, enlarged cervical lymph nodes, or tonsillar exudates.

The study excluded children with congenital anomalies, chronic systemic diseases, immunodeficiency disorders, autoimmune diseases, hematological disorders, previous tonsillectomy, recent hospitalization, or long-term use of corticosteroid therapy. For comparison, healthy controls without a history of recurrent upper respiratory tract infections (URIs) and chronic inflammatory diseases (CIDs) were enrolled.

Structured questionnaires were used to gather detailed demographic and environmental data from the parents/legal guardians of the children. Environmental factors evaluated were passive smoking exposure, household overcrowding, exposure to biomass fuel at home, ventilation of the household, recurrent dust allergen exposure, socioeconomic status, and personal hygiene. Pediatric physicians performed clinical examination for assessment of tonsillar grade, cervical lymphadenopathy, nutritional status, BMI, and other upper respiratory tract findings.

All the participants had venous blood samples taken under sterile conditions for biochemical and inflammatory studies. Laboratory parameters were complete blood count, total leucocyte count, eosinophil count, serum vitamin D, serum iron, serum calcium, C-reactive protein (CRP), and antistreptolysin O (ASO) levels. All biochemical analyses were performed by standard laboratory procedures and commercially available diagnostic kits, following the manufacturers' instructions.

The data were analysed using the statistical package for the social sciences (SPSS) version 25.0. Continuous variables were presented as mean ± standard deviation, and categorical variables as percentages and numbers. An independent sample t-test was used to compare continuous variables between groups, while Chi-square test was used for categorical variables. A multivariate logistic regression analysis was used to determine independent predictors of recurrent tonsillitis. Statistically significant results were determined using a p-value < 0.05.

Ethical approval was obtained from the Institutional Ethical Review Committee before commencement of the study. Written informed consent was obtained from parents or guardians of all participating children before enrollment.

RESULTS

A total of 120 school-age children were enrolled in the study, including 70 children with recurrent tonsillitis and 50 healthy controls. The mean age of children with recurrent tonsillitis was 9.1 ± 2.6 years, and the mean age of controls was 8.8 ± 2.4 years. Of the cases of recurrent tonsillitis, 57.1% were male and 42.9% were female. The majority of children affected were 6–10 years old. The most common clinical features noted among participants were recurrent sore throat, fever, difficulty with swallowing, enlarged tonsils, and enlarged lymph nodes in the neck.

The children with recurrent tonsillitis were exposed to a greater degree to passive smoking, household overcrowding, indoor biomass fuel smoke, and poor room ventilation than the healthy controls (P<0.05). There was also a significant difference between the recurrent tonsillitis group and the non-recurrent group regarding exposure to dust allergens and poor hygiene conditions. These findings suggest that there is a significant positive correlation between the unfavorable environmental conditions and the repeated tonsillitis in school-age children, as reflected in Table 1.

Among children with recurrent tonsillitis, there were significant biochemical and inflammatory abnormalities. Affected children had significantly higher mean CRP, ASO titers, leucocytes, and eosinophils than controls. However, the serum vitamin D, serum iron, and serum calcium levels were significantly decreased in patients with recurrent tonsillitis. All these biochemical changes indicate ongoing activation of the inflammatory process and impaired immune function in affected children. The detailed laboratory comparisons are shown in Table 2.

Table 1: Environmental Risk Factors Associated with Recurrent Tonsillitis

Environmental Factors	Recurrent Tonsillitis (n=70)	Controls (n=50)	p-value
Passive smoking exposure	45 (64.3%)	15 (30.0%)	0.001
Household overcrowding	42 (60.0%)	14 (28.0%)	0.002
Indoor biomass fuel exposure	31 (44.3%)	11 (22.0%)	0.014
Poor room ventilation	46 (65.7%)	16 (32.0%)	0.001
Frequent dust allergen exposure	39 (55.7%)	13 (26.0%)	0.003
Poor hygiene practices	34 (48.6%)	10 (20.0%)	0.004

Table 2: Comparison of Biochemical and Inflammatory Parameters

Parameters	Recurrent Tonsillitis (n=70)	Controls (n=50)	p-value
CRP (mg/L)	10.2 ± 3.7	3.4 ± 1.2	<0.001
ASO Titer (IU/mL)	392 ± 88	152 ± 49	<0.001
Total Leukocyte Count (×10⁹/L)	12.4 ± 2.3	7.8 ± 1.6	<0.001
Eosinophil Count (%)	7.4 ± 2.2	3.6 ± 1.3	0.002
Vitamin D (ng/mL)	18.9 ± 5.6	31.4 ± 6.9	<0.001
Serum Iron (µg/dL)	47.6 ± 11.8	71.8 ± 13.5	<0.001
Serum Calcium (mg/dL)	8.2 ± 0.5	9.1 ± 0.4	0.005

Table 3: Multivariate Logistic Regression Analysis for Predictors of Recurrent Tonsillitis

Variables	Odds Ratio (OR)	95% Confidence Interval	p-value
Passive smoking exposure	3.18	1.44 – 7.01	0.002
Poor room ventilation	2.91	1.29 – 6.34	0.004
Elevated ASO titer	4.26	1.98 – 8.87	<0.001
Vitamin D deficiency	3.67	1.61 – 8.04	0.001
Dust allergen exposure	2.09	1.02 – 4.28	0.041

Subsequent analyses revealed that 44 (62.9%) of the children with recurrent tonsillitis were vitamin D deficient, compared to 11 (22.0%) of the controls. ASO levels were also raised in 52 (74.3%) children with the disease, which is a sign of

repeated strep infections. Also, exposure to environmental allergens and passive smoking was significantly linked to eosinophilia in recurrent tonsillitis cases.

Passive smoking, poor ventilation at home, high ASO titers, and vitamin D deficiency are independent factors associated with recurrent tonsillitis according to multivariate logistic regression analysis. Children exposed to passive smoking had about three times the risk of developing recurrent tonsillitis as did non-exposed children. Disease recurrence was also found to be independently strongly associated with vitamin D deficiency. The results of the regression analysis are presented in Table 3.

Overall, the study findings demonstrated that both environmental exposures and biochemical abnormalities significantly contribute to recurrent tonsillitis among school-age children. A strong association was found between poor living, frequent allergen exposure, inflammatory, and nutritional disturbances and both disease recurrence and severity.

DISCUSSION

The current community-based clinical study showed that there was a significant association between environmental exposures, biochemical abnormalities, and recurrent tonsillitis among children of the school age group[1]. Because of the role of recurrent tonsillitis in recurrent infections, the impact on school performance, frequent antibiotic use, and poor quality of life, recurrent tonsillitis is a significant pediatric health problem[2]. This study's results indicate that the environment and inflammatory pathways are both important for tonsillar infection recurrence and persistence[3].

One of the major findings of this study was the strong association between passive smoking exposure and recurrent tonsillitis[4]. When children were exposed to household cigarette smoke, there were significantly more recurrent tonsillar infections compared to controls[5]. Passive smoking is associated with decreased mucociliary clearance, damage to respiratory epithelial surfaces, and changes in local immune defense systems that result in a higher risk of recurrent upper respiratory tract infections (RTIs)[6]. Exposure to tobacco smoke continuously may also lead to chronic inflammation in the tonsillar tissues and bacterial colonization[7].

Overcrowded houses and poor household ventilation were also significantly associated with recurrent tonsillitis[8]. Children living in poorly ventilated and densely populated households are more frequently exposed to airborne infectious pathogens and indoor pollutants[9]. Poor ventilation leads to higher humidity and the persistence of microorganisms, such as in closed areas, contributing to frequent respiratory infections.[10] This is consistent with the results of paediatric respiratory research in developing countries in which overcrowding and poor sanitation are still significant factors in the high prevalence of recurrent infectious diseases among children[11].

The present study also showed that environmental allergen exposure was associated with recurrent tonsillitis[12]. Exposure to dust particles, indoor pollutants, and airborne allergens may cause chronic irritation of the mucosa, and the lymphoid tissue may remain inflamed[13]. Allergic airway inflammation can compromise mucosal barrier integrity and facilitate microbial invasion, thereby increasing the frequency of tonsillar infections[14]. The increased eosinophil levels in affected children also suggest that allergic and inflammatory pathways play a role in recurrent tonsillar disease[15].

Biochemical analysis in the current study revealed significantly elevated CRP levels, leukocyte counts, and ASO titers among children with recurrent tonsillitis[16]. Elevated CRP reflects ongoing systemic inflammatory activity, while increased ASO titers indicate repeated streptococcal exposure and immune stimulation[17]. These results indicate that bacterial colonization and chronic inflammatory activation are important pathogenic factors in recurrent tonsillitis[18]. Elevated levels of leukocytes and eosinophils also indicate chronic inflammation and immune responses in affected children[19].

This study revealed a significant number of vitamin D-deficient children with recurrent tonsillitis, with a particularly important finding being the prevalence of this deficiency in children with recurrent tonsillitis. Multivariate analysis revealed that vitamin D deficiency was an independent predictor of disease recurrence[6]. Vitamin D plays a critical immunomodulatory role by enhancing innate immunity, regulating cytokine production, and promoting antimicrobial peptide synthesis within the respiratory mucosa[9]. Deficiency of vitamin D may impair host defense mechanisms and increase vulnerability to recurrent respiratory infections[12]. Several previous studies have similarly demonstrated a significant relationship between low vitamin D levels and recurrent tonsillar disease in pediatric populations[15].

Low serum iron and calcium levels were also observed among children with recurrent tonsillitis[17]. Iron deficiency may impair cellular immunity and reduce resistance against infectious pathogens, while altered calcium metabolism may affect normal immune regulation and inflammatory signaling pathways[18]. Children from low socioeconomic status are at high risk for nutritional deficiencies, which could play a large role in the occurrence of recurrent infectious morbidity[20].

The findings of this study emphasize the multifactorial nature of recurrent tonsillitis among school-age children[11]. Environmental pollution, passive smoking, poor living conditions, recurrent allergen exposure, inflammatory activation, and nutritional deficiencies collectively contribute to disease development and recurrence[13]. These results highlight the importance of adopting preventive community-based strategies focusing on environmental improvement, smoking avoidance, nutritional supplementation, and early clinical management to reduce the burden of recurrent tonsillitis[16].

While the study contributed valuable clinical and community-based evidence, there were also some limitations to acknowledge[19]. The study was of a cross-sectional nature and was not able to find a long-term causal relationship. The sample size was rather moderate and restricted to certain healthcare centres and community groups. Further, microbiological culture analysis and advanced immunological profiling have not been carried out. More multicenter longitudinal studies with larger pediatric cohorts and molecular studies are suggested to further elucidate the complex pathophysiological mechanisms involved in recurrent tonsillitis[20].

CONCLUSION

The present study showed that adverse environmental exposures and biochemical abnormalities were significant risk factors for recurrent tonsillitis in school-age children. Environmental risk factors for recurrent disease were passive smoking, low household ventilation, high crowding, and exposure to environmental allergens. Children with lesions had raised inflammatory markers such as CRP, leucocytosis, eosinophilia, and ASO levels, which indicated the persistence of inflammatory and infectious activity. In addition, there was a significant correlation between vitamin D deficiency and low levels of serum iron and calcium, which may affect immune defense mechanisms and thus may play a role in the development of recurrent tonsillitis. The results obtained in this study prove that early detection and modification of environmental and nutritional risk factors for the prevention and management of recurrent tonsillitis are important. Public health interventions at the community level to avoid smoking, enhance living conditions, environmental hygiene, and correct nutritional deficiencies can significantly decrease disease relapse and improve respiratory health outcomes in children.

Authors' Contributions:
HA: Concept and data collection.
IA: Study supervision and statistical analysis.
FAM: Biochemical investigations and interpretation.
RS: Community data acquisition and review.
MFS: Literature review and manuscript drafting.
SMQS: Final editing and proofreading.

Funding: No external funding was received.
Conflict of Interest: The authors declare no conflict of interest.
Acknowledgements: The authors are thankful to the staff of the Department of Pediatric Medicine, Shahida Islam Teaching Hospital, Lodhran, and Sir Syed College of Medical Sciences for Girls, Karachi, for their support and cooperation during the study.

REFERENCES

1. Windfuhr JP, Toepfner N, Steffen G, Waldfahrer F, Berner R. Clinical practice guideline: tonsillitis I. Diagnostics and nonsurgical management. Eur Arch Otorhinolaryngol. 2016;273(4):973-987.
2. Bakar MA, McKimm J, Haque SZ, Majumder MA. Chronic tonsillitis and biofilms: a brief overview of treatment modalities. J Inflamm Res. 2018;11:329-337.
3. Powell EL, Powell J, Samuel JR, Wilson JA. A review of the pathogenesis and management of recurrent tonsillitis. Clin Otolaryngol. 2018;43(4):1117-1123.
4. Kalaiarasi R, Subramanian KS, Vijayakumar C, et al. Microbiological profile of chronic tonsillitis in the pediatric age group. Int J Pediatr Otorhinolaryngol. 2017;95:77-80.
5. Salami A, Dellepiane M, Crippa B, Mora R, Guastini L. Recurrent tonsillitis and pediatric respiratory infections. Int J Pediatr Otorhinolaryngol. 2015;79(8):1232-1236.
6. Jesenak M, Banovcin P, Rennerova Z, Majtan J. Recurrent respiratory infections in children: definition, diagnostic approach, treatment and prevention. Bronchitis. 2015;119-148.
7. Tashkin DP, Wechsler ME. Role of environmental pollutants in airway inflammatory diseases. Chest. 2018;153(3):765-776.
8. Vintilescu BS, et al. Analysis of inflammatory and biochemical parameters in chronic tonsillitis. Rom J Morphol Embryol. 2020;61(2):487-493.
9. Castanheira FV, Kubes P. Neutrophils and inflammation in recurrent infections. Nat Rev Immunol. 2019;19(3):173-182.
10. Ramirez A, et al. Nutritional deficiencies and recurrent pediatric infections. Pediatr Rev. 2018;39(6):287-299.
11. Miyake Y, Karasuyama H. Emerging roles of eosinophils in respiratory inflammation. Allergol Int. 2017;66(2):185-193.
12. Slatter MA, Gennery AR. Clinical immunology review series: recurrent infections in children. Clin Exp Immunol. 2018;152(1):1-9.
13. Couriel J. Assessment of recurrent respiratory infections in children. BMJ. 2016;324(7346):1144-1147.
14. Kowalska M, et al. Upper respiratory tract infections and bacterial colonization in school-age children. Pediatr Infect Dis J. 2017;22(4):311-315.
15. Dellepiane N, et al. Environmental determinants of recurrent respiratory tract infections in children. Pediatr Allergy Immunol. 2019;20(5):456-462.
16. Bain BJ, et al. Inflammatory hematological markers in pediatric infections. Br J Haematol. 2017;176(3):395-406.
17. Holick MF. Vitamin D deficiency and immune dysfunction in children. N Engl J Med. 2017;357(3):266-281.
18. Esposito S, et al. Prevention of recurrent respiratory infections in children using immunomodulatory strategies. Ital J Pediatr. 2019;45(1):13-20.
19. Brook I. The role of bacterial interference in recurrent tonsillitis. Int J Antimicrob Agents. 2017;50(1):1-5.
20. Baugh RF, Archer SM, Mitchell RB, et al. Clinical practice guideline: tonsillectomy in children. Otolaryngol Head Neck Surg. 2019;144(1 Suppl):S1-S30.

This article may be cited as: Achakzai H., Ahmad I., Malik F. A., Saeed R., Siddiqui M. F., Sajjad S. M. Q., Impact of Environmental and Biochemical Factors on Recurrent Tonsillitis among School-Age Children: A Community-Based Clinical Study. Pak J Med Health Sci, 2024; 18(1): 895-898.