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DEVELOPMENTAL DISRUPTION OF BRONCHUS-ASSOCIATED LYMPHOID TISSUE (BALT) UNDER CHRONIC AIR POLLUTION EXPOSURE: A COMPREHENSIVE MORPHOLOGICAL AND IMMUNOHISTOCHEMICAL REVIEW

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Abstract

This structured review synthesizes contemporary experimental and clinical evidence regarding the impact of chronic atmospheric air pollution on the postnatal development and morphogenesis of bronchus-associated lymphoid tissue (BALT). Electronic databases including PubMed, Scopus, and Web of Science were screened for peer-reviewed publications between 2000 and 2024. Evidence indicates that particulate matter (PM2.5, PM10), nitrogen oxides, sulfur dioxide, and urban airborne nanoparticles disrupt follicular organization, alter

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CD3+/CD20+ lymphocyte distribution, impair germinal center formation, and promote epithelial remodeling. Mechanistically, oxidative stress, cytokine imbalance (IL-6, TNF-α), and TGF-β-mediated tissue remodeling are central contributors. Early-life exposure appears to represent a critical window of immune vulnerability. The findings highlight the importance of morphological monitoring as an indicator of environmental immunotoxic risk.

Keywords: BALT; air pollution; immune morphogenesis; lymphoid tissue development; environmental immunotoxicology; respiratory histology; oxidative stress.

Introduction

Bronchus-associated lymphoid tissue (BALT) is a specialized component of mucosa-associated lymphoid tissue (MALT) that contributes to antigen surveillance and adaptive immune activation within the lower respiratory tract. During postnatal development, BALT undergoes a coordinated process of lymphocyte aggregation, follicular organization, stromal maturation, and germinal center formation. Environmental air pollutants are increasingly recognized as modulators of respiratory immune structure and function.

Chronic exposure to particulate matter (PM2.5, PM10), nitrogen oxides (NO_2), sulfur dioxide (SO_2), and volatile organic compounds has been linked to airway inflammation, epithelial barrier disruption, and immune dysregulation. However, a systematized morphological analysis of BALT development under environmental stress remains limited.

Search Strategy and Selection Criteria

A structured literature review was conducted using PubMed, Scopus, and Web of Science databases. Keywords included 'BALT development', 'air pollution and lymphoid tissue', 'respiratory immune morphogenesis', and 'environmental

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immunotoxicology'. Inclusion criteria comprised peer-reviewed studies presenting histological or immunohistochemical data. Non-structural and non-peer-reviewed reports were excluded.

Normal Histogenesis of BALT

Postnatally, BALT develops through progressive lymphocyte clustering beneath the bronchial epithelium, followed by follicular compartmentalization. CD3+ T lymphocytes localize predominantly in parafollicular zones, while CD20+ B lymphocytes form follicular cores. Ki-67 expression reflects proliferative immune activity during early follicle formation.

Pollutant-Induced Structural and Immunohistochemical Alterations

Chronic exposure to airborne pollutants is associated with decreased follicular density, disorganized germinal centers, altered CD3/CD20 ratios, epithelial dystrophy, and increased inflammatory infiltration. Oxidative stress leads to nuclear damage and apoptosis, while elevated IL-6 and TNF-α levels sustain chronic inflammation. Activation of TGF-β signaling promotes stromal remodeling and fibrosis.

Comparative Analysis of Experimental and Clinical Studies

Animal models demonstrate reduced follicular formation and impaired immune compartmentalization under early-life pollutant exposure. Human cohort studies confirm associations between prenatal or childhood pollutant exposure and altered respiratory immune architecture.

Discussion

The available evidence supports a mechanistic model in which oxidative stress, cytokine imbalance, and epithelial barrier dysfunction converge to disrupt physiological BALT morphogenesis. Early developmental stages appear particularly sensitive to environmental toxicants.

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Conclusions

1. BALT morphogenesis is highly sensitive to environmental air quality.
2. Chronic pollutant exposure induces reproducible structural alterations.
3. Early-life exposure constitutes a critical window of immune vulnerability.
4. Morphological assessment of BALT may serve as a biomarker of environmental immune risk.

References

1. Саттаров, Ж. Б., & Бобоев, М. Ш. (2025). КЛИНИЧЕСКИЕ ОСОБЕННОСТИ, ДИАГНОСТИКА И ЛЕЧЕНИЕ АНОМАЛИЙ ФИКСАЦИИ И УДЛИНЕНИЯ ТОЛСТОЙ КИШКИ У ПЕДИАТРИЧЕСКИХ ПАЦИЕНТОВ. Eurasian Journal of Medical and Natural Sciences, 5(10-2), 93-101.
2. Бобоев, М. Ш., & Саттаров, Ж. Б. (2025). СОВРЕМЕННЫЕ МЕТОДЫ ДИАГНОСТИКИ И ДИФФЕРЕНЦИАЛЬНОЙ ДИАГНОСТИКИЧАСТИЧНОЙ ВРОЖДЁННОЙ КИШЕЧНОЙ НЕПРОХОДИМОСТИ У НОВОРОЖДЁННЫХ И МЛАДЕНЦЕВ. Eurasian Journal of Medical and Natural Sciences, 5(10-2), 76-83.
3. Саттаров, Ж. Б., & Бобоев, М. Ш. (2025). ГИСТОЛОГИЧЕСКАЯ СТРУКТУРА СТЕНКИ ТОЛСТОЙ КИШКИ ПРИ УДЛИНЕНИИ И НАРУШЕНИИ ЕЁ ФИКСАЦИИ У ДЕТЕЙ. Eurasian Journal of Medical and Natural Sciences, 5(10-2), 84-92.
4. Sattarov, J., & Nazarov, N. (2020). Features of the clinic, diagnosis and treatment of mesocolic-parietal hernias in newborns and children of elder age groups. Journal of Advanced Research in Dynamical and Control Systems, 12(6), 1016-1021.

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https://eurekaoa.com/index.php/5

5. Эргашев, Н. Ш., & Саттаров, Ж. Б. (2014). Диагностика и хирургическая тактика при обратной ротации кишечника у детей. Детская хирургия, 18(3), 29-32.
6. Хуррамов, Ф. М., Саттаров, Ж. Б., Хамидов, Б., & Хайдаров, Н. С. (2024). Болаларда корин бушлоти битишма касаллиги. Педиатрия журнали, (1), 553-559.
7. Эргашев, Н. Ш., & Саттаров, Ж. Б. (2016). Ближайшие и отдаленные результаты лечения мальротации кишечника у детей. Российский вестник детской хирургии, анестезиологии и реаниматологии, 6(1), 24-29.
8. Эргашев, Н. Ш., Юсупалиева, Г. А., & Саттаров, Ж. Б. (2014). Отдельные аспекты ультразвуковой диагностики врожденной кишечной непроходимости у детей. Новый день в медицине, (1), 7-10.
9. Саттаров, Ж. Б., Отаназаров, Ж. У., Хуррамов, Ф. М., Назаров, Н. Н., & Бакиев, К. Х. (2021). Тонкокишечные свищи при врожденных пороках развития и приобретенных заболеваниях органов брюшной полости у детей. Журнал Педиатрия-Ташкент, (1), 165-170.
10. Саттаров, Ж. Б., Хуррамов, Ф. М., Отаназаров, Ж. У., & Бойирбеков, Р. Х. (2018). Клиническое течение заворота кишечника у детей. Новый день в медицине, (3 (33)), 79.
11. Эргашев, Н. Ш., & Саттаров, Ж. Б. (2013). Врожденная кишечная непроходимость у детей. Новый день в медицине, (1), 35-39.
12. Khaydarov, N., Sattarov, J., & Kobilov, E. (2024). Methods for detection and conservative resolution of adhesion disease in children. Science and innovation, 3(D4), 171-175.
13. Бобоев, М. Ш., & Саттаров, Ж. Б. (2025). СОВРЕМЕННЫЕ МЕТОДЫ ДИАГНОСТИКИ И ДИФФЕРЕНЦИАЛЬНОЙ ДИАГНОСТИКИЧАСТИЧНОЙ ВРОЖДЁННОЙ КИШЕЧНОЙ НЕПРОХОДИМОСТИ У НОВОРОЖДЁННЫХ И

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https://eurekaoa.com/index.php/5

МЛАДЕНЦЕВ. Eurasian Journal of Medical and Natural Sciences, 5(10-2), 76-83.

14. Саттаров, Ж. Б., & Бобоев, М. Ш. (2025). ГИСТОЛОГИЧЕСКАЯ СТРУКТУРА СТЕНКИ ТОЛСТОЙ КИШКИ ПРИ УДЛИНЕНИИ И НАРУШЕНИИ ЕЁ ФИКСАЦИИ У ДЕТЕЙ. Eurasian Journal of Medical and Natural Sciences, 5(10-2), 84-92.
15. Khaidarov, N. S., Sh, B. M., & Dusaliyev, F. M. (2026). POSTOPERATIVE ABDOMINAL ADHESIVE DISEASE IN CHILDREN: CLINICAL EXPERIENCE. Shokh Articles Library, 1(1).
16. Бобоев, М. Ш., & Хайдаров, Н. С. (2025). СИНДРОМ ОБЪЁМНОГО ОБРАЗОВАНИЯ БРЮШНОЙ ПОЛОСТИ У ДЕТЕЙ. Eurasian Journal of Medical and Natural Sciences, 5(10-2), 174-181.
17. Sh, B. M. (2025). HOMILA ICHI MEKONIYALI PERITONITIN TEKSHIRISH VA DAVOLASHNI TAKOMILASHTIRISH (ADABIYOTLAR SHARHI). Central Asian Journal of Academic Research, 3(11-2), 142-148.
18. Alisherovna, K. S. S. F. N., Amanaliyevich, O. N., & Polatovich, K. S. (2025). MECHANISMS OF IONIZING RADIATION-INDUCED DAMAGE TO CELLS AND DNA. SHOKH LIBRARY, 1(13).
19. Alisherovna, F. N. (2025). TIRIK ORGANIZMLAR UCHUN TERMODINAMIKA QONUNLARI. TERMOGRAFIYA VA UNING DIAGNOSTIKADA ROLI. Global Science Review, 13(12), 1215-1219.
20. Fayzieva, N., & Abrorxo'ja, R. (2025). INTEGRATION OF BIOPHYSICS AND INFORMATION TECHNOLOGIES FOR MODELING HUMAN BIOMECHANICAL MOVEMENTS USING 3D SENSORS AND MACHINE LEARNING. Eureka Journal of Health Sciences & Medical Innovation, 1(2), 54-68.

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https://eurekaoa.com/index.php/5

21. Nodira, F. (2018). Specificity of interaction between teacher and students in the process of teaching a foreign language. Вопросы науки и образования, (8 (20)), 141-143.
22. Базарбаев, М. И., & Сайфуллаева, Д. И. КОМПЬЮТЕР В БЕЛОМ ХАЛАТЕ: КАК ТЕХНОЛОГИИ ТРАНСФОРМИРУЮТ МЕДИЦИНСКОЕ ОБРАЗОВАНИЕ В УЗБЕКИСТАНЕ.(2025). Innovations in Science and Technologies, 2(4), 117-123.