ISSN-p 3080-8707
ISSN-e 3080-8715

AKHMET YASSAWI UNIVERSITY

YASSAWI JOURNAL OF HEALTH SCIENCES

MEDICINE
PUBLIC HEALTH

TURKISTAN
KAZAKHSTAN

ISSN-p 3080-8707
ISSN-e 3080-8715

ҚОЖА АХМЕТ ЯСАУИ
АТЫНДАҒЫ ХАЛЫҚАРАЛЫҚ
ҚАЗАҚ-ТҮРІК УНИВЕРСИТЕТІ

KHOJA AKHMED YASSAWI
INTERNATIONAL KAZAKH-
TURKISH UNIVERSITY

Yassawi Journal of Health Sciences

№3 (3), 2025
december

FOUNDER

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The journal was registered in the Republican State Institution “Information Committee of the Ministry of Culture and Information of the Republic of Kazakhstan” on February 7, 2025 and issued certificate No. KZ95VPY00111809.
Publication: 1 time in 4 months. Language PPP: English. Territory of distribution: the Republic of Kazakhstan, near and far abroad.

ҚҰРЫЛТАЙШЫ

Қожа Ахмет Ясауи атындағы Халықаралық қазақ-түрік университеті
Журнал «Қазақстан Республикасы Мәдениет және ақпарат министрлігінің Ақпарат комитеті» республикалық мемлекеттік мекемесінде 2025 жылғы 7 ақпанда тіркеліп,
№ KZ95VPY00111809 куәлігі берілген.
Шығу жиілігі: 4 айда 1 рет. МББ тілі: ағылшынша. Тарату аумағы: Қазақстан Республикасы, алыс және жақын шетел.

УЧРЕДИТЕЛЬ

Международный казахско-турецкий университет имени Ходжа Ахмеда Ясави
Журнал зарегистрирован в Республиканском государственном учреждении «Комитет информации Министерства культуры и информации Республики Казахстан» 7 февраля 2025 года и выдано свидетельство №KZ95VPY00111809.
Периодичность издания: 1 раз в 4 месяца. Язык ППИ: английский.
Территория распространения: Республика Казахстан, дальнее и ближнее зарубежье.

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Yassawi Journal of Health Sciences, №3(3), 2025 **ISSN-p 3080-8707**
ISSN-e 3080-8715

ГРНТИ 76.29.55
УДК 616.594.14 http://doi.org/10.47526/YJoHS-2025.3-12

DIAGNOSTIC VALUE OF TRICHOSCOPY IN THE DIFFERENTIAL DIAGNOSIS OF VARIOUS FORMS OF ALOPECIA

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Abstract. Alopecias of various origins present a significant diagnostic challenge in dermatological practice. Trichoscopy, a non-invasive method for visualizing the scalp, has become a key tool in recent years for the early and accurate diagnosis of hair loss.

Objective. To determine the modern capabilities of trichoscopy in the differential diagnosis of various forms of alopecia and to assess its diagnostic value.

Materials and Methods. An analytical review of 28 publications from 2019–2025 was conducted, including original studies and meta-analyses on trichoscopic diagnostic criteria in alopecias. Key morphological features, their sensitivity and specificity, as well as the role of the method in monitoring treatment effectiveness were analyzed.

Results. It was established that in androgenetic alopecia the most informative features are hair shaft diameter variability and the perifollicular halo; in alopecia areata - yellow and black dots, “exclamation mark” hairs; in scarring forms - absence of follicular openings and vascular changes. According to systematic reviews, the average diagnostic accuracy of trichoscopy is 90–95%. New digital technologies and artificial intelligence enhance the objectivity and reproducibility of interpretation.

Conclusions. Trichoscopy is an essential component in the diagnosis of alopecias, allowing differentiation of their forms, determination of disease activity, and assessment of treatment effectiveness. Standardization of terminology and the development of digital platforms will create new opportunities for integrating the method into clinical practice.

Keywords: trichoscopy, alopecia, differential diagnosis, dermoscopy, hair loss, scarring alopecia, androgenetic alopecia.

Алопецияның әртүрлі түрлерін ажыратуда трихоскопияның диагностикалық құндылығы

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Received: 01.12.2025 / **Accepted:** 11.12.2025

Аңдатпа. Әртүрлі этиологиялы алопециялар дерматологиялық тәжірибеде елеулі диагностикалық қиындық тудырады. Трихоскопия – шаш пен бас терісін бейнелейтін инвазивті емес дерматоскопиялық әдіс, ол көзге көрінбейтін морфологиялық және тамырлық өзгерістерді анықтауға мүмкіндік беретін заманауи диагностикалық құралға айналды.

Мақсат. Алопеция түрлерін ажыратуда трихоскопияның диагностикалық мүмкіндіктерін бағалау және оның дәлдігі мен клиникалық маңыздылығы туралы қазіргі деректерді жүйелеу.

Материалдар мен әдістер. 2019-2025 жылдар аралығындағы 28 ғылыми жарияланымға аналитикалық шолу жүргізілді. Оларға трихоскопиялық белгілердің диагностикалық маңыздылығын, сезімталдық пен ерекшелік деңгейін және трихоскопияның ауру барысын бақылаудағы рөлін талдаған түпнұсқа зерттеулер, жүйелі шолулар мен метаанализдер кірді.

Нәтижелер. Андрогенетикалық алопеция кезінде ең ақпаратты белгілер – шаш өзегінің диаметрінің өзгергіштігі мен перифолликулярлық ореол; ошақты алопецияда – сары және қара нүктелер, «леп белгісі» тәрізді және сынған шаштар; ал рубцылы түрлерде – фолликулярлы тесіктердің жоғалуы, перифолликулярлы эритема және атрофиялық ақ ошақтар анықталды. Трихоскопияның орташа диагностикалық дәлдігі гистологиялық тексеріспен салыстырғанда 90-95% құрады. Заманауи зерттеулерде цифрлық трихоскопия мен жасанды интеллект технологиялары трихоскопиялық бейнелерді автоматты тану мен сандық бағалаудың жаңа мүмкіндіктерін ашатыны көрсетілген.

Қорытынды. Трихоскопия алопецияның кез келген түрін анықтауда алғашқы диагностикалық әдіс ретінде қарастырылуы тиіс.Бұл әдіс ауру түрлерін ерте және дәл ажыратуға, қабыну белсенділігін бағалауға және емнің тиімділігін бақылауға мүмкіндік береді. Терминологияны стандарттау және цифрлық платформаларды дамыту трихоскопияны клиникалық тәжірибеге кеңінен енгізуге жол ашады.

Түйін сөздер: трихоскопия, алопеция, дифференциалды диагностика, дерматоскопия, шаштың түсуі, рубцылы алопеция, андрогенетикалық алопеция.

Диагностическая ценность трихоскопии в дифференциальной диагностике различных форм алопеции

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Аннотация. Алопеции различного генеза представляют серьёзную диагностическую проблему в дерматологической практике. Трихоскопия, как неинвазивный метод визуализации волосистой части головы, в последние годы стала ключевым инструментом для ранней и точной диагностики выпадения волос.

Цель. Определить современные возможности трихоскопии в дифференциальной диагностике различных форм алопеций и оценить её диагностическую ценность.

Материалы и методы. Проведён аналитический обзор 28 публикаций 2019-2025 гг., включающих оригинальные исследования и метаанализы по диагностическим критериям трихоскопии при алопециях. Рассмотрены ключевые морфологические признаки, их чувствительность и специфичность, а также роль метода в контроле эффективности терапии.

Received: 01.12.2025 / **Accepted:** 11.12.2025

Результаты. Установлено, что при андрогенетической алопеции наиболее информативны вариабельность диаметра волос и перипиларный ореол; при очаговой – жёлтые и чёрные точки, «восклицательные волосы»; при рубцовых формах – отсутствие фолликулярных устьев и сосудистые изменения. Средняя диагностическая точность трихоскопии по данным систематических обзоров составляет 90-95%. Новые цифровые технологии и искусственный интеллект повышают объективность и воспроизводимость интерпретации.

Выводы. Трихоскопия является обязательным компонентом диагностики алопеций, позволяя дифференцировать их формы, определить активность процесса и оценить эффективность лечения. Стандартизация терминологии и развитие цифровых платформ откроют новые перспективы для внедрения метода в клиническую практику.

Ключевые слова: трихоскопия, алопеция, дифференциальная диагностика, дерматоскопия, выпадение волос, рубцовая алопеция, андрогенетическая алопеция

Introduction

Trichoscopy is a non-invasive method of visualizing the scalp that allows for detailed assessment of hair follicle structure, hair shafts, and perifollicular tissues. In recent years, this method has become an integral part of diagnosing hair disorders, enabling early detection of pathological changes and increasing the accuracy of differential diagnosis of various forms of alopecia [1]. Modern studies show that trichoscopy makes it possible to determine the nature of the lesion and differentiate androgenetic, alopecia areata, scarring, telogen, and traction alopecia based on characteristic visual features. For alopecia areata, the typical findings include so-called “yellow dots,” “black dots,” “exclamation mark hairs,” short vellus hairs, and broken hairs [2]. These signs reflect active follicular destruction and temporary involution.

In androgenetic alopecia, pronounced hair-shaft diameter variability, an increased proportion of thin vellus hairs, and the presence of a perifollicular halo predominate, indicating follicular miniaturization under the influence of androgens [3]. Scarring forms of alopecia are characterized by the disappearance of follicular openings, atrophy and sclerosis of perifollicular tissues, as well as typical vascular changes [4]. These features allow scarring processes to be distinguished from reversible forms of hair loss at an early stage and enable timely adjustment of therapy. Trichoscopy plays a particularly important role in dynamic monitoring and evaluation of treatment effectiveness. Sequential photography of the same areas allows clinicians to track the appearance of new terminal hairs, a reduction in the number of “black dots,” and decreased hair fragility, making trichoscopy an objective monitoring tool [5]. Nevertheless, recent reviews show that the interpretation of trichoscopic findings requires high expertise and uniform terminology. The lack of standardized diagnostic criteria and grading scales often leads to variability in results. Therefore, current research focuses on developing unified algorithms and digital image-analysis systems to ensure comparability of data between clinics and improve diagnostic reliability [6]. Thus, trichoscopy occupies a key place in modern alopecia diagnostics, combining high informativeness, safety, and accessibility. Its use not only increases diagnostic accuracy but also helps determine optimal treatment strategies, which is especially important given the rising prevalence of hair disorders in the population.

The objective of this work is to systematize the trichoscopic patterns of the most common forms of alopecia, assess their sensitivity and specificity for differential diagnosis, and propose a practical

Received: 01.12.2025 / **Accepted:** 11.12.2025

algorithm for using trichoscopy in outpatient and specialized settings based on current publications from 2023–2025.

Materials and Methods

This study is an analytical review of modern publications devoted to the use of trichoscopy in the diagnosis of various forms of alopecia. A literature search was conducted in the PubMed, Scopus, and Web of Science databases for the period 2019–2025 using the following keywords: trichoscopy, alopecia, hair loss, dermoscopy, diagnosis, androgenetic alopecia, alopecia areata, scarring alopecia, telogen effluvium. Additional publications from open sources (Google Scholar, ResearchGate) and reports of international dermatological societies (EADV, ISHRS, ILDS) were also considered.

The inclusion criteria were:

- original studies, meta-analyses, or systematic reviews focused on the diagnostic capabilities of trichoscopy in alopecia;
- specification of concrete trichoscopic features and their diagnostic value (sensitivity, specificity, predictive value);
- publications in English or Russian with access to the full text.

The exclusion criteria were:

- single clinical case reports without quantitative data;
- studies concerning trichoscopy in infectious and inflammatory skin diseases without alopecia (e.g., seborrheic dermatitis or psoriasis).

A total of 42 publications were analyzed, of which 28 met the inclusion criteria and were used for the systematization of trichoscopic patterns. The analysis included studies on androgenetic, alopecia areata, scarring, telogen, traction, and infectious alopecia (tinea capitis).

To structure the data, a comparative analysis approach was used, including:

- classification of trichoscopic features into morphological groups (follicular, interfollicular, vascular);
- comparison of the frequency of identified features across different types of alopecia;
- assessment of their diagnostic specificity according to original studies and reviews (Rakowska et al., 2024; Rudnicka et al., 2025; Pirmez et al., 2023) [1–8].

Results and Discussion

Analysis of the selected publications (n = 28) showed that trichoscopy has high diagnostic value for all major forms of alopecia, including androgenetic, alopecia areata, telogen, scarring, infectious, and traction alopecia. The combination of trichoscopic features allows, in most cases, reliable differentiation of the etiology and activity of the process without the need for biopsy, which has been confirmed in the works of Rakowska et al. (2024), Rudnicka et al. (2025), and Pirmez et al. (2023) [1–8].

The summarized data are presented in a table (Table 1), reflecting key diagnostic features and their clinical significance. The methodological approach was based on the principles of evidence-based medicine, prioritizing studies with levels of evidence A–B according to the Oxford Centre for Evidence-Based Medicine classification (2020) [9–15].

Received: 01.12.2025 / **Accepted:** 11.12.2025

Table 1 – Trichoscopic Patterns in Different Forms of Alopecia and Their Differential Significance
Differential Diagnostic Significance

Type of Alopecia	Key Trichoscopic Features	Differential Criteria	Clinical Significance
Androgenetic Alopecia (AGA)	Variable hair shaft diameter (>20%), increased proportion of vellus hairs, yellow dots, peripilar halo, single empty follicles	Differs from TE by preserved follicular openings and gradual thinning	Main diagnostic method; assesses stage and treatment effectiveness
Alopecia Areata (AA)	Yellow dots, black dots, exclamation-mark hairs, broken hairs, short vellus hairs	Differs from TTM by absence of uneven hair lengths and hemorrhages	Early non-invasive marker of disease activity
Telogen Effluvium (TE)	Even thinning without yellow dots, normal hair diameter, no empty follicles, preserved skin pattern	Differs from AGA by absence of hair diameter variability and peripilar halo	Helps avoid overdiagnosis of AGA
Trichotillomania (TTM)	Hairs of different lengths, stubble hairs, broken hairs, hemorrhagic spots, empty follicles, V-shaped hairs	Differs from AA by absence of yellow dots and presence of trauma signs	Confirms psychogenic nature of hair loss
Scarring Alopecia (LPP, DLE, FFA)	Absence of follicular openings, white patches, perifollicular erythema, vascular loops, bluish background	Differs from non-scarring forms by loss of follicles	Allows early diagnosis and prevention of irreversible hair loss
Tinea capitis	Comma-shaped hairs, black dots, short broken hairs, gray-white scales, inflammatory pustules	Differs from AA by presence of scaling and infection signs	Requires mycological confirmation (PCR/culture)
Traction Alopecia	Hairs of different lengths, tulip hairs, empty follicles, no inflammation	Differs from AGA by absence of perifollicular halo and localization along hairline	Confirms mechanical nature of damage

The table systematizes trichoscopic features with the highest diagnostic value during visual examination of the scalp. In clinical practice, the combination of 2–3 characteristic features allows reliable differentiation of the most common forms of alopecia and minimizes the need for biopsy. Modern studies (Miteva et al., 2023; Rakowska et al., 2024; Rudnicka et al., 2025) confirm the high

Received: 01.12.2025 / **Accepted:** 11.12.2025

sensitivity of trichoscopy—up to 92% for androgenetic alopecia and 95% for alopecia areata—when standardized evaluation criteria are followed.

Androgenetic Alopecia (AGA).

The most characteristic features of androgenetic alopecia include variability of hair shaft diameter greater than 20%, an increased proportion of vellus hairs, and the presence of the peripilar sign (a thin hyperpigmented halo around the follicular opening). These changes reflect follicular miniaturization and perifollicular microinflammation. Additional markers include isolated empty follicles and yellow dots, which appear with long-standing disease. Modern research shows that in AGA, the sensitivity of trichoscopy reaches 92% and specificity—88% compared to histological verification. The method also allows objective evaluation of therapeutic response to antiandrogens or minoxidil through measurable changes in terminal hair density and diameter.

Alopecia Areata (AA).

For alopecia areata, a combination of five most informative signs has been described: yellow dots, black dots, exclamation-mark hairs, broken hairs, and short vellus hairs. These patterns indicate active hair destruction and its premature transition to the telogen phase. In the active stage, black dots and exclamation-mark hairs predominate, while in remission, vellus and short terminal hairs are more common. The presence of these features collectively allows highly accurate differentiation of alopecia areata from telogen effluvium and trichotillomania, where the structure and color patterns of broken hairs differ.

Telogen Effluvium (TE).

Telogen effluvium is characterized by uniform hair thinning without signs of inflammation and without significant variability in hair diameter. Follicular openings remain preserved, which distinguishes TE from AGA and scarring alopecias. Recent studies emphasize the value of combining trichoscopy with phototrichogram, which enables objective assessment of the proportion of telogen hairs and determination of the process's reversibility.

Scarring Alopecias (LPP, DLE, FFA).

The most challenging task remains the early diagnosis of scarring alopecias. Trichoscopic features typical of these forms include the absence of follicular openings, whitish atrophic patches, perifollicular erythema, and telangiectasias. In fibrosing folliculitis and lichen planopilaris, perifollicular white scales, a "bluish-gray" background, and irregular vessels may be present. In discoid lupus erythematosus, large follicular keratotic plugs and diffuse pigmentation changes of the skin are characteristic. Such features indicate the need for early initiation of immunomodulatory therapy to prevent irreversible scarring.

Trichotillomania and Tinea Capitis.

In trichotillomania, hairs of different lengths, hemorrhagic dots, V-shaped broken hairs, and empty follicles are observed, which helps distinguish it from AA. For tinea capitis, "black dots," short broken hairs, and scaling are typical, requiring mycological confirmation (PCR or culture). Trichoscopy enables early suspicion of infectious etiology and timely referral for laboratory testing.

General Trends and Practical Importance.

All analyzed sources emphasize that trichoscopy combines simplicity, accessibility, and high informativeness, while also serving as a tool for telemedicine and dynamic treatment monitoring. In recent years, the field of digital trichoscopy has been rapidly developing, with artificial intelligence being used for automatic pattern recognition and quantitative assessment of hair density. Publications

Received: 01.12.2025 / **Accepted:** 11.12.2025

from 2023–2025 (e.g., by Miteva, Rudnicka, Rakowska) show that machine-learning algorithms can achieve diagnostic accuracy of up to 94%, making the method promising for diagnostic standardization.

From a clinical perspective, trichoscopy is becoming an essential component of the evaluation of any form of alopecia. It not only enables identification of the type of hair loss, but also determines disease stage, assesses inflammatory activity, and evaluates treatment response. Thus, trichoscopy is evolving from an auxiliary method into a key tool of evidence-based trichology, requiring further standardization of terminology and integration into dermatological practice guidelines.

Conclusions

At the modern stage of dermatology development, trichoscopy is a highly informative, non-invasive, and accessible method for the visual diagnosis of alopecia. The conducted analysis showed that the use of trichoscopy significantly increases the accuracy of differential diagnosis between androgenetic, alopecia areata, scarring, telogen, traction, and infectious alopecia, allowing unnecessary biopsies to be avoided and treatment to be initiated earlier.

The most diagnostically significant signs are: hair diameter variability and peripilar halo in androgenetic alopecia; yellow and black dots, and “exclamation mark hairs” in alopecia areata; absence of follicular openings, perifollicular erythema, and atrophic areas in scarring forms.

Trichoscopy has also proven effective in the dynamic monitoring of therapy and disease progression. The development of digital trichoscopy and the application of artificial intelligence algorithms open new possibilities for standardizing assessments and increasing diagnostic accuracy.

Thus, trichoscopy should be considered an essential component of the comprehensive examination of patients with hair loss, ensuring early detection of pathological processes, individualized therapy, and improved clinical outcomes.

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Received: 01.12.2025 / **Accepted:** 11.12.2025

Yassawi Journal of Health Sciences, №3(3), 2025 **ISSN-p 3080-8707**
ISSN-e 3080-8715

ГРНТИ 07.06.10
УДК 76.29.62 http://doi.org/10.47526/YJoHS-2025.3-13

RADIOGRAPHY OF THE HIP JOINTS IN INFANTS: RADIATION EXPOSURE, IMPACT ON THE REPRODUCTIVE SYSTEM, AND PROTECTIVE MEASURES

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Abstract. Developmental dysplasia of the hip (DDH) occurs in 2–4% of newborns and requires early diagnosis to prevent complications. Radiography remains the primary imaging method for evaluating the hip joint in infants. Even low-dose ionizing radiation raises concerns regarding potential effects on the reproductive organs [1] The aim of this study was to assess the impact of hip radiographic examinations on the reproductive organs of children under one year of age and to analyze the use of protective aprons in city clinics of Shymkent, Kazakhstan.

Data collection and analysis were performed using the Akgun PACS Viewer software, which allowed systematic evaluation of radiographic images and compliance with radiation protection measures. Dosimetric assessment was conducted based on exposure parameters recorded by the system to calculate the absorbed dose to the gonads. Statistical analysis was applied to determine the frequency of protective apron use and to evaluate the potential risk of radiation exposure to reproductive organs [2]

The study analyzed 223 radiographic images of 87 infants from 5 major city clinics. Results showed that approximately 70% of infants underwent up to three hip radiographs in the first year of life, while protective aprons were used in only 60% of cases. Dosimetric analysis indicated that without protection, the testes and ovaries received doses exceeding recommended limits, whereas correct use of lead aprons and shields reduced the absorbed dose by approximately tenfold.

The relevance of this study is supported by the need to enforce the Ministry of Health of the Republic of Kazakhstan Order No. KR DSM-275/2020 (December 15, 2020) on sanitary and epidemiological requirements for radiation safety, which mandates the use of protective aprons for children during hip radiography.

The findings emphasize the necessity of strict adherence to radiation safety protocols and support the regulatory requirement for mandatory use of protective aprons and shields during infant hip radiography [3, 14]

Keywords: developmental dysplasia of the hip, pediatric radiography, radiation protection, dosimetric assessment, protective apron, reproductive organs.

Нәрестелердің жамбас буындарын рентгенографиялау: сәулелену дозасы, оның репродуктивтік жүйеге ықтимал әсерлері және радиациялық қорғаныс шаралары

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Received: 01.12.2025 / **Accepted:** 8.12.2025

Аңдатпа. Жамбас буынының дисплазиясы (ЖБД) жаңа туған нәрестелердің 2–4 %-ында кездеседі және асқынулардың алдын алу үшін ерте диагностикалауды талап етеді. Рентгенография нәрестелердегі жамбас буындарын бейнелеудің негізгі әдісі болып табылады. Тіпті төмен дозалы иондаушы сәулеленудің өзі репродуктивтік ағзаларға ықтимал әсеріне байланысты алаңдаушылық туындатады. Зерттеудің мақсаты – бір жасқа дейінгі балаларда жамбас буындарының рентгенологиялық зерттеулерінің репродуктивтік ағзаларға ықтимал әсерін бағалау және Қазақстан Республикасының Шымкент қаласындағы қалалық емханаларда қорғаныс фартукын қолдану тәжірибесін талдау.

Деректерді жинау және талдау Akgun PACS Viewer бағдарламасы арқылы жүргізілді, бұл рентгенологиялық кескіндерді жүйелі түрде бағалауға және радиациялық қорғаныс талаптарының сақталуын анықтауға мүмкіндік берді. Дозиметриялық бағалау жүйеде тіркелген экспозиция параметрлері негізінде жүргізіліп, гонадалардың жұтылған дозасын есептеуге бағытталды. Статистикалық өңдеу қорғаныс фартукын қолдану жиілігін анықтауға және репродуктивтік ағзалардың сәулелену қаупін бағалауға мүмкіндік берді.

Зерттеуде 5 ірі қалалық клиникадан 87 нәрестенің 223 рентгендік суреті талданды. Нәтижелер көрсеткендей, балалардың шамамен 70% алғашқы жылы 3 рентгендік зерттеуден өтті, ал қорғаныс фартуктары тек 60% жағдайда қолданылды. Дозиметриялық талдау қорғаныссыз жағдайда аталық және аналық бездердің ұсынылған нормадан жоғары доза алатынын, ал қорғасын фартуктері мен қорғаныс пластиналарын дұрыс пайдалану жұтылған дозаны шамамен он есеге төмендететінін анықтады.

Зерттеудің өзектілігі Қазақстан Республикасы Денсаулық сақтау министрінің 2020 жылғы 15 желтоқсандағы № ҚР ДСМ-275/2020 «Радиациялық қауіпсіздікті қамтамасыз етуге қойылатын санитариялық-эпидемиологиялық талаптар» бұйрығына сәйкес жамбас буынын рентгенографиялау кезінде балаларға қорғаныс фартукын міндетті түрде қолдануды нормативтік түрде бекітудің қажеттілігімен айқындалады.

Қорытындылар радиациялық қауіпсіздік талаптарын қатаң сақтаудың маңыздылығын және Қазақстан Республикасы Денсаулық сақтау министрлігінің нормативтік-құқықтық актілерінде жамбас буындарының рентгенографиясы кезінде қорғаныс фартуктері мен қорғаныс пластиналарын қолдануды міндетті талап ретінде бекітудің орынды екенін көрсетеді.

Түйін сөздер: жамбас буынының дисплазиясы, балалар рентгенографиясы, радиациялық қорғаныс, дозиметриялық бағалау, қорғаныс фартукы, репродуктивтік ағзалар.

Рентгенография тазобедренных суставов у младенцев: радиационная нагрузка, влияние на репродуктивную систему и меры защиты

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Аннотация. Дисплазия тазобедренных суставов (ДТС) встречается у 2–4 % новорождённых и требует ранней диагностики для предотвращения осложнений. Рентгенография остаётся основным методом визуализации тазобедренного сустава у детей грудного возраста. Даже низкодозовое ионизирующее излучение вызывает опасения относительно потенциального воздействия на репродуктивные органы. Цель исследования — оценить влияние рентгенологических исследований тазобедренных суставов на

Received: 01.12.2025 / **Accepted:** 8.12.2025

репродуктивные органы детей до одного года и проанализировать практику применения защитных фартуков в Городских поликлиниках города Шымкента (Казахстан).

Сбор и анализ данных осуществлялись с использованием программы *Akgun PACS Viewer*, что позволило систематически оценить рентгенологические изображения и соблюдение мер радиационной защиты. Дозиметрическая оценка проводилась на основе параметров экспозиции, зарегистрированных системой, для расчёта поглощённой дозы гонад. Статистическая обработка позволила определить частоту применения защитных фартуков и оценить потенциальный риск облучения репродуктивных органов.

В ходе исследования проанализировано 223 рентгенографических снимка 87 младенцев из 5 крупных городских поликлиник**.** Результаты показали, что до трёх рентгеновских исследований в первый год жизни проходили примерно 70% детей, при этом защитные фартуки использовались лишь в 60% случаев. Дозиметрический анализ выявил, что без защиты яички и яичники получают дозы, превышающие рекомендуемые нормы, а правильное применение свинцовых фартуков и пластин снижает поглощённую дозу примерно в десять раз.

Актуальность исследования определяется необходимостью нормативного закрепления в приказе Министерства здравоохранения Республики Казахстан от 15 декабря 2020 года № КР ДСМ-275/2020 "Санитарно-эпидемиологические требования к обеспечению радиационной безопасности" об обязательном применении защитных фартуков у детей при проведении рентгенографии тазобедренного сустава.

Выводы подчёркивают необходимость строгого соблюдения радиационной безопасности и целесообразно закрепить обязательное применение защитных фартуков и пластин при рентгенографии тазобедренных суставов в нормативных документах Министерства здравоохранения Республики Казахстан.

Ключевые слова: дисплазия тазобедренных суставов, рентгенография у детей, радиационная защита, дозиметрическая оценка, защитный фартук, репродуктивные органы

Introduction

The reproductive system of a child begins developing at the embryonic stage, and germline cells - spermatogonia in boys and oogonia in girls - are highly radiosensitive. Ionizing radiation can affect the ovarian follicular apparatus, where immature oocytes are located [12,16] Without adequate radiation protection, exposure to high doses of ionizing radiation may cause damage or destruction of oocytes, potentially reducing ovarian reserve and negatively impacting future reproductive function. Similar effects are observed in testicular tissue, as spermatogonia, the precursors of spermatozoa that actively proliferate in early life, also exhibit high radiosensitivity [4,5,13]

In infants with developmental dysplasia of the hip (DDH), the number of radiographic examinations typically reaches up to three procedures during the first year of life, emphasizing the necessity of strict adherence to radiation safety principles. Insufficient protection under conditions of increased radiation exposure may result in the following adverse effects:

- Damage to spermatogonia
- Reduction in the number of developing spermatozoa
- Delayed development of testicular tissue
- Decreased ovarian reserve [6,15]

The aim of this study is to evaluate the impact of X-ray radiation from hip radiography in infants on reproductive organs and to determine the extent to which protective aprons are utilized in the city clinics of Shymkent, Kazakhstan, for this age group.

Received: 01.12.2025 / **Accepted:** 8.12.2025

Materials and Methods

Study Population: Infants under one year of age who underwent radiographic examination of the hip joints in city clinics.

Study Focus: The impact of X-ray radiation on reproductive organs and the practice of using protective aprons during hip radiography in infants under one year of age.

Methods:

- Literature Review: Scientific publications, regulatory documents, and orders from the Ministry of Health of the Republic of Kazakhstan regarding radiation safety in pediatric radiology were analyzed.

- Systematic Observation: Systematic observation methods were applied to assess the practical implementation of radiation protection measures, including the use of protective aprons during radiographic procedures. Data collection and analysis were performed using the *Akgun PACS Viewer* software, which provides fast and reliable access to medical images stored in a PACS environment and allows radiologists and clinicians to view, compare, and annotate images.

To obtain the results of the study, a selective assessment was conducted across all city clinics in Shymkent from November 1, 2025 to November 15, 2025, which were equipped with radiology departments and the Akgun PACS system. A total of five major clinics that met the criteria for data accessibility and image quality were included in the analysis.

During the observation period, all cases of hip radiography in infants under one year of age were identified in the PACS system. After excluding duplicate entries and incomplete examinations, the final sample consisted of:

- N = 87 infants under 1 year of age
- 223 radiographic images in total

Analysis of Research

The assessment of the number of procedures per patient showed the following:

- 70% of infants (≈61 children) underwent up to three radiographic examinations during their first year of life

- 30% of infants (≈26 children) underwent more than three examinations, primarily due to hip dysplasia or suspected dysplasia

Use of Protective Aprons

Among the 223 radiographic images analyzed:

- 134 images (60%) were performed with the use of protective aprons
- 89 images (40%) were performed without protective shielding

These indicators were obtained through the analysis of radiographic images, where the presence or absence of a protective apron was visually confirmed.

Received: 01.12.2025 / **Accepted:** 8.12.2025

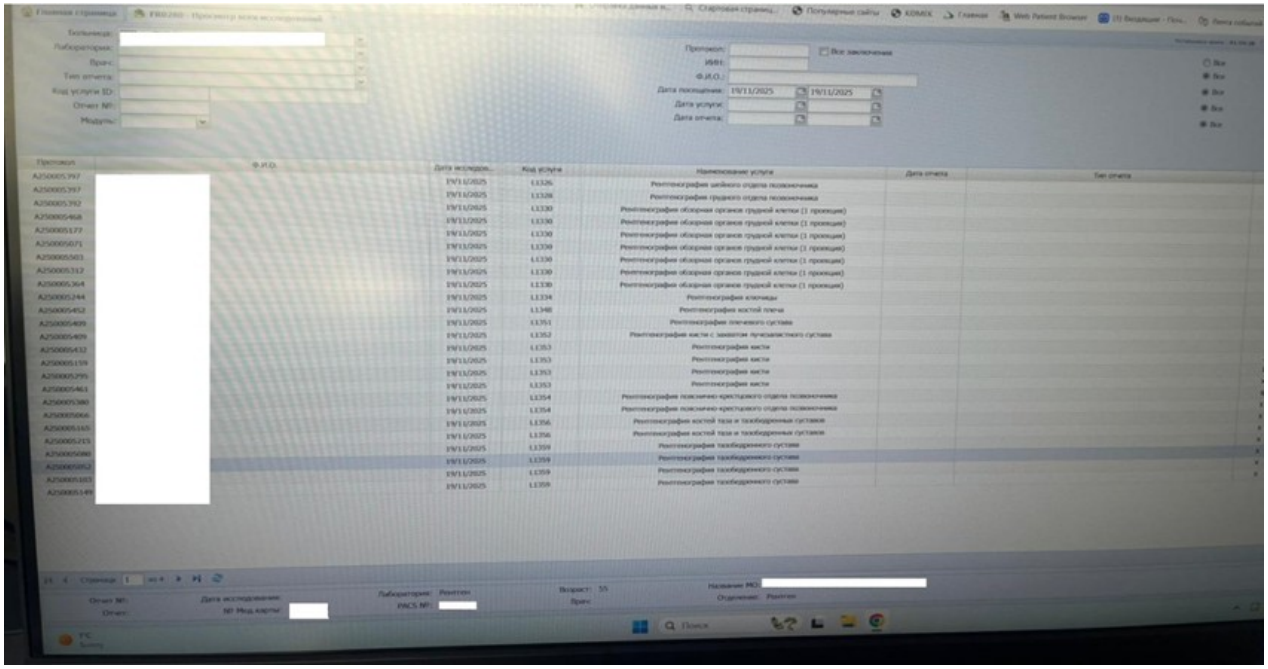

Figure1- . Akgun PACS Viewer – a program for fast and reliable access to medical images stored in a PACS environment

Figure2- The hip joint of a child in the absence of a protective apron

Received: 01.12.2025 / **Accepted:** 8.12.2025

Figure 3- The hip joint of a child in the absence of a protective apron

Figure 4-The protective apron is used in the image; however, it is improperly secured, which may reduce the effectiveness of the radiation protection

Received: 01.12.2025 / **Accepted:** 8.12.2025

Figure 5- The protective apron is correctly applied, but it unnecessarily covers adjacent organs, leading to additional radiation exposure

Dosimetric Assessment: To evaluate radiation exposure levels, absorbed doses received by patients during hip radiography were calculated. The assessment was based on exposure parameters recorded in the *Akgun* system, including entrance surface dose (ESD) and technical parameters of the examination.

Ethical Considerations

In this study, radiographic images obtained via the *Akgun* program were used. All materials were employed solely for scientific analysis and were anonymized prior to use. Identifying information about medical institutions was not disclosed; specifically, data indicating which clinics complied with radiation protection protocols were intentionally omitted. This approach ensures confidentiality, minimizes potential risks to healthcare facilities, and fully adheres to the ethical principles of conducting research.

Results

This amount of research (5 clinics, 87 patients, and 223 radiographic images) is sufficient to obtain statistically significant results and to provide an objective assessment of the current situation regarding radiation protection in the city.

Frequency of Radiographic Examinations and Use of Protective Aprons
The study demonstrated that most infants (approximately 70%) underwent up to three radiographic examinations of the hip joints within the first year of life. Protective aprons were used in only 60% of cases, indicating insufficient compliance with radiation protection protocols in the city clinics of Shymkent.

Received: 01.12.2025 / **Accepted:** 8.12.2025

Dosimetric Assessment and Gonadal Protection

Dosimetric calculations showed that without protective aprons, the testes in male infants and the ovaries in female infants could receive doses exceeding recommended sanitary limits for children under one year of age. The use of lead aprons or protective shields significantly reduces the absorbed dose to the reproductive organs:

- For girls, the shield should fully cover the ovarian region. The lower edge of the shield should be positioned distal to the upper edge of the iliac wings depending on age: 6 cm at 4 months, 7 cm at 8 months, and 8 cm at 1 year.
- For boys, the shield should cover the scrotum and testes.
- Proper gonadal protection with a shield reduces radiation exposure by approximately tenfold [7,8,17]

For restless infants, it is recommended to use a Velcro strap to secure the shield, and the accompanying parent should be provided with a protective apron during the procedure [9,10,11].

Figure 6-. Gonadal protection set with a Velcro strap.

Potential Impact on Reproductive Organs

In the absence of adequate protection, high doses of ionizing radiation may cause damage to spermatogonia and oocytes, reduce ovarian reserve, decrease the number of developing spermatozoa, and slow the development of testicular tissue. Dosimetric analysis underscores the importance of using protective aprons and shields to minimize the risk of radiation exposure to reproductive organs in infants.

Conclusions

The conducted analysis indicates that radiographic examination of the hip joints in infants may exert potential adverse effects on the reproductive organs, particularly in the absence of adequate protection. The use of protective aprons and radiation shields significantly reduces the radiation dose to the ovaries and testes, achieving up to a tenfold decrease in absorbed dose.

Given the high radiosensitivity of reproductive cells in early childhood, it is recommended to formally mandate the use of protective aprons and shields during hip radiography in infants within the regulatory framework of the Ministry of Health of the Republic of Kazakhstan. Standardizing these measures will ensure uniform compliance with radiation safety protocols across all clinics in the country and minimize potential risks to the reproductive health of future generations.

Received: 01.12.2025 / **Accepted:** 8.12.2025

Limitations of the study and directions for future research

The study was conducted only in selected urban polyclinics in Shymkent using the Akgun program, which is still under development and has not yet been implemented widely. Therefore, the obtained data may not fully reflect the practices of hip joint radiography and the use of protective aprons in other polyclinics within the city or in regions where the program is not used.

In the future, it is planned to continue studying this topic, expand the geographic scope of the research, and conduct a comparative analysis of hip joint radiography practices and the use of protective aprons for children in other countries. This will allow for an assessment of international radiation safety standards and the adaptation of recommendations to improve protection practices in Kazakhstan.

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Received: 01.12.2025 / **Accepted:** 8.12.2025

ГРНТИ 76.29.00
УДК 615.032.13-616.69-008.6 http://doi.org/10.47526/YJoHS-2025.3-14

ENDOLYMPHATIC ANTIBIOTIC THERAPY IN PATIENTS WITH RECURRENT UROGENITAL DISEASES RESISTANT TO TRADITIONAL ANTIBIOTIC THERAPY: A LITERATURE REVIEW

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Abstract. Endolymphatic and lymphotropic therapies have recently been applied across various medical fields, including acute surgical abdominal conditions, urology, gynecology, traumatology, phthisiology, and oncology. These therapies are used for both prevention and treatment of complications in urogenital diseases.

Objective: To review the literature on the efficacy of endolymphatic antibiotic therapy in men with recurrent urogenital diseases resistant to conventional antibiotic treatment.

Materials and methods: A comprehensive literature search was conducted using PubMed, Scopus, Web of Science, Medline, and Wiley Online Library for publications from 2015 to 2025. Fifty full-text, English-language articles were selected based on inclusion criteria: open access, high methodological quality, and relevance. Studies of low quality, conference abstracts, and articles without full-text access were excluded.

Results and Conclusions: Endolymphatic antibiotic administration is recommended as a primary treatment for men with acute inflammatory urogenital diseases. Literature analysis shows broad applications of endolymphatic and lymphotropic therapies in surgery, urology, gynecology, traumatology, phthisiology, oncology. Further research is needed to optimize drug selection, dosage, and administration schedules. Enhancing immune function through lymphological methods appears promising.

Keywords: anti-infective agents; drug resistance; endolymphatic infusion; urinary tract infections.

Дәстүрлі антибиотикотерапияға төзімді қайталама урогениталды аурулары бар науқастарда эндолимфатикалық антибиотикотерапия: әдебиеттерге шолу

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Жоғары медициналық оқу орнынан кейінгі білім беру факультеті
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Аңдатпа. Эндолимфатикалық және лимфотроптық терапия жақында абдоминальды жедел хирургиялық аурулар, урология, гинекология, травматология, фтизиатрия және онкология сияқты бірнеше медициналық салаларда қолданыс табуда. Бұл терапиялар урогениталды аурулардың асқынуларының алдын алу және емдеуде пайдаланылады.

Received: 02.11.2025 / **Accepted:** 11.12.2025

Мақсаты: Дәстүрлі антибиотикотерапияға төзімді қайталама урогениталды аурулары бар ер адамдарда эндолимфатикалық антибиотикотерапияның тиімділігін зерттеу мақсатында әдебиеттерді шолу.

Әдістері: PubMed, Scopus, Web of Science, Medline және Wiley Online Library дерекқорларында 2015 жылдан 2025 жылға дейінгі мерзімде әдебиеттерді жан-жақты іздеу жүргізілді. Іріктелген 50 толық мәтінді ағылшын тіліндегі мақала қамтылды, енгізу критерийлері: ашық қолжетімділік, жоғары әдістемелік сапа және релеванттылық. Төмен сапалы зерттеулер, конференция баяндамалары және толық мәтіні жоқ мақалалар алынып тасталды.

Нәтижелері мен қорытындылары: Эндолимфатикалық антибиотик енгізу ерлерде жедел қабыну урогениталды ауруларды емдеуде негізгі әдіс ретінде ұсынылады. Әдебиеттер талдауы эндолимфатикалық және лимфотроптық терапияның хирургияда, урологияда, гинекологияда, травматологияда, фтизиатрияда, онкологияда және әскери дала хирургиясында кеңінен қолданылатынын көрсетеді. Дәрілерді таңдау, дозасы және енгізу режимдерін оңтайландыру үшін қосымша зерттеулер қажет. Иммундық жүйенің қызметін лимфологиялық әдістер арқылы ынталандыру емдеудің тиімділігін арттырудың перспективалы жолдарының бірі болып табылады.

Түйін сөздер: антимикробтық заттар; дәрі-дәрмекке төзімділік; эндолимфатикалық инфузия; зәр шығару жолдарының инфекциялары.

Эндолимфатическая антибиотикотерапия у пациентов с рецидивирующими урогенитальными заболеваниями, резистентными к традиционной антибиотикотерапии: обзор литературы

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Аннотация. Эндолимфатическая и лимфотропная терапия в последнее время применяется в различных медицинских областях, включая острые хирургические заболевания брюшной полости, урологию, гинекологию, травматологию, фтизиатрию и онкологию. Эти методы используются как для профилактики, так и для лечения осложнений урогенитальных заболеваний.

Цель исследования: Провести обзор литературы по эффективности эндолимфатической антибиотикотерапии у мужчин с рецидивирующими урогенитальными заболеваниями, резистентными к традиционной антибиотикотерапии.

Методы исследования: Проведен комплексный поиск литературы в базах данных PubMed, Scopus, Web of Science, Medline и Wiley Online Library за период с 2015 по 2025 годы. Отобрано 50 полнотекстовых статьи на английском языке, соответствующих критериям включения: открытый доступ, высокая методологическая качество и релевантность. Исключены исследования низкого качества, тезисы конференций и статьи без полного текста.

Результаты и выводы: Эндолимфатическое введение антибиотиков рекомендуется в качестве основного метода лечения мужчин с острыми воспалительными урогенитальными заболеваниями. Анализ литературы показывает широкое применение эндолимфатической и лимфотропной терапии в хирургии, урологии, гинекологии, травматологии, фтизиатрии, онкологии и военной полевой

Received: 02.11.2025 / **Accepted:** 11.12.2025

хирургии. Требуются дальнейшие исследования для оптимизации выбора препаратов, дозировок и режимов введения. Усиление иммунной функции с помощью лимфологических методов представляется перспективным.

Ключевые слова: противоинфекционные средства; лекарственная устойчивость; эндолимфатическая инфузия; инфекции мочевыводящих путей.

Introduction

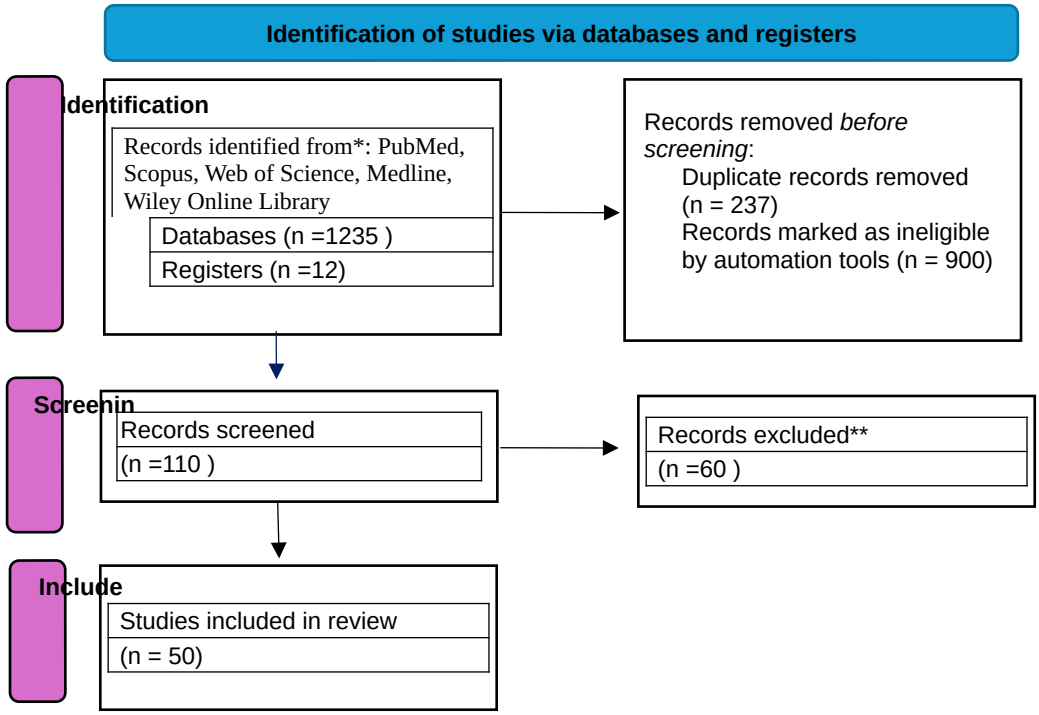
Endolymphatic and lymphotropic drug delivery strategies have emerged as promising alternatives to conventional systemic antibiotic therapies, particularly in disciplines such as abdominal surgery, urology, gynecology, and oncology, where optimizing pharmacokinetics and minimizing systemic toxicity are critical [1–3]. Their relevance is especially notable in the management of recurrent urogenital infections, where rising antimicrobial resistance significantly impairs the efficacy of traditional treatment regimens [4–6]. A key limitation of systemic antibiotic administration lies in its insufficient tissue penetration. For example, the prostate tissue-to-plasma ratio of piperacillin is only approximately 36%, underscoring the challenge of achieving adequate therapeutic concentrations in target organs [7]. In parallel, the emergence of multidrug-resistant uropathogens has contributed to persistent infections and high recurrence rates, particularly in chronic and recurrent urogenital conditions [8, 9]. In response to these challenges, alternative delivery routes such as endolymphatic and lymphotropic antibiotic administration have been increasingly explored. Endolymphatic antibiotic therapy (ELAT), which involves the direct administration of antimicrobial agents into the peripheral lymphatic system, enables targeted drug accumulation in regional lymph nodes and infected tissues. This not only improves local efficacy but also modulates immune responses through interactions with lymphatic immune cells [10]. Recent studies have revisited the clinical utility of ELAT in patients with urogenital infections refractory to standard systemic therapies, demonstrating prolonged local drug retention, enhanced therapeutic outcomes, and reduced systemic exposure [11, 12]. Moreover, lymphotropic antibiotic delivery has shown efficacy in the treatment of peritonitis of diverse etiologies and has been proposed as part of a novel therapeutic approach in conditions such as fibroplastic induration of the penis, particularly when combined with nitric oxide therapy [13]. Given the growing need for effective and targeted treatments in the era of antimicrobial resistance, this review aims to provide a comprehensive analysis of the current evidence on the efficacy, mechanisms, and clinical applications of endolymphatic antibiotic therapy in male patients with recurrent urogenital infections unresponsive to conventional antibiotic regimens.

Objective: To review the literature on the efficacy of endolymphatic antibiotic therapy in men with recurrent urogenital diseases resistant to conventional antibiotic treatment.

Materials and methods. A systematic search of literature from 2015 to 2025 was conducted using PubMed, Scopus, Web of Science, Medline, and Wiley Online Library. The inclusion criteria were English language, open access, and availability of full text; exclusion criteria included conference abstracts and low methodological quality studies. Fifty articles were selected for detailed analysis. The selection process followed PRISMA guidelines (Table 1).

Received: 02.11.2025 / **Accepted:** 11.12.2025

Table 1. PRISMA diagram



Risk of Bias Assessment. Since this review is based on published literature, a qualitative assessment of the risk of bias was performed for all included studies. Each article was evaluated according to key methodological criteria: clarity of study design, adequacy of sample size, presence of control groups, transparency of randomization (if applicable), completeness of outcome reporting, and potential conflicts of interest. For randomized controlled trials, the Cochrane Risk of Bias 2.0 (RoB 2) domains were considered. For non-randomized studies, relevant criteria from the ROBINS-I tool were applied. Each study was categorized as having a low, moderate, or high risk of bias based on the overall assessment of these domains. Discrepancies between reviewers were resolved by consensus. Because this work is a literature-based review, no formal statistical weighting or meta-analysis was performed, and the results of the bias assessment were used qualitatively to interpret the strength and reliability of the available evidence.

Results and Discussion. In urological practice, particularly among geriatric patients and individuals with immunosuppression, conventional systemic antibiotic therapy often fails to achieve sufficient drug concentrations in lymphatic structures involved in urogenital infections [14]. This pharmacokinetic limitation compromises the efficacy of treatment, contributing to persistent or recurrent infections. Recent studies have demonstrated that endolymphatic antibiotic therapy (ELAT) can lead to significant clinical improvement in patients with conditions such as prostatitis, epididymitis, and pyelonephritis, while utilizing lower antibiotic dosages compared to traditional systemic administration [15]. This reduction in dosage not only minimizes systemic toxicity but also potentially mitigates the emergence of antibiotic resistance. Furthermore, experimental and clinical data suggest that the sustained presence of antimicrobial agents within regional lymph nodes enhances local immune responses and helps contain the infection at the primary site [16]. Notably, the saturation of reticuloendothelial cells within lymphatic tissue appears to play a pivotal role in preventing

Received: 02.11.2025 / **Accepted:** 11.12.2025

microbial dissemination and the progression to systemic inflammatory responses or sepsis in the context of urogenital infections [17].

Application of Endolymphatic Antibiotic Therapy Across Various Medical Disciplines. Endolymphatic antibiotic therapy has demonstrated a significant reduction in the recurrence rate of erysipelatous inflammation, decreasing from 16.9% to 2.6%. This high efficacy is likely due to the early eradication of streptococcal infection reservoirs within the lymphatic system [18]. In a cohort of 160 patients with lung abscess, pneumonia, and chronic purulent bronchitis, treatment with gentamicin, brulamicin, pentrexyl, ketocef, and claforan via endolymphatic administration resulted in notable improvements in immune responsiveness. Delivering antibiotics directly into peripheral lymphatic vessels facilitates the saturation of reticuloendothelial components in lymph nodes, thereby enhancing their barrier function and preventing the dissemination of infection and multi-organ failure [19]. Furthermore, the efficacy of endolymphatic antibiotic therapy was assessed in pediatric patients suffering from chronic renal failure due to calculous etiology. The approach of short-course, lymphotropic antibiotic administration minimized systemic toxicity, particularly protecting structurally compromised renal tissue. Clinical data indicated that patients receiving regional endolymphatic antibiotics alongside conventional treatment exhibited earlier clinical improvement, with no incidence of acute exacerbation of calculous pyelonephritis or renal failure progression during the early postoperative phase [20]. Additionally, pharmacokinetic studies of ceftriaxone following endolymphatic infusion revealed sustained high drug concentrations in peritoneal exudate over a 24-hour period, supporting prolonged antimicrobial activity. The combination of antibacterial agents administered through both endovascular and endolymphatic routes was associated with accelerated recovery of organ function and improved outcomes in patients presenting with diffuse peritonitis complicated by intestinal failure syndrome [21]. The therapeutic effect of endolymphatic drug injection is based on three mechanisms: prolonged maintenance of therapeutic drug concentrations in biological fluids, lymph nodes, and the inflammation site due to antibiotic tropism to the lymphatic system; normalization of microcirculation in microvessels and interstitium; and an immunomodulatory effect through direct contact of the immunomodulator with immunocompetent lymph node cells [22]. Endolymphatic antibiotic therapy for peritonitis aims to provide anticoagulant, antibacterial, detoxifying, and immunostimulatory effects. Infusion via the lymphatic system enhances lymph transport into the bloodstream, promoting the restoration of normal microcirculatory function [23]. Endolymphatic antibiotic therapy has demonstrated high efficacy in managing erysipelas of the lower extremities. This effectiveness appears to result from targeted elimination of streptococcal infection within the lymphatic system, as confirmed by clinical and immunological assessments. A key measure of the therapy’s success is its pronounced ability to prevent disease recurrence [24]. The analysis of 34 female patients with locally advanced breast cancer allowed assessment of the outcomes of multimodal treatment and prognosis. Lymphatic duct drainage plays a key role in oncology, providing both cytological and immunological evaluation of lymph, as well as supporting therapeutic management of various malignancies, including locally advanced breast cancer [25]. Endolymphatic administration of sulodexide, selenase, and antibiotics promotes tissue repair, facilitating faster preoperative preparation. Although no statistically significant difference in ulcer healing was observed compared to controls, a trend toward improved healing of venous trophic ulcers suggests the need for further investigation [26]. Indirect endolymphatic therapy in patients with drug-resistant pulmonary tuberculosis promotes radiological stabilization, enhances microbiological clearance, and reduces the number of persistent bacilli excretors. It achieved a 95% reduction in bacilli carriers and closure of destruction cavities in 67.5% of cases

Received: 02.11.2025 / **Accepted:** 11.12.2025

[27]. Endolymphatic administration of anti-tuberculosis drugs improves treatment outcomes in patients with progressive tuberculosis [28]. Antimicrobial therapy remains the mainstay for chronic bacterial prostatitis. However, increasing antibiotic resistance and frequent treatment failures highlight the need for exploring novel therapeutic strategies [29]. A key challenge in medical research is developing therapeutic strategies targeting the lymphatic system, a critical contributor to the pathogenesis of acute and chronic conditions, including infections, atherosclerosis, diabetes, and autoimmune diseases [30]. Lymphatic drug delivery allows once-daily antibiotic administration, reducing total dosage, toxicity, allergenicity, and treatment costs. Compared to conventional methods, it can accelerate recovery, shorten hospital stays, and decrease complications and side effects [31]. The lymphatic system plays a key role in pathogen dissemination, including intra-abdominal infections. Pharmacology aims to develop targeted antibiotic delivery to lymphatic vessels and intestinal tissues, using agents that act as endolymphatic carriers to achieve high local drug concentrations [32]. The anatomical and physiological features of the lymphatic system make endolymphatic delivery of antibiotics and immunomodulators highly effective. Enhanced vessel permeability, slow lymph flow, and drug accumulation in lymph nodes contribute to improved outcomes in acute inflammatory and septic conditions of the thoracic and abdominal organs [33]. Microorganisms from the primary focus may spread via lymphatics to lymph nodes, causing obstruction and secondary infection. This supports the use of lymphotropic drug delivery, including antibiotics and therapeutic mixtures [34]. Antibiotic entry from the interstitial space into lymphatic capillaries is facilitated by increased local venous pressure (compression cuffs) and lymphotropic agents (lidase, trypsin, chymopsin), which enhance vessel permeability. This approach significantly improves drug delivery to pathological sites, including inflammation, wounds, and degenerative tissues [35]. Compared to conventional treatment, lymphotropic therapy accelerates healing of gunshot wounds, reduces edema, enhances resorption of necrotic tissue, foreign particles, and microbes, promotes early muscle fiber recovery, and limits pathological remodeling of the wound defect [36]. In lymphotropic therapy, drugs were administered subcutaneously in the submandibular region targeting the submandibular lymph nodes. Clinical recovery in patients with acute purulent maxillary sinusitis was 72.5% with conventional therapy and 94.4% following lymphotropic treatment [37]. In the treatment of facial furuncles and carbuncles, antibacterial lymphotropic therapy combined with phytotherapy improves microcirculation at the inflammation site and increases antibiotic concentration in biological fluids [38]. Lymphotropic antibiotic therapy reduced residual changes affecting lung function and promoted rapid subjective improvement in patients with tuberculous pleuritis [39]. During lymphotropic therapy, optimal drug concentration at the target site is maintained for 24 hours [40]. Analysis of endomesenteric lymphotropic therapy in postoperative abdominal surgery shows it accelerates gastrointestinal function recovery [41]. Regional lymphotropic administration delivers drugs directly to lymphatic capillaries, concentrating them in nearby lymph nodes and pathological sites, achieving higher local levels than conventional methods [42, 43]. Endolymphatic hydrops is an uncommon but recognized complication following cochlear implantation, and optimal management strategies are still being defined. Endolymphatic hydrops after cochlear implantation successfully managed with intratympanic gentamicin. This treatment effectively alleviated symptoms while maintaining implant performance. Intratympanic gentamicin may therefore serve as a less invasive alternative to labyrinthectomy [44, 45]. Endolymphatic shunt surgery achieved vertigo control comparable to that of intratympanic gentamicin injections, while demonstrating a lower rate of audiovestibular adverse effects [46, 47].

Using Endolymphatic Antibiotic Therapy in Urogenital Pathology. Inflammatory conditions of the genitourinary system in individuals aged over 70 frequently occur in the

Received: 02.11.2025 / **Accepted:** 11.12.2025

context of compromised lymphatic immunocompetence, often resulting in failure of the lymph nodes' barrier function and subsequent urosepsis. Conventional antibiotic administration methods inadequately target lymph node inflammation, leading to suboptimal therapeutic outcomes. In this context, endolymphatic antibiotic administration was employed in patients with acute inflammatory disorders, including pyelonephritis, prostatitis, and orchiepididymitis. Cannulation of the peripheral lymphatic vessel in the foot allowed administration of antibiotics such as gentamicin, tobramycin, amikacin, and ampiox at doses two to three times lower than those typically used in systemic therapy. This catheterization method maintained patient mobility, enabling concurrent prophylactic interventions against hypostatic complications. Clinical improvement was documented in 86% of cases, with 62.5% of patients receiving endolymphatic therapy following the failure of conventional antibiotic regimens. These findings suggest that endolymphatic antibiotic therapy represents a highly effective approach for managing purulent infections in elderly urological patients [48]. Moreover, endolymphatic antibiotic administration has been recommended as a frontline therapeutic strategy for acute inflammatory diseases of the scrotum [49]. In a separate investigation involving 21 patients with complicated urogenital tuberculosis, continuous endolymphatic antibiotic therapy using klaforan and gentamicin was administered over 3 to 13 days. The frequent occurrence of urinary tract lesions, chronic renal failure, and microbial resistance compromised the efficacy of standard treatment protocols. Utilizing a modified dosator device, continuous polycollector endolymphatic antibiotic delivery was combined with simultaneous lymphatic channel lavage, enhancing therapeutic outcomes [50].

Conclusion: Endolymphatic administration of antibiotics is recommended as a primary treatment method for male patients with acute inflammatory diseases of the urogenital system. The literature analysis demonstrates that endolymphatic and lymphotropic therapies have been successfully applied in acute surgical diseases of the abdominal cavity, urology, gynecology, traumatology, phthisiology, oncology, and military field surgery. However, further research is needed to determine the optimal drug selection, dosage, and duration of administration. Stimulating immune system mechanisms through lymphological therapy appears to be one of the most promising approaches to enhancing treatment effectiveness.

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ГРНТИ 76.29.30
УДК 614.2:616.12-008.331.1:616-056.52:304.42 http://doi.org/10.47526/YJoHS-2025.3-15

ASSESSMENT OF THE IMPACT OF SOCIO-DEMOGRAPHIC FACTORS ON QUALITY OF LIFE IN PATIENTS WITH COEXISTING ARTERIAL HYPERTENSION AND ABDOMINAL OBESITY

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Abstract. A comprehensive approach to the management of arterial hypertension and abdominal obesity should include both pharmacological therapy and psychosocial support. Educational programs aimed at informing patients about the severity of the disease and the necessity of adhering to all medical recommendations play a crucial role. Improving quality of life and enhancing patient adherence to treatment require comprehensive and individualized interventions

Objective: To assess the influence of socio-demographic and behavioral factors on health-related quality of life (HRQoL) in patients with coexisting arterial hypertension and abdominal obesity.

Material and Methods: A cross-sectional study included 101 patients (mean age 54.5 ± 1.02 years; 19 men, 82 women) registered at the Clinical-Diagnostic Center of Khoja Akhmet Yassawi International Kazakh-Turkish University. Inclusion criteria were adults aged ≥18 years with physician-diagnosed arterial hypertension (≥140/90 mmHg) and abdominal obesity (waist circumference ≥102 cm for men, ≥88 cm for women). Anthropometric measurements, blood pressure, and HRQoL were assessed using the SF-36 questionnaire. Data were analyzed using descriptive statistics, Mann–Whitney U, and Kruskal–Wallis tests in SPSS 29.0.

Results: Women had lower scores than men in Role Physical (RP) and Role Emotional (RE) domains. Married participants showed reduced scores in General Health (GH), Vitality (VT), Social Functioning (SF), and Mental Health (MH). No significant differences were observed regarding educational level or occupation. Behavioral factors, including low physical activity and smoking, were associated with lower HRQoL in specific domains.

Conclusion: Socio-demographic and behavioral factors significantly impact HRQoL in patients with coexisting hypertension and abdominal obesity. Women and married individuals demonstrated lower quality-of-life scores in several physical and mental health domains, emphasizing the importance of targeted lifestyle and psychosocial interventions.

Keywords: Arterial hypertension, abdominal obesity, HRQoL, socio-demographic factors, lifestyle, SF-36.

Артериялық гипертензиясы мен абдоминальды семіздігі қосарласқан науқастарда әлеуметтік-демографиялық факторлардың өмір сүру сапасының деңгейіне байланысты бағалануы

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Received: 02.12.2025 / **Accepted:** 11.12.2025

Аңдатпа. Артериялық гипертензия мен абдоминальды семіздікті емдеудің кешенді тәсілі дәрілік терапияны да, психоәлеуметтік қолдауды да қамтуы керек. Пациенттерге аурудың ауырлығы және дәрігердің барлық ұсыныстарын орындау қажеттілігі туралы хабардар болуға бағытталған білім беру бағдарламалары маңызды рөл атқарады. Өмір сүру сапасын жақсарту және науқастардың емделуге ұмтылысын арттыру кешенді және жекелендірілген шараларды қажет етеді.

Мақсаты: Қосарлас артериялық гипертензия және абдоминальды семіздігі бар науқастарда әлеуметтік-демографиялық және мінез-құлықтық факторлардың өмірге қатысты сапасына (HRQoL) әсерін бағалау.

Материал және әдістері: Зерттеу 101 науқасты қамтыды (орта жас 54,5 ± 1,02; 19 ер, 82 әйел), олар Қожа Ахмет Ясауи атындағы ХҚТУ Клиникалық-диагностикалық орталығында тіркелген. Қатысу критерийлері: 18 жастан асқан ересек адамдар, дәрігер тағайындаған артериялық гипертензия (≥140/90 мм сын. бағ.) және абдоминальды семіздік (ерлерде бел айналымы ≥102 см, әйелдерде ≥88 см). Науқастардың антропометриялық көрсеткіштері, қан қысымы өлшенді және өмір сапасы SF-36 сауалнамасы арқылы бағаланды. Мәліметтер сипаттамалы статистика, Манн–Уитни U және Краскел–Уоллис тесттері арқылы SPSS 29.0 бағдарламасында өңделді.

Нәтижелері: Әйелдерде ерлерге қарағанда Рөлдік физикалық қызмет (RP) және Эмоционалдық рөлдік шектеулер (RE) салаларында төменгі көрсеткіштер анықталды. Үйленген қатысушыларда Жалпы денсаулық (GH), Өміршеңдік, сергектік (VT), Әлеуметтік функционалдылық (SF) және Психикалық саулық (MH) салаларында төмен бағалар тіркелді. Білім деңгейі мен қызмет түрі бойынша статистикалық мәнділік байқалмады. Темекі шегу мен төмен физикалық белсенділік кейбір өмір сапасы салаларының төмендеуіне ықпал етті.

Қорытынды: Әлеуметтік-демографиялық және мінез-құлықтық факторлар қосарлас артериялық гипертензия мен абдоминальды семіздігі бар науқастарда өмір сапасына елеулі әсер етеді. Әйелдер мен үйленген қатысушылар бірнеше физикалық және психикалық салаларда төменгі көрсеткіштерге ие болды, бұл өмір салты мен психоәлеуметтік факторларды ескеретін мақсатты араласулардың маңыздылығын көрсетеді.

Түйін сөздер: Артериялық гипертензия, абдоминальды семіздік, HRQoL, әлеуметтік-демографиялық факторлар, өмір салты, SF-36.

Оценка влияния социально-демографических факторов на уровень качества жизни у пациентов с сочетанной артериальной гипертензией и абдоминальным ожирением

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Аннотация. Комплексный подход к лечению артериальной гипертензии и абдоминального ожирения должен включать как медикаментозную терапию, так и психосоциальную поддержку. Образовательные программы, направленные на информирование пациентов о тяжести заболевания и необходимости соблюдения всех рекомендаций врача, играют важную роль. Повышение качества жизни и укрепление приверженности пациентов лечению требуют комплексных и индивидуализированных мероприятий.

Received: 02.12.2025 / **Accepted:** 11.12.2025

Цель: Оценить влияние социально-демографических и поведенческих факторов на показатели качества жизни, связанные со здоровьем (HRQoL), у пациентов с сочетанной артериальной гипертензией и абдоминальным ожирением.

Материалы и методы: Кросс-секционное исследование включало 101 пациента (средний возраст 54,5 ± 1,02 года; 19 мужчин, 82 женщины), зарегистрированных в Клинико-диагностическом центре Международного казахско-турецкого университета имени Ходжи Ахмета Ясави. Критерии включения: взрослые ≥18 лет с установленной врачом артериальной гипертензией (≥140/90 мм рт. ст.) и абдоминальным ожирением (окружность талии ≥102 см у мужчин, ≥88 см у женщин). Измерялись антропометрические показатели, артериальное давление, а качество жизни оценивалось с помощью анкеты SF-36. Данные анализировались с использованием описательной статистики, тестов Манна–Уитни U и Краскелла–Уоллиса в SPSS 29.0.

Результаты: У женщин по сравнению с мужчинами наблюдались более низкие показатели в доменах Ролевые физические функции (RP) и Ролевые эмоциональные ограничения (RE). Женатые/замужние участники имели сниженные показатели в доменах Общее здоровье (GH), Жизненная энергия (VT), Социальное функционирование (SF) и Психическое здоровье (MH). Статистически значимых различий по уровню образования и профессиональной деятельности не выявлено. Курение и низкая физическая активность были связаны с ухудшением качества жизни в отдельных доменах.

Вывод: Социально-демографические и поведенческие факторы существенно влияют на качество жизни пациентов с сочетанной артериальной гипертензией и абдоминальным ожирением. Женщины и женатые участники продемонстрировали более низкие показатели в нескольких физических и психических доменах, что подчеркивает необходимость целевых вмешательств, учитывающих образ жизни и психосоциальные факторы.

Ключевые слова: Артериальная гипертензия, абдоминальное ожирение, HRQoL, социально-демографические факторы, образ жизни, SF-36.

Introduction

Arterial hypertension and abdominal obesity are interrelated pathological conditions that significantly increase the risk of cardiovascular diseases. The combination of these two factors substantially affects patients' quality of life and their adherence to treatment [1]. These conditions require long-term therapy and strict compliance with treatment regimens, which often pose challenges for patients [2]. Treatment adherence encompasses consistent follow-up with medical recommendations, timely medication intake, and maintaining prescribed diet and physical activity levels [3]. In patients with hypertension and obesity, quality of life is frequently compromised due to the chronic nature of therapy, medication side effects, psychological barriers, and economic constraints. Moreover, low motivation and lack of support from family or healthcare providers can negatively influence adherence [4]. Several factors influence both treatment adherence and quality of life in these patients:

- Social and economic factors – financial accessibility of medications and healthcare services, support from family and friends.
- Psychological factors – low motivation, stress, and depression may reduce adherence.
- Physical factors – obesity and related limitations may hinder the ability to follow lifestyle and physical activity recommendations.

A comprehensive approach to treating arterial hypertension and abdominal obesity should include both pharmacotherapy and psychosocial support [5]. Educational programs that raise patient awareness about disease severity and the importance of following medical

Received: 02.12.2025 / **Accepted:** 11.12.2025

recommendations play a crucial role. Improving quality of life and enhancing treatment adherence require comprehensive and individualized interventions [6]. Therefore, the objective of this study is to determine the level of quality of life in patients with arterial hypertension and abdominal obesity in relation to socio-demographic factors.

Material and methods. The study employed a single-stage cross-sectional design and was conducted among 101 residents of Turkistan city (mean age: 54.5 ± 1.02 years), including 19 men and 82 women. Each participant provided written informed consent prior to enrollment.

The primary population consisted of individuals registered at the Clinical-Diagnostic Center of the International Kazakh-Turkish University named after Khoja Akhmet Yassawi who participated in the study between 2012 and 2014. Out of 938 patients during that period, 56 had deceased, 130 had relocated to other cities or countries, and 200 declined participation. The remaining 552 individuals were contacted via telephone with the assistance of their primary care physicians using the electronic health records database. Clinical and laboratory assessments were conducted at the university's research and diagnostic laboratories, as well as at the "KDL Olymp" clinical diagnostic laboratory, and participants completed questionnaires. All collected data were subsequently processed statistically.

Inclusion criteria were: adults aged 18 years or older; physician-diagnosed arterial hypertension (≥140/90 mmHg); abdominal obesity (waist circumference ≥102 cm for men, ≥88 cm for women); and voluntary agreement to participate.

Exclusion criteria included: secondary hypertension; severe chronic conditions (oncological diseases, kidney failure, class IV heart failure); psychiatric or cognitive disorders; and pregnancy or lactation.

From the 552 eligible respondents, 101 participants meeting the inclusion criteria for arterial hypertension and abdominal obesity were selected for the final study sample. Anthropometric measurements (height, weight, waist and hip circumferences), blood pressure readings, socio-demographic characteristics, and health-related quality of life (assessed using the SF-36 questionnaire) were collected. All data were entered into an electronic database (Excel) to create a unified dataset.

As shown in Table 1, the participants' mean age was 54.5 ± 1.02 years. The sample comprised predominantly women (81.2%), individuals with higher or incomplete higher education (65.3%), civil servants (59.4%), and married respondents (93.1%). Among the participants, overweight and obesity were observed in 26.7% and 57.4%, respectively, and 94.1% exhibited elevated waist circumference.

Table 1. Socio-demographic characteristics of study participants (n=101)

Variables		abs. val. n=101	%
Gender	Men	19	18,8
	Women	82	81,2
Age	up to 40 years old	10	9,9
	between 40-49 years old	18	17,8
	between 50-59 years old	27	26,7
	between 60-69 years old	46	45,5
Education level	high/unfinished high	66	65,3
	average/below average	35	34,7
Occupation type	civil servant/educator	60	59,4
	unemployed (able to work or unable to work)/housewife/retired	41	40,6

Received: 02.12.2025 / **Accepted:** 11.12.2025

Marital status	Married	94	93,1
	unmarried/divorced/single	7	6,9
Waist circumference	Normal	6	5,9
	High	95	94,1
Body mass index	normal weight	16	15,8
	Overweight	27	26,7
	obesity (I, II, III degrees)	58	57,4

The distribution of the collected data was assessed using descriptive statistics, quantile plots, histograms, and tested with the Kolmogorov–Smirnov and Shapiro–Wilk tests. For normally distributed variables, values are presented as mean (M) ± standard deviation (SD). When comparison groups deviated from a normal distribution, central tendency was expressed as the median (Me) with 25th and 75th percentiles. Non-parametric methods were applied for statistical analysis: the Mann–Whitney U test was used to compare two independent groups, while the Kruskal–Wallis test was employed for three or more groups.

Statistical analyses were performed using the licensed version of SPSS 29.0. Statistical significance was set at $p < 0.05$ for all hypothesis testing.

Results. In accordance with the third objective of our study, the analysis examined the impact of socio-demographic characteristics—such as age, sex, educational level, occupation, and marital status—alongside key behavioral risk factors, including smoking, alcohol consumption, and low physical activity, on the quality of life of respondents with coexisting arterial hypertension and abdominal obesity.

For non-normally distributed variables involving three or more groups, the Kruskal–Wallis test was applied, and no statistically significant associations were found between these variables and the quality-of-life scales (Table 2).

Table 2. Comparison of age and SF-36 questionnaire scales

SF-36 scales	p-value related on Age
Physical Functioning (PF)	0,621
Role Physical (RP)	0,743
Bodily Pain (BP)	0,857
General Health (GH)	0,946
Vitality (VT)	0,753
Social Functioning (SF)	0,853
Role Emotiona (RE)	0,475
Mental Health (MH)	0,965

During the study, the Mann–Whitney U test was initially applied to compare two independent variables due to the non-normal distribution of the data. Based on Table 3, the results indicated that, relative to men, women demonstrated statistically significant differences in quality-of-life domains assessed by the SF-36 questionnaire, specifically in Role Physical (RP) ($p = 0.049$) and Role Emotional (RE) ($p = 0.034$).

Table 3. Comparison of gender and SF-36 questionnaire scales

Received: 02.12.2025 / **Accepted:** 11.12.2025

SF-36 scales	p-value related on Gender
Physical Functioning (PF)	0,089
Role Physical (RP)	0,049
Bodily Pain (BP)	0,359
General Health (GH)	0,724
Vitality (VT)	0,318
Social Functioning (SF)	0,560
Role Emotiona (RE)	0,034
Mental Health (MH)	0,692

As presented in Table 4, marital status was significantly associated with several SF-36 quality-of-life domains among respondents. Married participants exhibited statistically significant differences in General Health (GH) ($p = 0.028$), Vitality (VT) ($p = 0.014$), Social Functioning (SF) ($p = 0.005$), and Mental Health (MH) ($p = 0.026$). This finding indicates that, within the group of respondents with arterial hypertension and abdominal obesity, married individuals displayed lower scores in mental health-related domains compared to physical health components.

Table 4. Comparison of marital status and SF-36 questionnaire scales

SF-36 scales	p-value related on Martial status
Physical Functioning (PF)	0,814
Role Physical (RP)	0,721
Bodily Pain (BP)	0,941
General Health (GH)	0,028
Vitality (VT)	0,014
Social Functioning (SF)	0,005
Role Emotiona (RE)	0,851
Mental Health (MH)	0,026

No statistically significant associations were observed between educational level and quality-of-life scores among participants with arterial hypertension and abdominal obesity (Table 5).

Table 5. Comparison of educational level and SF-36 questionnaire scales

SF-36 scales	p-value related on Educational level
Physical Functioning (PF)	0,799
Role Physical (RP)	0,477
Bodily Pain (BP)	0,373
General Health (GH)	0,783
Vitality (VT)	0,600
Social Functioning (SF)	0,365
Role Emotiona (RE)	0,750
Mental Health (MH)	0,903

A similar pattern was observed for occupation, with no statistically significant association between occupational status and quality-of-life scores (Table 6).

Table 6. Comparison of occupational status and SF-36 questionnaire scales

Received: 02.12.2025 / **Accepted:** 11.12.2025

SF-36 scales	p-value related on Occupational status
Physical Functioning (PF)	0,244
Role Physical (RP)	0,779
Bodily Pain (BP)	0,260
General Health (GH)	0,687
Vitality (VT)	0,389
Social Functioning (SF)	0,833
Role Emotiona (RE)	0,776
Mental Health (MH)	0,617

Discussion. The analysis of coexisting arterial hypertension and abdominal obesity is of increasing importance due to the rising global prevalence of these conditions. Arterial hypertension represents a significant public health challenge, with prevalence increasing with age: approximately 7% of individuals under 30 years and 53% of those over 70 years are affected [7]. Non-communicable diseases (NCDs), including cardiovascular diseases and diabetes, account for 41 million deaths annually, representing 74% of all deaths worldwide [8]. Abdominal obesity is closely associated with these conditions, contributing to various metabolic disorders such as hypertension, diabetes, and cardiovascular disease, and adversely affecting health outcomes [8].

Abdominal obesity is characterized by excessive fat accumulation in the abdominal region and is a more accurate predictor of cardiovascular risk than general obesity determined by body mass index (BMI) [8]. Waist circumference, assessed according to sex-specific thresholds, is a standard measure for evaluating abdominal obesity [8]. Socio-demographic factors, including educational level and socioeconomic status, are critical for understanding the prevalence and management of these conditions. Research indicates that lower education levels and socioeconomic disadvantages are associated with higher risk factors for hypertension and obesity [9,10].

Previous studies have demonstrated that hypertension and hyperlipidemia significantly affect health-related quality of life (HRQoL), leading to impaired physical functioning and reduced overall well-being [11,12]. Lifestyle factors, such as low physical activity, smoking, and dietary habits, also contribute to the prevalence of abdominal obesity and hypertension, highlighting the need for targeted public health interventions [11,13]. Understanding these associations is essential for developing effective strategies to improve quality of life in populations with coexisting conditions.

Socio-demographic factors, including age, sex, educational attainment, marital status, family income, and employment, significantly influence HRQoL in patients with coexisting arterial hypertension and abdominal obesity. These variables substantially affect behavioral risk factors and overall health outcomes [9,10,14]. Age is one of the most important socio-demographic determinants of health. Studies analyzing patients with hypertension and obesity report that the most common age group is 50–60 years, comprising approximately 59.7% of participants [15]. This demographic group is at heightened health risk, making an understanding of age-related health trends critical for targeted interventions.

Sex-based differences in HRQoL are observed, with women typically reporting lower scores across multiple domains compared to men. These differences are influenced by factors such as mental health and social relationships. Men generally exhibit higher scores in physical and psychological health domains, while notable disparities exist in social functioning [12,16].

Received: 02.12.2025 / **Accepted:** 11.12.2025

These findings suggest that sex influences not only health outcomes but also social dynamics within healthcare settings.

Educational level and socioeconomic status are associated with health outcomes and health-related behaviors. Individuals with higher education are more likely to adopt healthy lifestyles and exhibit lower prevalence of chronic diseases, including hypertension [17]. Economic factors, such as family income, affect access to medical resources, dietary habits, and health management strategies [10]. Community health workers (CHWs) play a key role in addressing these gaps by providing education and resources tailored to socio-demographic characteristics, particularly in low-resource communities [14].

Marital status and family structure represent additional socio-demographic factors influencing HRQoL. Single individuals or those from larger families may experience different stressors compared to married participants. Support systems inherent to marital and family structures significantly influence health behaviors and overall well-being [18,19].

The interplay between hypertension, abdominal obesity, and quality of life is complex and influenced by various socio-demographic and clinical factors. Evidence indicates that HRQoL is significantly reduced in individuals with coexisting hypertension and obesity [10,19]. These populations often report lower quality-of-life scores, underscoring the need for targeted health interventions.

Socio-demographic characteristics such as sex, income, and lifestyle are key determinants of HRQoL in patients with hypertension and abdominal obesity. For instance, higher family income is sometimes associated with higher levels of abdominal obesity, suggesting that economic status does not always predict health outcomes [20]. Age and education also play crucial roles in shaping health-related behaviors and access to medical resources, thereby affecting quality of life [21].

Comorbid conditions, including blood pressure, BMI, and diabetes, substantially impact HRQoL. Individuals with coexisting hypertension and abdominal obesity are at higher risk for cardiovascular complications, further reducing quality of life [22]. The presence of multiple comorbidities increases physical limitations and psychological stress [8]. Understanding these clinical conditions and their relationship with HRQoL is essential for effective management and intervention strategies.

Lifestyle factors, such as physical activity and dietary habits, play a critical role in managing hypertension and obesity. Sedentary behavior and poor nutrition contribute to abdominal obesity, adversely affecting cardiovascular health and quality of life [21]. Interventions aimed at promoting healthy dietary habits and physical activity have been shown to improve HRQoL [21–23]. Therefore, considering modifiable lifestyle factors is crucial for enhancing health outcomes and overall quality of life in populations with these interrelated conditions.

Studying HRQoL in patients with coexisting hypertension and abdominal obesity provides insight into the interplay of socio-demographic, clinical, and lifestyle factors. The study included 332 participants and assessed physical, psychological, social, and environmental domains using the WHO Quality of Life questionnaire to evaluate HRQoL [12,19].

Analysis revealed significant sex differences in HRQoL scores, with men generally scoring higher across all domains, particularly in social functioning, consistent with trends observed in studies from Greece, Italy, the USA, and Oman. These differences are often linked to women’s lower social status in male-dominated settings and societal norms [12,16,21,24]. Women in the study reported lower quality-of-life scores, potentially reflecting sociocultural influences on mental health, self-esteem, and overall well-being [12,16].

Another notable finding was the relationship between educational level and quality of life. Participants with lower education had higher prevalence of hypertension, which correlated

Received: 02.12.2025 / **Accepted:** 11.12.2025

with reduced HRQoL [25,26]. Specifically, 56% of hypertensive participants had primary or lower education, substantially higher than in previous studies conducted in Chinese populations [25]. This underscores the role of education in managing health conditions and improving quality of life, highlighting the need for targeted educational interventions [25,26].

The study also examined the impact of lifestyle factors, such as dietary habits and physical activity, on HRQoL. While sex differences in dietary quality were minimal, prior studies have shown that female healthcare workers in Riyadh consume more fruits and vegetables than males [12,24]. Nonetheless, overall lifestyle practices among participants raised concerns, as poor dietary habits were prevalent and could negatively impact health in the context of hypertension and abdominal obesity [18,21].

The primary aim of this analysis was to investigate the importance of socio-demographic and behavioral factors related to dietary habits influencing blood pressure control. A comprehensive model incorporating 72 variables from questionnaires, dietary recalls, and medical records allowed for an in-depth examination of these relationships [14].

Socio-demographic and behavioral factors were self-reported via questionnaires, including age, sex, race/ethnicity, marital status, household size, income, educational attainment, and employment. Due to small sample sizes in certain categories, variables such as sex, race, education, marital status, and occupation were combined to ensure statistical reliability. Participants' insurance status was verified through medical records [14]. Incorporating these factors enables a deeper understanding of the effects of individual socio-behavioral characteristics on health outcomes, particularly in populations with hypertension and obesity.

The analysis aligns with broader studies examining education and health, especially in socioeconomically disadvantaged communities such as Richmond, Virginia. Engaging local residents helps uncover systemic health disparities, while community members emphasize the importance of visible role models and environmental factors in shaping health goals and outcomes. Limited access to green spaces and healthcare resources constrains physical activity and overall health [17].

Future research should extend these findings longitudinally to clarify causal relationships between socio-demographic and behavioral factors and health outcomes. Such studies can provide valuable evidence to guide policies aimed at improving HRQoL, particularly in resource-limited regions [24]. As this study was cross-sectional, it is limited in establishing causality, highlighting the need for further longitudinal research [27].

Conclusion: The study identified decreased health-related quality of life in specific demographic groups and among individuals with certain lifestyle characteristics. Educational level and occupation showed no meaningful association with overall well-being. These findings emphasize the role of demographic and behavioral factors in shaping quality-of-life outcomes.

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Received: 02.12.2025 / **Accepted:** 11.12.2025

ГРНТИ 76.29.47
УДК:616.98:578.834-036.8-053.2 http://doi.org/10.47526/YJoHS-2025.3-16

CHARACTERISTICS OF POST-COVID SYNDROME IN CHILDREN

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Abstract: This article presents information on the neurological features of children in the post-COVID period. Post-COVID syndrome (PCS) is a symptom complex that occurs during and after COVID-19, lasting more than 12 weeks, and is not the result of another disease. Clinical manifestations of PCS are diverse, and under their mask, either the debut or exacerbation of chronic organic pathology triggered by the virus may be hidden. PCS is a diagnosis of exclusion. The main manifestations of PCS include: autonomic dysregulation, cognitive and psycho-emotional disorders, and impairments of the respiratory, cardiovascular, and digestive systems. The direct pathogenetic factors of the main neurological manifestations of PCS are persistent cerebral hypoperfusion, hypoxia, and hypoxemia, which lead to energy deficits in neuronal structures, metabolic disturbances, as well as virus-induced structural damage to cortical neurons and subcortical structures of the brain.

Keywords: COVID-19, SARS-CoV-2, PCS, hypoxia, neuron

БАЛАЛАРДАҒЫ ПОСТКОВИДТІК СИНДРОМНЫҢ СИПАТТАМАСЫ

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Аңдатпа: Осы мақалада балалардағы постковидтік кезеңнің неврологиялық ерекшеліктері туралы мәліметтер ұсынылады. Постковидтік синдром (ПКС) – COVID-19 індеті кезінде немесе одан кейін пайда болып, 12 аптадан астам уақытқа созылатын, басқа аурулармен түсіндірілмейтін симптомдар кешені. ПКС-тің клиникалық көріністері алуан түрлі, олардың астарында вирустың триггерлік әсерінен туындаған созылмалы органикалық патологияның дебюті немесе өршуі жасырынуы мүмкін. ПКС – бұл басқа патологияны жоққа шығару арқылы қойылатын диагноз. ПКС-тің негізгі көріністеріне вегетативтік дисрегуляция, когнитивтік және психоэмоционалдық бұзылыстар, тыныс алу, жүрек-қантамыр және ас қорыту жүйелері тарапынан болатын өзгерістер жатады. ПКС-тің негізгі неврологиялық симптомдарының патогенетикалық факторларының бірі – ұзақ сақталатын ми гипоперфузиясы, гипоксия және гипоксемия. Бұл өзгерістер нейрондық құрылымдардың энергия тапшылығына, метаболизмнің бұзылыстарына, сондай-ақ вирус туындатқан ми қыртысы мен қыртысасты құрылымдарындағы нейрондардың құрылымдық зақымдануына әкеледі.

Түйін сөздер: COVID-19, SARS-CoV-2, постковидтік синдром, гипоксия, нейрон.

ХАРАКТЕРИСТИКА ПОСТКОВИДНОГО СИНДРОМА У ДЕТЕЙ

Received: 08.12.2025 / **Accepted:** 10.12.2025

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Аннотация: В данной статье представлены сведения о неврологических особенностях в постковидном периоде у детей. Постковидный синдром (ПКС) – симптомокомплекс, имеющий место во время и после COVID-19 продолжительностью более 12 нед, не являющийся результатом другого заболевания. Клинические проявления ПКС многолики, и под их маской могут быть скрыты дебют либо обострение хронической органической патологии, триггером которой явился вирус. ПКС – диагноз исключения. Основные проявления ПКС: вегетативная дисрегуляция, когнитивные и психоэмоциональные расстройства, нарушения со стороны респираторной, сердечно-сосудистой, пищеварительной систем. Непосредственными патогенетическими факторами основных неврологических проявлений ПКС являются сохраняющиеся гипоперфузия мозга, гипоксия и гипоксемия, влекущие за собой энергодефицит нейрональных структур, нарушения метаболизма, а также индуцированное вирусом структурное повреждение нейронов коры и подкорковых структур головного мозга.

Ключевые слова: COVID-19, SARS-CoV-2, постковидный синдром, гипоксия, нейрон.

Introduction

Currently, the entire global community is focused on one common problem—the spread of the novel coronavirus infection, COVID-19. The coronavirus has affected not only adults but also children, showing high aggressiveness and causing serious neurological complications [1]. In severe acute respiratory syndrome caused by SARS-CoV-2, neurological and psychiatric complaints are widespread and often occur both during the acute phase of the disease and in the recovery period [2]. Post-COVID syndrome (PCS) is a set of symptoms that arise during COVID-19 and after it, persist for more than 12 weeks, and are not associated with other diseases. The clinical manifestations of post-COVID syndrome are diverse; under their influence, the development or exacerbation of chronic organic pathology triggered by the virus is possible. The main manifestations of post-COVID syndrome include autonomic dysregulation, cognitive and psycho-emotional disorders, as well as dysfunctions of the respiratory, cardiovascular, and digestive systems [3]. The key pathogenetic factors of the neurological manifestations of post-COVID syndrome are persistent cerebral hypoperfusion, hypoxia, and hypoxemia, which lead to an energy deficit in neuronal structures, metabolic disturbances, and virus-induced structural damage to cortical neurons and subcortical brain structures [4].

Despite the relatively low prevalence of acute COVID-19 in children, it has been established that SARS-CoV-2 infection primarily causes two long-term effects. The first is multisystem inflammatory syndrome in children (MIS-C), temporarily associated with SARS-CoV-2, which is an immune-mediated condition. It occurs in a small percentage of children (approximately 0.1%) and develops 2–6 weeks after a SARS-CoV-2 infection [5].

The second is the so-called “long COVID,” also known as post-COVID syndrome or the long-term consequences of SARS-CoV-2 infection. These terms refer to symptoms that persist after recovering from COVID-19. However, it has been found that they mainly affect the emotional, neurological, and cardiopulmonary systems, as well as the mental health of patients. In addition to respiratory illnesses, COVID-19 in children is associated with various neurological

Received: 08.12.2025 / **Accepted:** 10.12.2025

disorders, including headache, encephalopathy, and multisystem inflammatory syndrome [6]. Furthermore, severe neurological conditions have been observed in children, such as encephalitis, epilepsy, dysgeusia or ageusia, aseptic meningitis, stroke, dysarthria, dysphagia, cerebellar ataxia, hypotonia, drowsiness, coma, and peripheral neuropathy [7].

Objective of the study: To investigate the characteristics of post-COVID syndrome in children.

Materials and Methods: The study included 100 children aged 8 to 17 years who received treatment at the Specialized Multidisciplinary Infectious Diseases Hospital in the Zangiata District of Tashkent Region during the period from 2021 to 2023. Clinical-neurological examinations, neuropsychological tests, biochemical analyses, and statistical research methods were used in the study.

To identify post-COVID conditions among children, a survey was conducted involving 100 patients. It was found that the novel coronavirus infection occurred significantly more often in children aged 8 to 17 years (55%). The average age of the patients was 8.7 ± 4.6 years (95% CI: 7.8–9.7). A comparison of age groups showed that the highest number of hospitalizations occurred in children aged 4–7 years (31%) and 8–12 years (29%) ($p < 0.01$).

Among the respondents, 69% reported complaints related to various organs and systems. The most frequent were disorders of the central nervous system — in 71.9% of children — and gastrointestinal disturbances — in 37.7%. Nearly one-quarter of patients exhibited cardiovascular and respiratory system disorders, 30.4% experienced thermoregulation issues, and 8.7% had skin pathologies (Fig. 1).

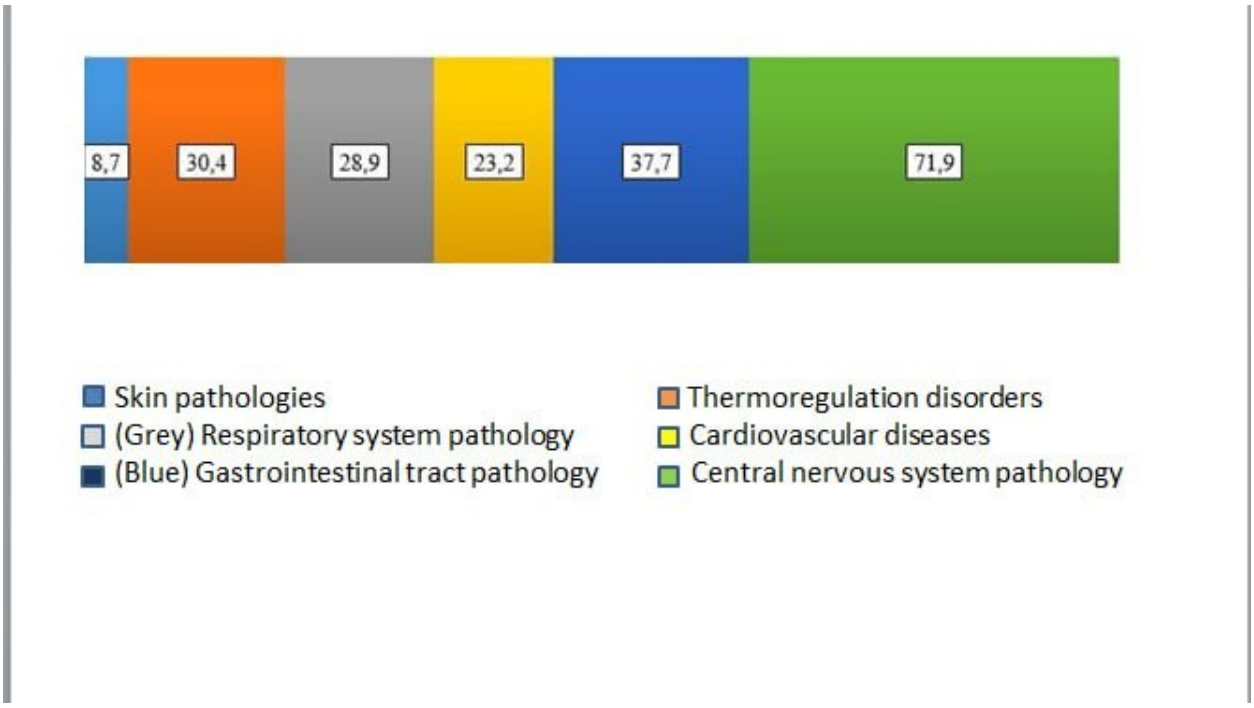

Figure 1. Post-COVID diseases of various organs and systems

In the post-COVID period, children experienced psycho-emotional disorders such as general fatigue, weakness, drowsiness, increasing anxiety, and lowered mood. Some children after recovering from COVID-19 also showed impairments in smell and taste, as well as complaints of headaches (Table 1).

Age-related complaints in children who had COVID-19

Received: 08.12.2025 / **Accepted:** 10.12.2025

Symptoms:	Up to 12 months	1–3 years	4–7 years	8–12 years	13–18 years	p
Weakness	4 (100,0)	10(100,0)	31(100,0)	28 (96,6)	25 (96,2)	0,794
Cough	0 (0,0)	0 (0,0)	12 (38,7)	21 (72,4)	20 (76,9)	<0,001
Headache	0 (0,0)	1 (10,0)	1 (3,2)	3 (10,3)	3 (11,5)	0.732
Anosmia (loss of smell)	3 (0,0)	2 (20,0)	6 (19,4)	8 (27,6)	6 (23,1)	0,188
Abdominal pain	0 (0,0)	2 (20,0)	0 (0,0)	3 (10,3)	2 (7,7)	0.219
Diarrhea	0 (0,0)	2 (20,0)	3 (9,7)	4 (13,8)	3 (11,5)	0,844
Runny nose	0 (0,0)	2 (20,0)	6 (19,4)	8 (27,6)	5 (19,2)	0,749
Sore throat	0 (0,0)	0 (0,0)	2 (6,5)	0 (0,0)	1 (3,8)	0,616
Shortness of breath	0 (0,0)	2 (20,0)	1 (3,2)	3 (10,3)	4 (15,4)	0,409
Nausea / vomiting	0 (0,0)	0 (0,0)	2 (6,5)	4 (13,8)	2 (7,7)	0,619
Dizziness	0 (0,0)	0 (0,0)	0 (0,0)	2 (6,9)	2 (7,7)	0.488
Myalgia (muscle pain)	0 (0,0)	0 (0,0)	0 (0,0)	1 (3,4)	0 (0,0)	0,649
Ageusia (loss of taste)	0 (0,0)	0 (0,0)	0 (0,0)	1 (3,4)	2 (7,7)	0,497
Increased sweating	0 (0,0)	2 (20,0)	6 (19,4)	2 (6,9)	3 (11,5)	0,534
Loss of appetite	2 (50,0)	7 (70,0)	26 (83,9)	23 (79,3)	19 (73,1)	0,547
Anxiety	1 (25,0)	2 (20,0)	5 (16,1)	4 (13,8)	4 (15,4)	0,976
Fever	3 (75,0)	9 (90,0)	26 (83,9)	26 (89,7)	23 (88,5)	0,896

As shown in the figure, in children after COVID-19, abnormalities of the central nervous system most often manifested as general fatigue (39.1%), drowsiness (29%), cognitive impairments (27.5%), as well as psycho-emotional changes — irritability (23.2%) and decreased mood (15.9%).

Received: 08.12.2025 / **Accepted:** 10.12.2025

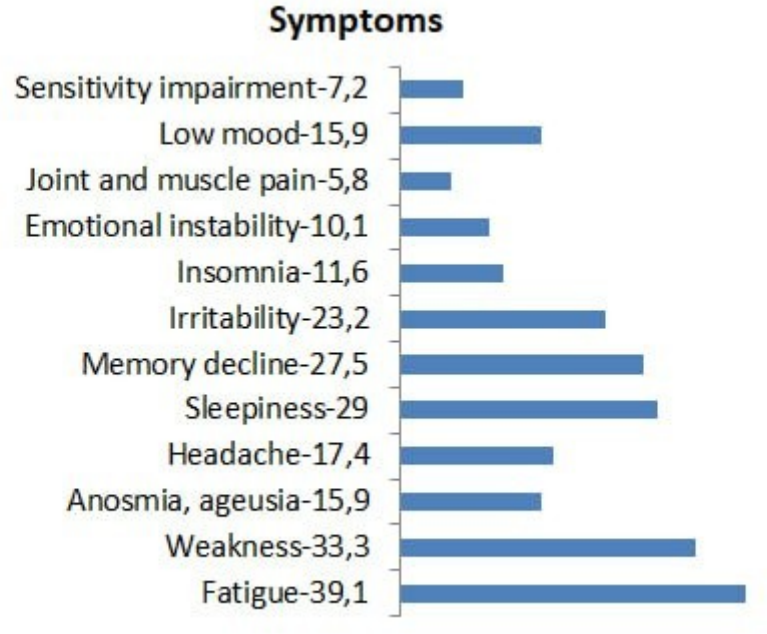

Fig. 2. Major neurological disorders in children with post-COVID complications.

In some children after recovering from COVID-19, disturbances of smell and taste perception persisted (15.9%), and 17.4% complained of headaches (see Fig. 2).

To determine whether the SARS-CoV-2 pathogen has a direct impact on the psycho-emotional and cognitive state of children, we analyzed the data using the Spielberger–Khanin Anxiety Inventory and the Montreal Cognitive Assessment (MoCA).

To assess the cognitive domain, the Montreal Cognitive Assessment (MoCA) was used - a screening method for mild cognitive impairment. Using this method, various cognitive abilities of children were evaluated during the study. This assessment covers such important aspects as attention, executive functions, memory, speech, visuospatial perception, logical thinking, calculation, and orientation.

The methodology includes 10 separate sections, with points calculated depending on the successful completion of the proposed tasks. The maximum possible score is 30. A score of 26 and above is considered sufficient to indicate the absence of cognitive impairments.

To assess the psycho-emotional state of school-aged children, the Spielberger–Hanin method was used. This method is widely applied in clinical practice and has proven its effectiveness. It allows the study of anxiety in two dimensions:

- as a stable personality trait,
- and as a temporary, situational (reactive) state.

The questionnaire consists of two parts, each containing 20 questions. For each question, four response options are offered:

1 - No, this is not true
2 - Possibly yes
3 - True
4 - Completely true

Scoring was carried out using a key by summing the points corresponding to the selected responses. Data interpretation was performed according to the established anxiety scale:

Low level - up to 30 points
Medium level - 31–44 points
High level - above 45 points

Received: 08.12.2025 / **Accepted:** 10.12.2025

To identify the characteristics of the psycho-emotional and cognitive spheres in the structure of post-COVID syndrome, two groups of children over 8 years old were formed:

- Group I-A — children with central nervous system (CNS) disorders
- Group I-B — children without CNS disorders in the post-COVID period

Results of anxiety assessment revealed significant differences depending on the presence of post-COVID manifestations ($p<0.001$ for both; Mann–Whitney test).

When comparing the indicators between Groups I-A and I-B, a statistically significant difference in anxiety levels was observed:

In Group I-A, children had a high level of anxiety — 48.0 (43.5; 50.0), exceeding the upper limit of the norm.

In Group I-B, situational anxiety averaged 43.0 (40.8; 44.0) points.

At the same time, according to the Montreal Cognitive Assessment (MoCA), adolescents in Group I-A showed lower cognitive function scores, allowing for the diagnosis of cognitive deficit — 26.0 (25.0; 26.0) ($p_1<0.001$).

Even considering the older age category of patients in Group I-B, the average MoCA score was 28.0 (27.0; 29.0).

Conclusions

1. Post-COVID syndrome in children and adolescents occurs quite frequently. According to the results of this study, its signs were observed in 69% of the examined participants, indicating a high prevalence of post-infectious neurological and psycho-emotional disorders in the pediatric population after COVID-19.

2. The main clinical manifestations of the post-COVID period in children were: central nervous system dysfunctions, increased fatigue, general weakness, drowsiness, decreased memory and attention, heightened anxiety, irritability, and headaches. These symptoms typically persisted for several months after recovering from COVID-19.

3. According to neuropsychological assessment using the Montreal Cognitive Assessment (MoCA), adolescents in Group I-A (children with CNS disorders) exhibited significant cognitive impairments, with scores reduced to 26.0 (25.0; 26.0) points ($p_1<0.001$). In contrast, children in Group I-B (without CNS disorders) had an average score of 28.0 (27.0; 29.0), which corresponds to the normal range.

4. Analysis of the psycho-emotional state using the Spielberger–Hanin method revealed significant differences between the groups. Adolescents in Group I-A showed a high level of anxiety -- 48.0 (43.5; 50.0), significantly exceeding normative values, whereas in Group I-B, anxiety was at a medium level - 43.0 (40.8; 44.0) ($p<0.001$).

5. The obtained data indicate complex involvement of the neuro-psychological sphere in children who have recovered from COVID-19, encompassing both psycho-emotional disorders and cognitive deficits, as confirmed by psychometric scale results ($p<0.001$ for both methods).

6. The development of cognitive and emotional impairments is likely associated with the neurotropic effects of the SARS-CoV-2 virus, as well as secondary metabolic and hypoxic disorders that occur during the acute and subacute phases of the disease.

7. Therefore, post-COVID syndrome in children and adolescents requires a multidisciplinary approach, involving a neurologist, psychoneurologist, psychologist, and pediatrician. Long-term dynamic assessment of cognitive functions and implementation of rehabilitation programs aimed at restoring memory, attention, emotional stability, and the child’s adaptive abilities are necessary.

8. Early detection and correction of post-COVID impairments allow for the prevention of persistent neurological and psycho-emotional consequences, improving the quality of life and social adaptation of children.

Received: 08.12.2025 / **Accepted:** 10.12.2025

Conflicts of Interest: The authors declare no conflicts of interest.

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Received: 08.12.2025 / **Accepted:** 10.12.2025

ГРНТИ 76.31.29
УДК 615.33 http://doi.org/10.47526/YJoHS-2025.3-17

THE STATE OF ANTIBIOTIC USE AT SHYMKENT CITY CLINICAL HOSPITAL 1

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Abstract. In medical practice, monitoring the effectiveness of antibiotics and the susceptibility of pathogens plays an important role. According to the recommendations of the World Health Organization, controlling the efficacy and safety of antibacterial therapy can reduce infection resistance. Studying the patterns of antibiotic use in a hospital that provides emergency and planned specialized medical care is of both scientific and practical interest.

Aim of the study: To examine cases of antibacterial therapy prescriptions in the clinic and to assess the state of antibacterial therapy based on the results of a cross-sectional (point-prevalence) study.

Materials and methods: The study of antibacterial prescriptions was conducted in the clinical departments of City Clinical Hospital No. 1 in Shymkent. All medical records of patients receiving treatment at the time of the study were analyzed. A cross-sectional epidemiological method was used to assess the effectiveness of antibacterial therapy.

Results and conclusions: The prevalence of antibacterial therapy in the hospital in our study was 91.9%. Most patients (75%) received one antibiotic during treatment. The proportion of patients who were prescribed two antibacterial drugs was 17.6% of all patients receiving antibacterial therapy, while the combined proportion of those prescribed three or more antibiotics was 7.4%. Cephalosporins were used as initial antibacterial therapy in 81% of cases, and in 72.0% of these cases the effectiveness of the drugs was sufficient. Cefazolin and Ceftriaxone, which were used as the main antibiotics in postoperative patients, demonstrated effectiveness rates of 81% and 66.4%, respectively. The low effectiveness of ceftriaxone observed in our study highlights the need for enhanced monitoring of this antibiotic.

Keywords: antibacterial therapy; cross-sectional point-prevalence study; effectiveness of cephalosporins; cefazolin; ceftriaxone.

Шымкент қаласының №1 қалалық клиникалық аруханасындағы антибиотиктерді қолданудың жағдайы

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Андатпа. Медициналық тәжірибеде антибиотиктердің тиімділігін және ауру қоздырғыштардың сезімталдығын бақылау маңызды орын алады. Дүниежүзілік денсаулық

Received: 02.12.2025 / **Accepted:** 9.12.2025

сақтау ұйымының (ДДҰ) ұсынымдарына сәйкес, антибактериалдық терапияның тиімділігі мен қауіпсіздігін бақылау арқылы инфекциялардың резистенттілігін төмендетуге мүмкіндік береді.

Мақсаты: Клиникадағы антибактериалдық терапия тағайындау жағдайларын зерттеу және антибактериалдық терапияның жағдайына көлденең (бірсәттік) әдісінің нәтижелері негізінде баға беру.

Зерттеу материалдары мен әдістері: Антибактериалдық тағайындаулардың жай-күйін зерттеу Шымкент қаласының №1 Қалалық клиникалық ауруханасының клиникалық бөлімшелерінде жүргізілді. Ем қабылдап жатқан барлық науқастардың медициналық карталары бір мезетте талдауға алынды. Антибактериалдық терапияның тиімділігін бағалауында эпидемиологиялық зерттеудің бір сәттік көлденең зерттеу әдісі қолданылды.

Нәтижелері мен қорытындылары: Антибактериалдық терапияның таралуы біздің зерттеуімізде 91,9% құрады. Науқастардың басым бөлігі (75%) емдеу барысында бір антибиотик қабылдаған, екі антибактериалдық препарат антибактериалдық ем алған барлық науқастардың 17,6%-ын құрады, ал үш және одан да көп антибиотик тағайындалған науқастардың жиынтық үлес салмағы 7,4% болды. Стартық антибактериалдық терапия ретінде 81% жағдайда цефалоспориндер тағайындалған, және олардың жалпы тиімділігі 72,0% жағдайларда байқалды. Операциядан кейінгі науқастарда негізгі антибиотиктер ретінде қолданған Цефазолин мен Цефтриаксонның тиімділігі 81% мен 66,4% болды. Клиникадағы антибактериалдық терапияның жай-күйін бағалау үшін көлденең зерттеу аясында цефтриаксонның тиімділігі төмен екендігі және бұл препаратты бақылау қажет екендігін көрсетті.

Түйін сөздер: антибактериалді терапия, бір сәттік көлденең зерттеу, цефалоспориндердің тиімділігі, цефазолин, цефтриаксон.

Состояние антибактериальной терапии в городской клинической больнице № 1 г. Шымкент

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Аннотация. В медицинской практике важное место занимает контроль эффективности антибиотиков и чувствительности возбудителей болезней. Согласно рекомендациям Всемирной организации здравоохранения, контролируя эффективность и безопасность антибактериальной терапии, можно снизить резистентность инфекций. Изучение практики применения антибиотиков в больнице, оказывающей экстренную и плановую специализированную медицинскую помощь, вызывает научный и практический интерес.

Цель исследования: Изучить случаи назначения антибактериальной терапии в клинике и дать оценку состояния антибактериальной терапии на основании результатов поперечного (одномоментного) метода исследования.

Материалы и методы исследования: Исследование антибактериальных назначений проведены на базе клинических отделений Городской клинической больницы №1 города Шымкент. Были проанализированы все медицинские карты больных, получающих лечение на

Received: 02.12.2025 / **Accepted:** 9.12.2025

момент исследования. Для оценки эффективности антибактериальной терапии использовался поперечный метод эпидемиологического исследования.

Результаты и выводы: Распространенность антибактериальной терапии в больнице в нашем исследовании составила 91,9%. Большинство пациентов (75%) получали в ходе лечения один антибиотик. Удельный вес пациентов, которым назначены два антибактериальных препарата составил 17,6% от всех пациентов, получавших антибактериальное лечение, а совокупный удельный вес пациентов, которым были назначены три и более антибиотика, составил 7,4%. В качестве стартовой антибактериальной терапии цефалоспорины применялись в 81% случаев, при этом в 72,0% случаев эффективность препаратов была достаточной. Цефазолин и Цефтриаксон, которые использовались в качестве основных антибиотиков у послеоперационных пациентов, имели эффективность 81% и 66,4% соответственно. Низкие значения эффективности цефтриаксона в антибактериальной терапии в клинике в нашем исследовании показывают о необходимости контроля этого препарата.

Ключевые слова: антибактериальная терапия; поперечное одномоментное исследование; эффективность цефалоспоринов; цефазолин; цефтриаксон.

Introduction

Issues of antibiotic resistance are among the current pressing areas of both theoretical and practical medicine and hold significant importance in the healthcare system as well as in society [1,2].

In clinical practice, the widespread prescription of antibacterial therapy, insufficient monitoring of antibiotic effectiveness and safety, as well as the lack of standardized protocols for antibiotic use, are considered among the main factors contributing to the emergence of multidrug-resistant bacterial strains [3,4,5].

To monitor the spread of antimicrobial-resistant forms of microorganisms (pathogens), internationally recognized tools for rational antibiotic use, such as the AWaRe and AMS programs, are being implemented in clinical settings [6,7].

According to the recommendations of the World Health Organization (WHO), classifying antibiotics within the AWaRe system into “Access,” “Watch,” and “Reserve” groups allows for better monitoring of the effectiveness and safety of antibacterial therapy, as well as helps reduce the development of antimicrobial resistance.

The successful implementation of the AMS program in clinical institutions, and its widespread adoption across all healthcare organizations, contributes to the rational use of antibacterial agents, timely identification of hospital-acquired resistant infections, and the prevention of their development [7].

Studying the current state of antibacterial therapy in the healthcare system, as well as the experience before and after the implementation of a monitoring program, is of particular scientific interest [8,9].

Materials and research methods

The search for research methods capable of providing an objective and comprehensive assessment of antibacterial therapy, while requiring minimal time and resources, is of both theoretical and practical importance [10].

Received: 02.12.2025 / **Accepted:** 9.12.2025

To rapidly assess the state of antibacterial therapy, a cross-sectional (one-time) study design is used, which allows for capturing the situation at a specific point in time without taking into account the many factors that may influence the infection treatment process [11].

During the monitoring of antibacterial therapy, the cross-sectional study design allows for the assessment of the current state of therapy, analysis of the effectiveness and safety of drugs, and timely adjustments to prescribing practices to prevent the development of antibiotic resistance.

A prospective (longitudinal) study is a long-term monitoring method in which the expected outcomes have not yet occurred at the start of the study. This approach allows for the evaluation of the rationality of antibacterial therapy practices, as well as the assessment of drug effectiveness and safety [12].

A cross-sectional study is an epidemiological study design in which participants are examined only once, and information (in this case, the criteria and data for prescribing antibacterial therapy to patients) is collected at a single point in time.

In large scientific projects, cross-sectional studies are typically conducted at the initial stage of the research. Their purpose is to obtain preliminary data on the prevalence of the issue under investigation and to formulate scientific hypotheses that serve as a basis for subsequent in-depth studies and complex statistical analyses [13,14].

Despite some limitations of this method, its main advantage lies in the ability to assess the state of antibacterial therapy practices in a clinical setting.

The study of the state of antibacterial prescriptions was conducted in the clinical departments of Shymkent City Clinical Hospital No. 1.

Shymkent City Clinical Hospital No. 1 is a multidisciplinary medical institution providing both emergency and planned specialized care in surgical, trauma, urological, neurosurgical, gynecological, neurological, and therapeutic fields.

According to the data from the Medical Information System (MIS), during the study period from October 20 to 23, 2025, the medical records of all patients receiving treatment at the hospital were analyzed.

Objective of the study: To investigate the patterns of antibacterial therapy prescription in the clinic and to assess the current state of antibacterial therapy.

To achieve this objective, the following tasks were set:

1. To investigate the patterns of antibacterial therapy prescription;
2. To analyze the use of cefazolin and ceftriaxone in both monotherapy and combination therapy;
3. To assess the effectiveness of empirical antibacterial therapy.

The following criteria were selected to assess the state of antibacterial therapy:

1. The proportion of patients prescribed antibacterial therapy;
2. The number of patients prescribed a single antibiotic;
3. The proportion of patients prescribed cephalosporins;
4. The number of patients prescribed two antibiotics;
5. The number of patients prescribed three or more antibiotics.

To determine the effectiveness of cefazolin and ceftriaxone as empirical antibacterial therapy, their use in both monotherapy and combination therapy was analyzed.

Assessment of Risk of Bias. Since this study aimed to investigate the state of antibacterial therapy in the clinic, a one-time cross-sectional study was chosen to assess the effectiveness of antibacterial therapy as a rapid and low-cost method for evaluating the efficacy of antibacterial drugs.

Received: 02.12.2025 / **Accepted:** 9.12.2025

The examination of antibacterial prescription practices in the clinical departments was conducted without interfering in the treatment process. The patients' condition and diagnosis were not selected, and the final outcome of anti-infective therapy was not considered. The primary criterion for evaluating the effectiveness of antibacterial therapy was the adequacy of a single prescribed drug or the addition of an extra antibiotic at the time of the study. This approach helps to reduce the risk of bias in clinical research.

Results and Discussion. To assess the state of antibacterial therapy in the clinic, we attempted to interpret the results of a prospective cross-sectional study conducted on the medical records of patients in the hospital.

Medical records of 235 patients who received treatment from October 20 to 23, 2025, were analyzed. Among them, 216 patients were prescribed antibacterial therapy. In our study, the prevalence of antibacterial therapy was 91.9%.

The results of the study are presented in Table 1. As shown in Table 1, in a hospital providing both emergency and planned medical care, antibacterial therapy was most often administered as monotherapy. At the time of the study, the majority of patients (75%) received a single antibiotic during treatment. Two antibacterial drugs were prescribed to 38 patients, accounting for 17.6% of all patients who received antibacterial therapy.

Table 1 – State of Antibacterial Therapy

Number of Antibiotics	Number of Patients	Proportion (%)
1 antibiotic	162	75%
2 antibiotics	38	17,6%
3 antibiotics*	14	6,5%
4 antibiotics*	2	0,9%
Total	216	100%

*Note: * — Cases where 3 or 4 antibiotics were prescribed in total, taking into account previously administered antibiotics.*

The combined proportion of patients prescribed three or more antibiotics was 7.4%. Analysis of the medical records of 162 patients who received a single antibacterial agent during the study period showed that 126 patients were treated with cephalosporins (cefazolin – 52, ceftriaxone – 73), while 36 patients received antibiotics from other groups: fluoroquinolones – 26 (ofloxacin, ciprofloxacin, levofloxacin), aminoglycosides – 7 (amikacin, gentamicin), and metronidazole – 3.

To evaluate the effectiveness of cefazolin and ceftriaxone as the main antibiotics in postoperative patients, all medical records in which these antibiotics were used were analyzed.

In the overall pattern of antibacterial prescriptions, cephalosporins were prescribed as initial antibacterial therapy in 175 out of 216 patients, corresponding to 81.0% (Table 2).

Table 2. Number of Patients Prescribed Drugs Belonging to the Cephalosporin Group

Antibiotics	1 drug	2 drugs	3 drugs	Total
Cefazolin	52	12	-	64
Ceftriaxone	73	24	13	110
Cefuroxime	1	-	-	1
Cephalosporins	126	36	13	175

Received: 02.12.2025 / **Accepted:** 9.12.2025

In this study, cephalosporins were prescribed as monotherapy to 126 patients, while a second antibiotic was added for 36 patients. Among 14 patients who received three antibiotics, 13 were treated with cephalosporins.

The study of the overall effectiveness of antibiotics belonging to the cephalosporin group showed that their effectiveness was observed in 72.0% of cases.

Cefazolin was prescribed to 64 patients, including 52 as monotherapy and 12 with an additional second antibiotic. The effectiveness of cefazolin was 81.3%.

Ceftriaxone was prescribed to 110 patients: 73 received it as monotherapy, 24 with an additional second antibiotic, and 13 with a third antibiotic. The effectiveness of ceftriaxone was 66.4%.

Cefuroxime was prescribed to only one patient. According to the study results, the effectiveness of cefazolin was 81.3%, while that of ceftriaxone was 66.4%.

Conclusion

1. A cross-sectional study can be used to assess the state of antibacterial therapy in a clinical setting.

2. The low effectiveness of ceftriaxone in antibacterial therapy indicates the need for careful monitoring of this drug.

Conflicts of Interest: The authors declare no conflicts of interest.

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Received: 02.12.2025 / **Accepted:** 9.12.2025

ГРНТИ 76.75.75
УДК: 614.258.8 : 331.101.32 http://doi.org/10.47526/YJoHS-2025.3-18

MANAGING INCENTIVE PAYMENTS IN PRIMARY HEALTH CARE: BUSINESS SOLUTIONS FOR SUSTAINABLE HEALTHCARE DEVELOPMENT

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Abstract. This study examines incentive payment schemes in primary care and their impact on healthcare effectiveness and equity. We analyze four principal remuneration models: Fee-for-Service, Capitation Financing, Pay-for-Performance (P4P), and hybrid approaches.

Kazakhstan introduced capitation financing with P4P elements in 2009. Our analysis identifies three fundamental paradoxes in this system. First, weak risk-adjustment mechanisms chronically underfund facilities serving vulnerable populations. Second, payment delays undermine financing predictability and create financial instability. Third, incentives for selective patient enrollment contradict universal health coverage goals. The P4P component shows additional weaknesses: questionable quality indicators, inadequate outcome attribution, and poor integration across care levels.

Based on international experience (Kyrgyzstan, Uzbekistan, United States), we propose four optimization strategies: strengthening risk-adjustment models; refining P4P mechanisms with emphasis on equity and provider support; eliminating payment delays; and developing comprehensive motivation frameworks that combine adequate base salaries and fair capitation rates with non-financial incentives such as professional development and improved working conditions.

Our findings show that financial mechanisms without broader systemic support generate counterproductive incentives. These results inform remuneration policy development, primary care quality improvement, and healthcare expenditure optimization.

Keywords: Primary Health Care (PHC), incentive payments, pay-for-performance, capitation financing, health sector reform, motivation of healthcare workers.

Біріншілік денсаулық сақтауда ынталандыру төлемдерін басқару: тұрақты денсаулық сақтауды дамыту үшін бизнес-шешімдер

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Аңдатпа. Бұл зерттеу біріншілік медициналық көмек жүйесіндегі ынталандыру төлемдерін және олардың денсаулық сақтау тиімділігі мен әділеттілігіне ықпалын қарастырады. Біз төрт негізгі еңбекақы төлеу моделін талдаймыз: қызмет үшін төлем, жан басына шаққан қаржыландыру, нәтижеге бағытталған төлем (P4P) және аралас тәсілдер.

Қазақстан 2009 жылы жан басына шаққан қаржыландыруды P4P элементтерімен енгізді. Біздің талдау осы жүйедегі үш негізгі парадоксты анықтайды. Біріншіден, тәуекелді түзету тетіктерінің әлсіздігі осал топтарға қызмет көрсететін ұйымдардың созылмалы түрде жеткіліксіз қаржыландырылуына әкеледі. Екіншіден, төлемдердің кешігуі қаржыландырудың

Received: 04.12.2025 / **Accepted:** 11.12.2025

болжамдылығын төмендетіп, қаржылық тұрақсыздық туғызады. Үшіншіден, пациенттерді іріктеп тіркеуге арналған ынталандыру жалпыға бірдей медициналық қамтудың мақсаттарына қайшы келеді. P4P компонентінде қосымша әлсіз тұстар бар: сапа көрсеткіштерінің күмәнділігі, нәтижелерді орындаушыға дұрыс телудің қиындығы және медициналық көмектің деңгейлері арасындағы интеграцияның төмендігі.

Халықаралық тәжірибеге (Қырғызстан, Өзбекстан, АҚШ) сүйене отырып, біз төрт оңтайландыру стратегиясын ұсынамыз: тәуекелді түзету модельдерін күшейту; әділеттілік пен қызмет көрсетушілерді қолдауға көңіл бөле отырып, P4P тетіктерін жетілдіру; төлемдердің кешігуін жою; базалық жалақы, әділ жанбасылық тарифтер және кәсіби даму мен еңбек жағдайларын жақсартуға бағытталған материалдық емес ынталандыруларды қамтитын кешенді мотивациялық жүйелерді дамыту.

Біздің нәтижелер жүйелік қолдаудың болмауы қаржылық тетіктердің кері ынталандырулар тудыруына әкелетінін көрсетеді. Бұл тұжырымдар еңбекақы төлеу саясатын әзірлеу, біріншілік медициналық көмектің сапасын жақсарту және денсаулық сақтау шығындарын оңтайландыруға ықпал етеді.

Түйін сөздер: біріншілік медициналық көмек (БМК), ынталандыру төлемдері, нәтижеге бағытталған төлем, жан басына шаққан қаржыландыру, денсаулық сақтау реформасы, медицина қызметкерлерінің мотивациясы.

Управление стимулирующими выплатами в ПМСП: бизнес-решения для устойчивого развития здравоохранения

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Аннотация. Статья посвящена анализу систем стимулирующих выплат в первичной медико-санитарной помощи как инструменту повышения эффективности и справедливости здравоохранения. Исследование базируется на критическом анализе четырех основных моделей оплаты труда медицинских работников: Fee-for-Service, капитационного финансирования, оплаты по результатам (Pay-for-Performance) и комбинированных подходов.

Анализ казахстанского опыта внедрения с 2009 года капитационного финансирования с элементами P4P выявляет три критических системных парадокса: недостаточная адекватность механизмов корректировки по рискам приводит к хроническому недофинансированию организаций, обслуживающих социально уязвимые популяции; хронические задержки платежей трансформируют механизм предсказуемости в инструмент финансовой нестабильности; структурные стимулы к селективному обслуживанию противоречат целям универсального охвата. Система P4P демонстрирует проблемы валидности показателей качества и неадекватной атрибуции результатов при слабой интеграции уровней оказания помощи.

На основе международного опыта (Кыргызстан, Узбекистан, США) предложены четыре направления оптимизации: совершенствование многофакторных моделей риск-корректировки; переработка P4P с фокусом на справедливость и поддержку; устранение задержек платежей; развитие комплексной системы мотивации, интегрирующей финансовые компоненты (адекватные оклады, справедливая капитация) и нефинансовые стимулы (профессиональное развитие, карьерный рост, улучшение условий труда).

Исследование демонстрирует, что фокусировка исключительно на финансовых механизмах без системной поддержки неизбежно создает контрпродуктивные стимулы.

Received: 04.12.2025 / **Accepted:** 11.12.2025

Результаты релевантны для органов управления здравоохранения при разработке политики оплаты труда, повышения качества ПМСП и оптимизации расходов.

Ключевые слова: ПМСП, стимулирующие выплаты, оплата по результатам, капитационное финансирование, реформа здравоохранения, мотивация медицинских работников

Introduction

Primary Health Care (PHC) forms the backbone of effective health systems and remains essential for achieving universal health coverage (World Health Organization, 2018) [1]. The 1978 Alma-Ata Declaration first positioned PHC as a priority in national health system development. Forty years later, the 2018 Astana Declaration reaffirmed this commitment in the face of new population health challenges (World Health Organization & UNICEF, 2018) [2]. Quality primary care depends fundamentally on motivated, professional healthcare workers. WHO evidence shows that countries with strong PHC systems achieve 30–40% better health outcomes at lower cost [3-5].

Kazakhstan, an upper-middle-income post-Soviet country [4], is transforming its healthcare system from the Soviet hospital-centered model toward primary care. The country launched mandatory social health insurance (MSHI) on January 1, 2020, now covering over 14 million people. This reform fundamentally changed how healthcare workers are financed and paid [6].

The PHC workforce includes approximately 18,000 physicians and 35,000 mid-level healthcare workers, but shortages persist. Rural areas face the most severe gaps, with only 68% of physician positions filled [7-10].

Despite major financing reforms, Kazakhstan's incentive payment system faces serious problems. First, no unified methodology exists for determining incentive payments or allocation criteria. Regional approaches vary widely - from simple salary supplements to complex point systems. This creates inequities and reduces transparency [11].

Second, quantity trumps quality in physician performance assessment. A 2023 survey found that 67% of PHC physicians said their incentive payments depended more on patient volume than care quality, driving a formalistic, volume-focused approach [12].

Third, financial incentives fall short of expectations. PHC physicians earn about 280,000 tenge (roughly USD 600) on average - 20–30% less than university-educated professionals in other sectors. This pay gap fuels workforce attrition: approximately 8% of PHC physicians leave annually, mostly young doctors with under five years' experience [10].

Fourth, COVID-19 intensified professional burnout. WHO data show that 41–52% of healthcare workers experienced burnout during the pandemic, with higher rates among women (76% of Kazakhstan's PHC physicians), early-career professionals, and parents of young children [2]. Inadequate motivation and support systems worsened these challenges, harming both care quality and patient satisfaction [13].

Work motivation theory traces back to Maslow's hierarchy of needs (1943), Herzberg's two-factor theory (1959), Vroom's expectancy theory (1964), and modern self-determination frameworks [14,15]. Franco et al. (2002) showed that healthcare worker motivation combines intrinsic factors (professional duty, altruism) with extrinsic ones (pay, recognition, working conditions, career prospects).

Healthcare remuneration systems have been extensively studied [13,14]. The main payment models - fee-for-service, capitation, salary, pay-for-performance, and mixed approaches - each shape physician behavior differently. Fee-for-service increases service volume but risks overtreatment. Capitation encourages prevention but risks undertreatment. Pay-for-performance theoretically drives quality improvement but requires valid, reliable measurement [16-18].

International research [17] shows that successful incentive systems combine financial and non-financial elements, balance quantitative and qualitative indicators, and adapt to local contexts [9,17].

Received: 04.12.2025 / **Accepted:** 11.12.2025

Post-Soviet studies [19] examine remuneration reforms in Russia, Ukraine, and Central Asia. However, Kazakhstan-specific research remains limited. Existing studies [17] describe the overall system structure but lack deep analysis of incentive mechanisms under MSHI.

A gap exists between established international theory on incentive systems and our understanding of how these mechanisms work in Kazakhstan's transforming healthcare system.

Research objective: To analyze incentive payment systems in healthcare, examining both theoretical frameworks of worker motivation and contemporary remuneration models in primary health care.

Materials and methods

1. Structure of the healthcare system

Kazakhstan’s healthcare system is centrally managed by the Ministry of Health, which is responsible for developing national health policies, regulating medical institutions, and defining benefit packages. Regional (provincial) health departments are tasked with delivering primary, secondary, and tertiary care.

Since 2020, two complementary benefit packages provide state-funded medical services: the State Guaranteed Benefit Package and the Social Health Insurance Package. Both packages are administered by the Social Health Insurance Fund (SHIF), but they operate with separate funding pools.

2. Research design

The present study is based on the mixed-methods approach, which combines quantitative and qualitative methods of data collection and analysis. This approach allows us to gain a comprehensive understanding of the functioning of the incentive payment system in terms of both statistical patterns and the subjective experience of medical professionals (Creswell & Plano Clark, 2017). The study was conducted in the period from January to August 2025 on the basis of primary care medical organizations in the Turkestan region (a predominantly rural region with a high population density).

3. Analysis of the regulatory framework

The first stage of the quantitative study involved a systematic analysis of regulatory documents governing the remuneration and incentive payment system for PHC workers. The following categories of documents from 2018 to 2024 were examined: (1) laws of the Republic of Kazakhstan (e.g., *On Mandatory Social Health Insurance*, *On the Health of the People and the Healthcare System*); (2) Government resolutions; (3) orders of the Ministry of Health of the Republic of Kazakhstan; and (4) local regulatory acts of medical organizations in the three studied regions (Bowen, 2009).

Documents were analyzed using content analysis, focusing on the following parameters: types of incentive payments, criteria for allocation, calculation methods, sources of funding, payment frequency, and recipient categories. To systematize the information, a specialized analysis matrix was developed in Microsoft Excel, enabling the comparison of regional variations in the application of incentive mechanisms (Braun & Clarke, 2006).

In parallel, an analysis of anonymized administrative data on the salaries and incentive payments of primary care physicians for the period 2022–2024 was conducted.

Results

1 PHC Payment Models and Their Systematic Analysis

Our literature review identified four main remuneration models for primary healthcare workers (Figure 1). Each model has distinct financing mechanisms with different effects on system performance.

Fee-for-Service (FFS) is the most common PHC payment model. Providers earn more when they deliver more services - a straightforward proportionality between interventions and pay. This creates clear financial incentives for activity and initiative. However, it also encourages

Received: 04.12.2025 / **Accepted:** 11.12.2025

overtreatment. Physicians may perform unnecessary tests or procedures to boost income, wasting resources and potentially harming patients. This is especially problematic in primary care, where prevention and coordination should take priority over service volume.

Capitation financing works differently - providers receive a fixed amount per registered patient, regardless of services delivered. This shifts financial risk to providers and flips the incentive structure. Capitation encourages prevention and reduces unnecessary interventions, making healthcare spending more predictable. But it also creates opposite risks. Providers may underserve patients, especially those with complex needs, since the payment stays fixed. Without proper risk adjustment, facilities can game the system by enrolling healthier patients and avoiding sicker, more expensive ones. This marginalizes vulnerable populations.

Pay-for-Performance (P4P) adds bonuses for meeting quality and efficiency targets. In theory, this aligns provider interests with system goals by rewarding good outcomes. In practice, significant problems emerge. Many quality indicators are hard to measure validly in primary care, where outcomes depend on factors beyond provider control. The system can distort clinical practice - doctors focus on measurable targets while neglecting important but unmeasured aspects of care. Gaming behaviors appear: cherry-picking patients, manipulating data to hit targets. These undermine both objectivity and fairness.

Hybrid models combine multiple payment mechanisms - typically capitation as the base, with P4P bonuses and selective fee-for-service for specialized services. This approach tries to balance competing incentives. Success depends heavily on design quality, component balance, and risk-adjustment adequacy. The complexity *and information infrastructure requirements can be barriers, especially in resource-limited settings.*

Figure 1. Remuneration Models in Primary Health Care (PHC)

2. Healthcare Financing

Kazakhstan spends over 4% of GDP on healthcare, with public funding at 2.6% of GDP - meeting WHO's minimum recommendation for achieving Sustainable Development Goals. Per capita spending rose dramatically from USD 50 in 2000 to USD 273 in 2018. Among CIS countries, Kazakhstan maintained relatively high government share in total health spending, though out-of-pocket payments still reached 33.5% in 2018.

Yet spending levels don't match performance. Despite substantial investment, the system shows limited access to innovative diagnostics and treatments, slow adoption of evidence-based practices. This suggests structural inefficiencies in how resources are allocated and used.

The 2025–2027 Republican Budget (Law No. 141-VIII, December 4, 2024) sets key financial indicators (Figure 2):

- Monthly Calculation Index (MCI): 3,932 KZT

Received: 04.12.2025 / **Accepted:** 11.12.2025

- Minimum Wage (MW): 85,000 KZT
- Subsistence Minimum: 46,228 KZT
- Minimum Pension: 62,771 KZT
- Basic Pension Payment: 32,360 KZT

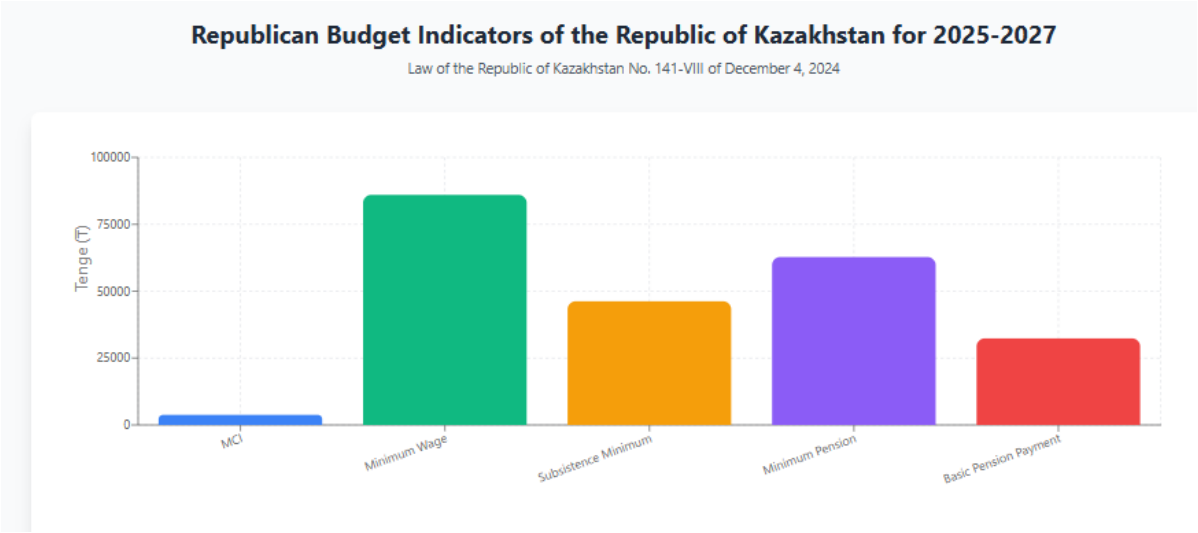

Figure 2. Key Indicators of the Republican Budget of the Republic of Kazakhstan for 2025–2027

The Monthly Calculation Index (MCI) is used to calculate benefits and other social payments, as well as to determine fines, taxes, and other mandatory contributions. The minimum wage (MW) is intended to include all types of incentive payments (bonuses and allowances), compensations, and social benefits.

3. Incentive Payment Management in PHC

Since 2009, Kazakhstan's PHC system uses capitation financing supplemented by pay-for-performance elements (Table 1). Each facility receives a fixed amount per registered resident, adjusted for demographics, socioeconomic factors, and regional epidemiology.

Table 1 – Capitation Financing Model with Risk Adjustment

1	**Advantages of the Model:**	- Predictable financing for service providers - Encouragement of preventive activities - Focus on continuity of care - Reduction of the risk of overprovision of services
2	**Implementation Challenges:**	- Need to develop an adequate risk-adjustment system - Risk of under-provision of services for complex patients - Payment delays from the Social Health Insurance Fund (SHIF) - Financial pressure on providers in cases of untimely payments

Received: 04.12.2025 / **Accepted:** 11.12.2025

Capitation brings predictability for budget planning, incentivizes prevention, and encourages continuous patient management. It should reduce unnecessary services and promote efficient resource use.

But implementation problems emerged. The biggest issue is inadequate risk adjustment. Current demographic coefficients (age, sex, location) miss crucial social determinants of health - poverty, education, ethnicity. Facilities serving vulnerable populations with high chronic disease burdens get systematically underfunded. This isn't a minor technical problem; it's a structural flaw that punishes providers for serving those who need care most.

Payment delays from the Social Health Insurance Fund (SHIF) create another major problem, especially in rural and financially constrained regions. Late payments pressure providers, making it hard to pay staff salaries and cover basic supplies. The state effectively shifts insolvency risk to healthcare organizations - exactly the opposite of what capitation should do.

Under financial pressure, capitation may push providers to avoid complex, multimorbid patients who consume more resources. This contradicts equity principles in Kazakhstan's healthcare law.

Pay-for-Performance in Kazakhstan

The P4P system adds bonuses for meeting targets in four areas:

1. Preventive coverage (vaccination, NCD screening)
2. Chronic disease management quality (diabetes, hypertension)
3. Patient satisfaction
4. Resource efficiency

The concept is sound: link pay to care quality, shifting focus from volume to outcomes.

But implementation reveals serious flaws. Many indicators don't actually measure quality well. They're proxies that can be manipulated. Vaccination rates get inflated by counting people with contraindications - unethical and clinically inappropriate. Chronic disease indicators depend on patient adherence, socioeconomic factors, and hospital care quality - all beyond PHC control. This creates unfair payment distribution and demoralizes staff working with disadvantaged populations.

Worse, the system offers no support for underperforming facilities. Without technical assistance, training, or resources, P4P just widens existing quality gaps between regions and urban-rural areas.

Discussion. Our analysis of remuneration models in primary health care exposes a fundamental tension between theoretical premises and actual implementation outcomes in Kazakhstan's healthcare system. The four main models - Fee-for-Service, capitation, Pay-for-Performance, and hybrid approaches - each have inherent advantages and critical limitations requiring targeted adjustments for Kazakhstan's specific context.

Kazakhstan's healthcare financing structure shows substantial growth: public investment stands at 2.6% of GDP, with per capita expenditure rising from USD 50 in 2000 to USD 273 in 2018 [13]. This represents a genuine expansion of the resource base. Yet a significant mismatch exists between increased funding and system performance, pointing to structural inefficiencies in how resources get allocated and used.

Capitation financing, introduced in 2009, was a well-founded strategic decision based on international experience. But our analysis reveals something deeper than implementation shortcomings - it uncovers a systemic paradox [20]. A model designed to enhance equity and efficiency has produced the opposite effect in practice.

Paradox One: Demographic Reductionism in Socially Determined Health. The first contradiction stems from "demographic reductionism." Current adjustment systems rely on age, sex, and place of residence - factors chosen because they're easy to formalize statistically [21-23]. The underlying assumption was that these demographics could capture major differences in healthcare needs. They can't.

Received: 04.12.2025 / **Accepted:** 11.12.2025

Key determinants of primary care demand in Kazakhstan - socio-economic status, education level, ethnicity, degree of urbanization - aren't incorporated into adjustment coefficients. Organizations in socially deprived regions end up chronically underfunded relative to their actual workload [24].

This exemplifies a broader problem: transplanting international adjustment methodologies without adapting them to local epidemiological and social contexts inevitably redistributes deficits rather than resolving them. The system punishes providers who serve vulnerable populations.

Paradox Two: Predictable Financing as a Source of Operational Unpredictability. Here's the second paradox: a system designed to ensure predictable budgets has instead created financial instability. Chronic payment delays from the Social Health Insurance Fund (SHIF) reflect a fundamental problem in Kazakhstan's budgetary system - setting expenditure plans doesn't guarantee adequate cash execution [25-28].

Rural institutions are particularly vulnerable. They have smaller financial buffers to absorb delays. The capitation mechanism has shifted from a tool for reducing financial risk to a means of redistributing it in favor of the state and to the detriment of healthcare organizations. This contradicts the basic principle of equitable risk distribution within financing systems [29-30].

Paradox Three: Creating Structural Incentives for Unequal Service Provision While Pursuing Universality. Under conditions of inadequate capitation - especially with payment delays - organizations are forced to adapt. They focus on patients with predictable costs and avoid complex cases. This illustrates a theoretical principle: externally imposed incentive systems, when combined with resource constraints, inevitably generate adaptive provider behaviors aimed at minimizing risk at the expense of care quality.

The paradox cuts deep: incentives originally intended to promote universal coverage and equity structurally produce the opposite outcome [31]. Providers aren't being irrational or unethical - they're responding rationally to perverse incentives.

Our findings gain depth when compared with regional and international experiences. Kyrgyzstan introduced a mandatory health insurance fund with capitation payments in 1996 but abandoned the Pay-for-Performance system by 2021, reverting to basic capitation financing [32-35]. This provides an important lesson: even after long-term implementation, P4P may prove insufficiently effective.

Kazakhstan, like Uzbekistan and Kyrgyzstan, has chosen hybrid financing models. But Kazakhstan possesses a larger resource base - public healthcare expenditure at 2.6% of GDP ranks among the highest in the CIS [36-40]. This creates both opportunities for more ambitious reforms and a responsibility to utilize existing resources more efficiently.

The U.S. experience offers an alternative approach worth examining. The Affordable Care Act and National Health Service Corps integrate financial mechanisms with systemic human resource support, including student loan forgiveness programs and incentives for working in underserved areas [38]. Our results show that Kazakhstan's system insufficiently incorporates such non-financial motivational components.

These results demonstrate that Kazakhstan's current primary health care financing system, despite substantial investments and theoretically grounded mechanisms (capitation with P4P), contains structural problems hindering the achievement of equity, efficiency, and quality objectives [41].

Critical dysfunctions relate to:

- The adequacy of risk-adjustment mechanisms
- The reliability of financing
- The validity of quality indicators
- The lack of integration of non-financial motivational components

Received: 04.12.2025 / **Accepted:** 11.12.2025

Recommended optimization strategies draw on international experience, theoretical foundations of human resource management in healthcare, and practical lessons from Kazakhstan's system [42]. Implementing these changes requires coordinated engagement across all levels of the healthcare system and corresponding adjustments to the regulatory framework, aligned with principles in Kazakhstan's State Programs for Healthcare Development [43-45].

A systemic approach can facilitate the transition from mechanical application of financial instruments to creation of a genuinely equitable, efficient, and professionally rewarding primary health care system.

Limitations of the Study and Directions for Future Research

This study focused on analyzing financing systems and remuneration models but didn't directly examine healthcare workers' perceptions of existing mechanisms and their influence on practical behavior. Quantitative data on the actual relationship between applied financial mechanisms and quality-of-care indicators require further analysis.

Future research should incorporate qualitative components - in-depth interviews with healthcare providers and facility administrators - and analyses of healthcare institution data from the Social Health Insurance Fund and statistical systems. This would document the real-world impact of these mechanisms on care quality and accessibility. Comparative studies examining reform outcomes in neighboring regional countries would also provide valuable insights.

Conclusion. Incentive payment management in primary health care is critically important for sustainable healthcare system development. Effective systems need to integrate multiple remuneration mechanisms - combining financial and non-financial incentives - while remaining transparent, equitable, and quality-oriented.

Kazakhstan stands at a pivotal point in its healthcare transformation. Mandatory social health insurance (MSHI) implementation, the shift to capitation financing with P4P elements, and the focus on strengthening primary health care create real opportunities to build an effective motivation system for healthcare workers. But significant challenges persist: inadequate funding, uneven resource distribution, and gaps in monitoring and evaluation.

Reform success depends on comprehensive approaches that go beyond financial mechanisms. Organizational culture matters. Professional values of healthcare workers matter. Population needs and system capacity matter. International experience shows there are no universal solutions—each country must adapt best practices to its own context.

To achieve the Sustainable Development Goals and universal health coverage, Kazakhstan needs to continue these reforms. Three priorities stand out: strengthening primary health care, ensuring equitable resource allocation, and creating a genuinely motivating environment for healthcare professionals.

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Received: 04.12.2025 / **Accepted:** 11.12.2025

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Received: 04.12.2025 / **Accepted:** 11.12.2025

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YASSAWI JOURNAL OF HEALTH SCIENCES

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161200, Republic of Kazakhstan, Turkistan, Khoja Ahmed Yasawi International Kazakh-Turkish University, B. Sattarkhanov Avenue, No. 29B, Main Building, Room 404
Tel.: +7 (725 33) 6-38-26

This journal was printed at the *"Turan" Publishing House* of Khoja Ahmed Yasawi International Kazakh-Turkish University.
Format: 60×84/8. Offset paper.
Conventional printed sheet: 4.8. Print run: 100 copies.

Printing House
161200, Republic of Kazakhstan, Turkistan, Khoja Ahmed Yasawi International Kazakh-Turkish University, B. Sattarkhanov Avenue, No. 29B, Building 2
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