Received: 16 May 2025 / Accepted: 28 August 2025 / Published online: 30 October 2025

DOI 10.34689/SH.2025.27.5.020

UDC 616.351-006.6(574)"2005/2024"+614.2:616-083.98 + 578.834.1

RECTAL CANCER IN KAZAKHSTAN, 2005–2024: COMPONENT ANALYSIS OF INCIDENCE TRENDS IN THE CONTEXT OF SCREENING AND COVID-19

Nurbek S. Igissin[1,2,3], https://orcid.org/0000-0002-2517-6315
Zhansaya B. Telmanova[2,4], https://orcid.org/0000-0002-2364-6520
Nurymzhan A. Murzagulov[1,4], https://orcid.org/0009-0006-7705-1270
Gulnur S. Igissinova[5,2], https://orcid.org/0000-0001-6881-2257
Dulat K. Turebaev[6,2], https://orcid.org/0000-0003-1557-3496
Sergey S. Dyakov[7,2,4], https://orcid.org/0000-0001-7566-7094
Rustem S. Moldagali[8,2], https://orcid.org/0000-0003-4406-413X
Ivan Yu. Shishkin[1,2], https://orcid.org/0009-0007-3620-5541
Alikhan R. Bilyalov[2,9], https://orcid.org/0009-0000-9730-4155
Niyazbek N. Mamatov[4,2], https://orcid.org/0000-0002-4923-847X
Zarina A. Bilyalova[2,3], https://orcid.org/0000-0002-0066-235X

[1] Research Institute of Life and Health Sciences, Higher School of Medicine, Kokshetau University named after Sh. Ualikhanov, Kokshetau, Republic of Kazakhstan;
[2] Central Asian Institute for Medical Research, Astana, Republic of Kazakhstan;
[3] Asian Pacific Organization for Cancer Prevention, Bishkek, Republic of Kyrgyzstan;
[4] Akhunbaev Kyrgyz State Medical Academy, Bishkek, Republic of Kyrgyzstan;
[5] Asfendiyarov Kazakh National Medical University, Almaty, Republic of Kazakhstan;
[6] Astana Medical University, Astana, Kazakhstan;
[7] National Scientific Center of Traumatology and Orthopedics named after Academician Batpenov N.D. of the Ministry of Health of the Republic of Kazakhstan, Astana, Republic of Kazakhstan;
[8] Kokshetau Higher Medical College, 020000, Kokshetau, Republic of Kazakhstan;
[9] L.N. Gumilyov Eurasian National University, Astana, Republic of Kazakhstan.

Abstract

Introduction. Rectal cancer constitutes a sizable share of the oncology workload. Reliable interpretation of long‑term trends requires disentangling demographic forces from genuine changes in age‑specific risk, particularly during program roll‑out and the service disruptions associated with COVID‑19.

The aim of the study is to quantify the separate contributions of population size, age structure, and age‑specific risk to rectal cancer incidence in Kazakhstan, 2005–2024, partitioned into five phases: pre‑screening (2005–2010), early roll‑out (2011–2013), program stabilization (2014–2019), pandemic impact (2020–2021), and post‑pandemic recovery (2022–2024).

Material and research methods. A population‑based retrospective study using the Ministry of Health Form No. 7 (ICD‑10: C19–C21). We applied a seven‑term decomposition with demographic components and risk‑related terms; here, "risk" denotes residual change in age‑specific incidence after removing demographic effects.

Results. Over 2005–2024, 28,368 new cases were registered. The crude incidence rate (CR) increased from 7.80 to 9.13 per 100,000 (+1.34). Decomposition of CR yielded: $\sum\Delta_A$=+1.42, $\sum\Delta_R$=−0.05, $\sum\Delta_{RA}$=−0.03 (per 100,000), indicating a rise driven by population ageing with stable or slightly declining age-specific risks. By phase: 2005–2010 – declines in CR and ASR due to $\Delta R<0$; 2011–2013 – screening-related "peak" ($\Delta_R>0$); 2014–2019 – CR rises while ASR falls, increase fully demographic; 2020–2021 – compensatory increase versus 2020, yet 2021 below 2019; 2022–2024 – CR rises with a "flat" ASR, contribution almost exclusively demographic. Age profile stable: ages 50–79 ≈80.7% of registrations.

Conclusions. The upward drift in crude incidence is primarily demographic, while true risk variation is phase‑bound and program‑linked. Policy should prioritize resilient early‑detection pathways, surge capacity for endoscopy, and routine component‑based surveillance focused on ages 50–79.

Key words: *rectal cancer, incidence, trends, component analysis.*

For citation:

Igissin N.S., Telmanova Zh.B., Murzagulov N.A., Igissinova G.S., Turebaev D.K., Dyakov S.S., Moldagali R.S., Shishkin I.Yu., Bilyalov A.R., Mamatov N.N., Bilyalova Z.A. Rectal cancer in Kazakhstan, 2005–2024: component analysis of incidence trends in the context of screening and COVID-19 // *Nauka i Zdravookhranenie* [Science & Healthcare]. 2025. Vol.27 (5), C.160-168. *doi 10.34689/SH.2025.27.5.020*

Резюме

РАК ПРЯМОЙ КИШКИ В КАЗАХСТАНЕ, 2005–2024 ГГ.: КОМПОНЕНТНЫЙ АНАЛИЗ ТРЕНДОВ ЗАБОЛЕВАЕМОСТИ НА ФОНЕ СКРИНИНГА И COVID-19

Нұрбек С. Игісін[1,2,3], https://orcid.org/0000-0002-2517-6315
Жансая Б. Тельманова[2,4], https://orcid.org/0000-0002-2364-6520
Нурымжан А. Мурзагулов[1,4], https://orcid.org/0009-0006-7705-1270
Гульнур С. Игисинова[5,2], https://orcid.org/0000-0001-6881-2257
Дулат К. Туребаев[6,2], https://orcid.org/0000-0003-1557-3496
Сергей С. Дьяков[7,2,4], https://orcid.org/0000-0001-7566-7094
Рустем С. Молдағали[8,2], https://orcid.org/0000-0003-4406-413X
Иван Ю. Шишкин[1,2], https://orcid.org/0009-0007-3620-5541
Алихан Р. Билялов[2,9], https://orcid.org/0009-0000-9730-4155
Ниязбек Н. Маматов[4,2], https://orcid.org/0000-0002-4923-847X
Зарина А. Билялова[2,3], https://orcid.org/0000-0002-0066-235X

[1] Исследовательский институт науки о жизни и здоровье, Высшая школа медицины, Кокшетауский университет имени Ш. Уалиханова, г. Кокшетау, Республика Казахстан;
[2] Central Asian Institute for Medical Research, г. Астана, Республика Казахстан;
[3] Asian Pacific Organization for Cancer Prevention, г. Бишкек, Республика Кыргызстан;
[4] Кыргызская государственная медицинская академия им. Ахунбаева, г. Бишкек, Республика Кыргызстан;
[5] НАО «Казахский национальный медицинский университет им. С.Д. Асфендиярова», г. Алматы, Республика Казахстан;
[6] НАО «Медицинский университет Астана», г. Астана, Республика Казахстан;
[7] Национальный научный Центр Травматологии и Ортопедии имени академика Батпенова Н.Д. МЗ РК, г. Астана, Республика Казахстан;
[8] Кокшетауский высший медицинский колледж, г. Кокшетау, Республика Казахстан;
[9] Евразийский университет имени Л.Н. Гумилева, г. Астана, Республика Казахстан.

Введение. Рак прямой кишки вносит существенный вклад в суммарную нагрузку онкологических заболеваний. Корректная интерпретация временных рядов требует раздельной оценки демографических эффектов и подлинной динамики возраст‑специфического риска, особенно при развёртывании организованного скрининга и структурных ограничениях периода COVID‑19.

Цель исследования: количественно разложить вклад демографических факторов (численность населения и возрастная структура) и возраст‑специфического риска в изменение заболеваемости раком прямой кишки в Казахстане в 2005-2024 гг., с анализом пяти фаз: доскрининговый этап (2005-2010), раннее развёртывание (2011-2013), стабилизация программы (2014-2019), пандемическое воздействие (2020-2021) и постпандемическое восстановление (2022-2024).

Материалы и методы. Популяционное ретроспективное исследование на основе официальной отчётной формы № 7 Минздрава РК (МКБ‑10: C19–C21). Для оценки динамики числа случаев применено компонентное разложение с выделением семи факторов.

Результаты. За 2005–2024 гг. зарегистрировано 28 368 первичных случаев. Грубый показатель заболеваемости (ГП) вырос с 7,80 до 9,13 на 100 000 (+1,34). Декомпозиция ГП: суммарно $\sum\Delta_A$=+1,42, $\sum\Delta_R$=−0,05, $\sum\Delta_{RA}$=−0,03 (на 100 000) – прирост обусловлен старением населения при стабильных/слегка снижающихся возрастных рисках. По этапам: 2005–2010 – снижение ГП и ВСП за счёт Δ_R<0; 2011–2013 – скрининговый «пик» (Δ_R>0); 2014–2019 – рост ГП при снижении ВСП, прирост полностью демографический; 2020–2021 – компенсаторный рост относительно 2020 г., но уровень 2021 г. ниже 2019 г.; 2022–2024 – рост ГП при «плоском» ВСП, вклад почти исключительно демографический. Возрастной вклад устойчив: 50–79 лет ≈80,7% всех регистраций.

Выводы. Долгосрочный рост заболеваемости определяется главным образом старением и увеличением численности населения; изменения «истинного» риска носят кратковременный характер и совпадают с программными и организационными сдвигами. Рекомендуется внедрять устойчивое компонентное наблюдение, планировать резерв мощности эндоскопии и фокусировать профилактику на когортах 50–79 лет.

Ключевые слова: *рак прямой кишки, заболеваемость, тренды, компонентный анализ.*

Для цитирования:

Игісін Н.С., Тельманова Ж.Б., Мурзагулов Н.А., Игисинова Г.С., Туребаев Д.К., Дьяков С.С., Молдағали Р.С., Шишкин И.Ю., Билялов А.Р., Маматов Н.Н., Билялова З.А. Рак прямой кишки в казахстане, 2005–2024 гг.: компонентный анализ трендов заболеваемости на фоне скрининга и COVID-19 // Наука и Здравоохранение. 2025. Vol.27 (5), С. 160-168. *doi 10.34689/SH.2025.27.5.020*

Түйіндеме

ҚАЗАҚСТАНДАҒЫ ТІК ІШЕКТІҢ ҚАТЕРЛІ ІСІГІ, 2005–2024 ЖЖ.: СКРИНИНГ ПЕН COVID-19 АЯСЫНДА АУРУШАҢДЫҚ ҮРДІСТЕРІНІҢ КОМПОНЕНТТІК ТАЛДАУЫ

Нұрбек С. Игісін[1,2,3], https://orcid.org/0000-0002-2517-6315
Жансая Б. Тельманова[2,4], https://orcid.org/0000-0002-2364-6520
Нурымжан А. Мурзагулов[1,4], https://orcid.org/0009-0006-7705-1270
Гульнур С. Игисинова[5,2], https://orcid.org/0000-0001-6881-2257
Дулат К. Туребаев[6,2], https://orcid.org/0000-0003-1557-3496
Сергей С. Дьяков[7,2,4], https://orcid.org/0000-0001-7566-7094
Рустем С. Молдағали[8,2], https://orcid.org/0000-0003-4406-413X
Иван Ю. Шишкин[1,2], https://orcid.org/0009-0007-3620-5541
Алихан Р. Билялов[2,9], https://orcid.org/0009-0000-9730-4155
Ниязбек Н. Маматов[4,2], https://orcid.org/0000-0002-4923-847X
Зарина А. Билялова[2,3], https://orcid.org/0000-0002-0066-235X

[1] Өмір және денсаулық ғылымдары ғылыми-зерттеу орталығы, Көкшетау қ., Қазақстан Республикасы Республикасы;
[2] Central Asian Institute for Medical Research, Астана қ., Қазақстан Республикасы;
[3] Asian Pacific Organization for Cancer Prevention, Бішкек қ., Қырғызстан Республикасы;
[4] Ахунбаев атындағы Қырғыз Мемлекеттік Медицина Академиясы, Бішкек қ., Қырғызстан Республикасы;
[5] С. Асфендияров атындағы Қазақ ұлттық медицина университеті, Алматы қ., Қазақстан Республикасы;
[6] Астана медицина университеті, Астана қ., Қазақстан Республикасы;
[7] ҚР ДСМ Академик Н.Д. Батпенов атындағы Ұлттық Травматология және ортопедия ғылыми орталығы, Астана қ., Қазақстан Республикасы;
[8] Көкшетау жоғары медициналық колледжі, Көкшетау, Қазақстан Республикасы;
[9] Л.Н. Гумилев атындағы Еуразия ұлттық университеті, Астана, Қазақстан Республикасы.

Кіріспе. Тік ішек қатерлі ісігі онкологиялық қызметтің елеулі бөлігін құрайды. Ұзақ мерзімді динамиканы дұрыс түсіндіру үшін демографиялық әсерлерді жас‑ерекшелік қауіптің нақты өзгерісінен ажырату қажет, әсіресе скринингті енгізу және COVID‑19 кезіндегі қызметтің шектелуі жағдайында.

Зерттеу мақсаты: 2005–2024 жж. Қазақстандағы тік ішек қатерлі ісігінің аурушаңдығына халық саны, жас құрылымы және жас‑ерекшелік қауіптің үлесін бөлек‑бөлек сандық бағалау; кезеңдік талдау: скринингке дейінгі (2005–2010), бастапқы енгізу (2011–2013), бағдарламаның тұрақтануы (2014–2019), пандемиялық әсер (2020–2021) және постпандемиялық қалпына келу (2022–2024).

Зерттеу материалдары мен әдістері. ҚР ДСМ № 7 нысанының (МКБ‑10: C19–C21) деректеріне негізделген ретроспективті популяциялық зерттеу. Жеті компоненттен тұратын компоненттік декомпозиция қолданылды: демографиялық және ауру даумуы қауіпіне байланысты.

Нәтижелері. 2005–2024 жж. аралығында 28 368 жаңа жағдай тіркелді. Қатаң аурушаңдық (ҚА) көрсеткіші 7,80-ден 9,13-ке дейін (100 000 тұрғынға; +1,34) өсті. Декомпозиция: $\sum\Delta_A$=+1,42, $\sum\Delta_R$=−0,05, $\sum\Delta_{RA}$=−0,03 (100 000 тұрғынға) – өсу халықтың қартаюымен түсіндіріледі, ал жас-ерекшелік тәуекел тұрақты немесе сәл төмендеуде. Кезеңдер бойынша: 2005–2010 – ҚА және жасқа стандартталған аурушаңдық (ЖСА) төмендеуі, Δ_R<0; 2011–2013 – скринингке байланысты «шақпақ» (Δ_R>0); 2014–2019 – ҚА өсіп, ЖСА төмендейді, өсім толықтай демографиялық; 2020–2021 – 2020 жылмен салыстырғанда өтемдік өсу, бірақ 2021 деңгейі 2019-дан төмен; 2022–2024 – «тегіс» ЖСА аясында ҚА-ның өсуі, үлес дерлік тек демографиямен анықталады. Жас құрылымы тұрақты: 50–79 жас ≈80,7% тіркелімдер.

Тұжырымдар. Жалпы аурушаңдықтағы өсімнің басым бөлігі демографиялық факторлармен түсіндіріледі; нақты қауіптің өзгерісі қысқа мерзімді және бағдарламалық өзгерістермен байланысты. Эндоскопиялық қызметтің өткізу қабілетін күшейту және 50–79 жас топтарына бағытталған компоненттік мониторингті жүйелі жүргізу қажет.

Түйін сөздер: *тік ішектің қатерлі ісігі, аурушаңдық, трендтер, компоненттік талдау.*

Дәйексөз үшін:

Игісін Н.С., Тельманова Ж.Б., Мурзагулов Н.А., Игисинова Г.С., Туребаев Д.К., Дьяков С.С., Молдағали Р.С., Шишкин И.Ю., Билялов А.Р., Маматов Н.Н., Билялова З.А. Қазақстандағы тік ішектің қатерлі ісігі, 2005–2024 жж.: Скрининг пен COVID-19 аясында аурушаңдық үрдістерінің компоненттік талдауы // Ғылым және Денсаулық сақтау. 2025. Vol.27 (5), С. 160-168. *doi 10.34689/SH.2025.27.5.020*

Introduction

Colorectal malignancies – especially tumors of the rectum—continue to account for a large share of the global oncologic workload [12]. In 2020, international compilations indicated that colorectal cancer occupied the top tier of cancers by occurrence and was among the leading causes of cancer death [2]. The steady accumulation of prevalent cases reflects both longer survival and an ongoing inflow of newly diagnosed patients [5]. Against this backdrop, population ageing and lifestyle-related exposures (dietary patterns, excess weight, insufficient physical activity) interact with unequal access to prevention and early detection, shaping country-specific burdens [9]. Looking ahead, modelling exercises consistently anticipate further growth in case counts, which highlights the practical need to enhance screening pathways, streamline patient flows, and maintain fit-for-purpose epidemiologic surveillance systems [19].

Patterns remain highly uneven across settings: age-standardized incidence tends to be greatest in high-income health systems and lower in parts of Asia, yet secular changes in lifestyle and expanding diagnostic capacity are narrowing these gaps [8, 15]. Importantly, summary metrics alone cannot distinguish how much of the observed change comes from shifting demographics versus true alterations in age-specific risk or screening effects. Accordingly, methods that separate demographic components from risk dynamics are essential for credible trend interpretation.

In Kazakhstan, CRC and rectal cancer in particular – represents a public health priority: thousands of new cases are registered annually, and the disease contributes substantially to the national cancer burden [5]. Growth in the absolute number of recorded cases coexists with improvements in quality indicators of oncologic care, partially attributed to the development of organized screening and strengthening of oncology services [1, 20]. At the same time, structural demographic transformation (increasing share of older adults) and regional disparities in diagnostic access call for analyses that disentangle the demographic backdrop from changes in the underlying risk of disease. A prior nationwide component analysis of CRC incidence documented upward trends across all regions, with increases explained predominantly by demographic factors – population growth and shifts in the age structure [10].

Kazakhstan's organized CRC screening began in 2011 with a two-step pathway (iFOBT followed by diagnostic colonoscopy for positives) and later expanded age eligibility. As documented internationally, program initiation often produces a short-term rise in detected disease due to lead-time and depletion of the preclinical reservoir, which then stabilizes. Service reconfiguration during COVID-19 likely influenced endoscopy capacity and screening coverage, complicating interpretation of routine metrics [13]. In this study, we conduct a component analysis of long-term rectal cancer incidence dynamics in Kazakhstan to quantify the respective contributions of demography and disease risk across program phases and within the context of pandemic constraints – pre-screening (2005–2010), early rollout (2011–2013), program stabilization (2014–2019), pandemic impact (2020–2021), and post-pandemic recovery (2022–2024). This design enables (i) separation of demographic drivers from the true dynamics of risk, (ii) quantitative assessment of phase-specific screening effects, and (iii) characterization of the magnitude of pandemic-related underdiagnosis and subsequent compensation.

Materials and Methods

Cancer registration and case ascertainment

We ascertained incident rectal cancer from the Ministry of Health reporting system (Form No. 7), which consolidates the population-based registry. Eligible records were first primary tumors registered between 2005 and 2024 and coded as C19–C21 (ICD-10).

Population denominators

Population denominators used for rate calculations were sourced from the Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan. We used mid‑year totals for each calendar year; all figures are publicly accessible [3].

Study design and setting

This was a registry-based, retrospective ecological analysis at the national level. We applied a repeated cross-sectional time-trend framework with a seven-term component decomposition across pre-specified program phases and the COVID-19 interval. Reporting followed STROBE principles for observational studies using routinely collected data.

Statistical analysis

We calculated ASR using eighteen five-year age strata (0–4 through ≥85) and the 2013 WHO world standard population. Alongside ASR, we tabulated crude and extensive rates, annual means with standard errors and 95% confidence intervals, and the average annual percent change (T, %) [6, 11].

Long‑term temporal dynamics were described using ordinary‑least‑squares models applied to annual indicators. To attribute changes in the number of cases, we used a seven‑term decomposition separating demographic drivers from residual risk components, with the latter reflecting shifts in age‑specific incidence that may arise from etiologic change or ascertainment intensity [4].

We express the net change in case numbers as the sum of seven terms. Three capture purely demographic forces: (i) the shift in total population size (Δ_P); (ii) the shift in age composition (Δ_A); and (iii) their joint interaction ($\Delta_{P\times A}$). A fourth term isolates the contribution of altered disease risk, independent of demography (Δ_R). The remaining three terms quantify how changes in risk combine with population growth and ageing—namely the interactions of ΔR with ΔP, with ΔA, and with both simultaneously. In this framework, "risk of disease" is defined as the residual change in age-specific incidence after removing demographic effects, and may reflect etiologic influences as well as diagnostic and ascertainment intensity.

Symbols and abbreviations used: AC – absolute count; Δ_A (ASP) – age structure of the population; Δ_P (PS) – population size; Δ_R (RD) – risk of disease.

Ethics approval

We analyzed only de-identified, publicly available administrative data and did not contact individuals. The study protocol was reviewed and approved by the local ethics committee of the Central Asian Institute for Medical Research.

Results

Overall picture (2005–2024). Over the 20-year period, 28,368 new rectal cancer cases were registered. The annual case count increased from 1,181 in 2005 to 1,830 in 2024 (minimum – 1,132 in 2008; maximum – 1,893 in 2023; median – 1,434 per year).

The age profile was strongly right-skewed: individuals aged 50–79 accounted for ~80.7% of registrations (50–54: 9.0%; 55–59: 13.3%; 60–64: 16.2%; 65–69: 17.0%; 70–74: 14.7%; 75–79: 10.4%).

The crude incidence rate increased from 7.8 to 9.13 per 100,000 (+1.34 per 100,000; Fig. 1).

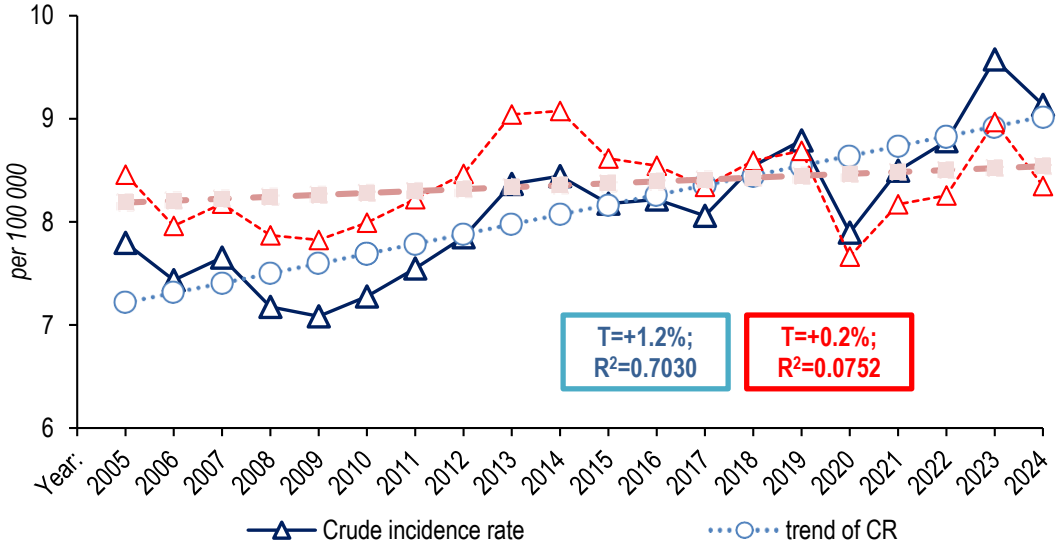

Figure 1. Long-term rectal cancer incidence in Kazakhstan, 2005–2024.

Component decomposition of the CR increase indicated a dominant demographic contribution: the age-structure term ($\sum\Delta_A$) was +1.42 per 100,000, whereas risk of disease term ($\sum\Delta_R$) was −0.05 per 100,000, and the joint age structure × risk term ($\sum\Delta_{R+A}$) was −0.03 per 100,000.

In counts, the total increase was +649 cases (1,181 → 1,830). Decomposition of ΔN:

- **Population growth (Δ_P): +381** cases (**+32.3%**);
- **Shift in age structure of the population (Δ_A): +215** (**+18.2%**);
- **Joint** effect **Δ_{P+A}: +69** (**+5.9%**);
- **Change in** risk of developing disease **(Δ_R): −7** (**−0.6%**);
- **Interactions:** $\Delta_R \times \Delta_P$ **−2** (**−0.2%**), $\Delta_R \times \Delta_A$ **−5** (**−0.4%**), $\Delta_R \times \Delta_P \times \Delta_A$ **−2** (**−0.2%**).

Taken together, these findings confirm that the **primary driver of the increased burden is demographic (population growth and ageing)**, whereas the "pure" risk component shows **no sustained long-term increase**.

Periods. Pre-screening period (2005–2010). The CR declined from 7.80 to 7.28 per 100,000 (−0.52 per 100,000, −6.7%), and the ASR decreased from 7.80 to 7.31 per 100,000 (−6.2%). The total number of cases was virtually unchanged: 1181 → 1179 (ΔN=−2). The overall reduction in the CR (−0.52) was driven primarily by the risk component (Δ_R=−0.48), with a small negative contribution from age structure (Δ_A=−0.07); their interaction term was mildly compensatory (Δ_{R+A}=+0.04) (Table 1). Thus, the observed decline reflects a true decrease in age-specific incidence, rather than demographic shifts. Although population growth generated a potential increase of +82 cases, this was fully offset by a decrease in risk (−73 cases) and an unfavorable redistribution by age (−11 cases), with minimal cross-effects overall (≈ 0) (Tables 2, 3).

Table 1.

Decomposition of changes in rectal cancer incidence (rates per 100,000), 2005–2024.

Periods	Incidence rate, ‰		Changes in incidence, ‰			
			Total	Including due to		
	P_1	P_2	(P_1-P_2)	Δ_A	Δ_R	Δ_{RA}
2005–2010	*P*=7.8	*P*=7.3	−0.52	−0.07	−0.48	+0.04
2011–2013	*P*=7.55	*P*=8.37	+0.82	+0.15	+0.60	+0.08
2014–2019	*P*=8.44	*P*=8.79	+0.35	+0.70	−0.36	+0.003
2020–2021	*P*=7.90	*P*=8.50	+0.60	+0.12	+0.50	−0.02
2022–2024	*P*=8.78	*P*=9.13	+0.35	+0.32	+0.01	+0.02

Δ_A – age structure of the population. Δ_R – risk of disease.
Δ_{RA} – combined effect of disease risk and population age structure.

Early rollout of screening (2011–2013). During 2011–2013, concurrent with the rollout of screening, a clear increase in incidence was observed: the crude rate rose from 7.55 to 8.37 per 100,000 (total increase +0.82 per 100,000), which cannot be attributed to demography alone (Table 1). The component decomposition confirms dominance of the risk component (+0.60) with a moderate accompanying contribution of age structure (+0.15) and a

small positive interaction (+0.08). The rise from 1,241 to 1,415 cases (+174) decomposed into +98 due to change in risk (56.6% of the increase), +35 due to population growth (20.4%), and +24 due to population ageing (13.7%) (Tables 2,3). Taken together, this reflects the typical early-screening phenomenon of depleting the preclinical pool (lead time), yielding a short-term rise in incidence indicators.

2014–2019 (program stabilization). In 2014–2019, a "stabilization" phase was observed: with a modest rise in the crude rate from 8.44 to 8.79 per 100,000 (+0.35 per 100,000), the age-standardized rate decreased from 8.44 to 8.08 per 100,000, while case counts increased from 1,449 to 1,617 (+168) (Tables 1,2). The component decomposition indicates a demographic pattern: the rise in the crude rate was generated by age structure (+0.70), whereas the risk component was negative (−0.36). In counts, demography almost entirely explains the increase: +104 from population growth, +120 from ageing, and +9 from their joint effect; change in risk contributed a dampening effect (−62; interactions involving risk were slightly negative overall) (Table 3). In other words, after the initial screening-related uptick, the depletion effect waned and demographic drivers predominated, alongside a tendency toward declining age-specific incidence.

*Pandemic impact (2020–2021).*Amid partial restoration of diagnostic activity after the 2020 downturn, the crude rate increased from 7.90 to 8.50 per 100,000 (+0.60 per 100,000) (Table 1). The period was characterized by dominance of the risk component (+0.50), with a moderate contribution from age structure (+0.12) and a small negative interaction (−0.02). Case counts rose from 1,471 to 1,604 (+133), 69.4% of which is attributable to change in risk (+92), while population growth (+20) and ageing (+23) contributed 32% in total; cross-effects were minimal. Thus, within 2020–2021, a compensatory ("catch-up") effect in detection predominated; nevertheless, the 2021 level remained below the pre-pandemic 2019 level (8.50 vs 8.79) (Table 2).

Table 2.

Component analysis of rectal cancer incidence in Kazakhstan, 2005–2024.

Indicators	Registered cases (n_{ij})		Population size (N_{ij})		Crude incidence rate (P_{ij})		Age-standardized incidence rate (P^c_{ij})		Expected number of cases
2005-2010									
Total	n_{2005}=1181	n_{2010}=1179	N_{2005}=15147029	N_{2010}=16203274	P_{2005}=7.80	P_{2010}=7.28	P^c_{2005} = 7.80	P^c_{2010} = 7.31	$E(n_{2010})$=1252
Change	$\frac{n_{2005}-n_{2010}}{n_{2005}}100 = -0.2\%$		$\frac{N_{2005}-N_{2010}}{N_{2005}}100 = +7.0\%$		$\frac{P_{2005}-P_{2010}}{P_{2005}}100 = -6.7\%$		$\frac{P^c_{2005}-P^c_{2010}}{P^c_{2005}}100 = -6.2\%$		
2011-2013									
Total	n_{2011}=1241	n_{2013}=1415	N_{2011}=16440470	N_{2013}=16910246	P_{2011}=7.55	P_{2013}=8.37	P^c_{2011} = 7.55	P^c_{2013} = 8.15	$E(n_{2013})$=1301
Change	$\frac{n_{2011}-n_{2013}}{n_{2011}}100 = +14.0\%$		$\frac{N_{2011}-N_{2013}}{N_{2011}}100 = +2.9\%$		$\frac{P_{2011}-P_{2013}}{P_{2011}}100 = +10.9\%$		$\frac{P^c_{2011}-P^c_{2013}}{P^c_{2011}}100 = +7.9\%$		
2014-2019									
Total	n_{2014}=1449	n_{2019}=1617	N_{2014}=17160855	N_{2019}=18395567	P_{2014}=8.44	P_{2019}=8.79	P^c_{2014} = 8.44	P^c_{2019} = 8.08	$E(n_{2019})$=1682
Change	$\frac{n_{2014}-n_{2019}}{n_{2014}}100 = +11.6\%$		$\frac{N_{2014}-N_{2019}}{N_{2014}}100 = +7.2\%$		$\frac{P_{2014}-P_{2019}}{P_{2014}}100 = +4.1\%$		$\frac{P^c_{2014}-P^c_{2019}}{P^c_{2014}}100 = -4.3\%$		
2020-2021									
Total	n_{2020}=1471	n_{2021}=1604	N_{2020}=18631779	N_{2021}=18878966	P_{2020}=7.90	P_{2021}=8.50	P^c_{2020} = 7.90	P^c_{2021} = 8.39	$E(n_{2021})$=1514
Change	$\frac{n_{2020}-n_{2021}}{n_{2020}}100 = +9.0\%$		$\frac{N_{2020}-N_{2021}}{N_{2020}}100 = +1.3\%$		$\frac{P_{2020}-P_{2021}}{P_{2020}}100 = +7.6\%$		$\frac{P^c_{2020}-P^c_{2021}}{P^c_{2020}}100 = +6.3\%$		
2022-2024									
Total	n_{2022}=1713	n_{2024}=1830	N_{2022}=19503159	N_{2024}=20033842	P_{2022}=8.78	P_{2024}=9.13	P^c_{2022} = 8.78	P^c_{2024} = 8.79	$E(n_{2024})$=1825
Change	$\frac{n_{2022}-n_{2024}}{n_{2022}}100 = +6.8\%$		$\frac{N_{2022}-N_{2024}}{N_{2022}}100 = +2.7\%$		$\frac{P_{2022}-P_{2024}}{P_{2022}}100 = +4.0\%$		$\frac{P^c_{2022}-P^c_{2024}}{P^c_{2022}}100 = +0.1\%$		

Post-pandemic recovery (2022–2024)

In 2022–2024, a post-pandemic consolidation was observed: the crude rate rose from 8.78 to 9.13 per 100,000 (+0.35 per 100,000) alongside an essentially flat age-standardized rate (8.78 → 8.79, +0.1%), i.e., without a substantive increase in risk of disease. Component decomposition confirms the demographic nature of the crude-rate increase: age structure +0.32, risk +0.01, interaction +0.02. Case counts increased 1,713 → 1,830 (+117), 96% of which is explained by demography (+47 from population growth and +63 from ageing; joint effect +2), while change in risk contributed only +2 cases (≈1.7% of the increase). Overall, this indicates a return to a stable level of detectability, with demographic drivers predominating and the prior catch-up effect largely exhausted.

Table 3.

Contributions of demographic and risk components to case counts (%), Kazakhstan, 2005–2024.

Компоненты прироста числа заболевших за счет:	Change, %				
	2005-2010	2011-2013	2014-2019	2020-2021	2022-2024
1. Growth PS $\Delta_P = \frac{N_1 - N_2}{N_1} n_1$	+7.0	+2.9	+7.2	+1.3	±2.7
2. Changes ASP $\Delta_A = \frac{N_1}{N_2}(E(n_2) - n_2 - \Delta_H$	−0.9	+1.9	+8.3	+1.5	+3.7
3. Combined effect of changes in PS+ASP $\Delta_{PA} = \frac{N_2 - N_1}{N_1} \Delta_A$	−0.1	+0.1	+0.6	+0.02	+0.1
	$\sum_{1-3}$=+6.0	$\sum_{1-3}$=+4.8	$\sum_{1-3}$=+16.1	$\sum_{1-3}$=+2.9	$\sum_{1-3}$=+6.5
4. Change in risk of disease (RD) $\Delta_R = N_1(P_2^c - P_1^c) \times 10^{-5}$	−6.2	+7.9	−4.3	+6.3	+0.1
5. Combined effect of changes of RD+PS $\Delta_{RP} = \frac{N_2 - N_1}{N_1} \Delta_R$	−0.4	+0.2	−0.3	+0.1	0.00
6. Combined effect of changes of RD+ASP $\Delta_{RA} = \frac{N_2 - N_1}{N_1} \Delta_R$	+0.5	+1.0	+0.04	−0.2	+0.2
7. Combined effect of the changes RD+PS+ASP $\Delta_{RAP} = \frac{N_1}{N_2}\left(n_2 - n_1 - \sum_{x=1}^{5}\right)$	+0.03	+0.03	0.00	0.00	+0.01
	$\sum_{4-7}$=−6.1	$\sum_{4-7}$=+9.2	$\sum_{4-7}$=−4.5	$\sum_{4-7}$=+6.1	$\sum_{4-7}$=+0.3
Total $\sum_{1-7}$	−0.2	+14.0	+11.6	+9.0	+6.8

Discussion

Our 20-year analysis shows that the increase in rectal cancer incidence in Kazakhstan (2005-2024) was driven predominantly by demographic forces (population ageing and growth), whereas risk component overall remained stable or slightly declined. Two short-lived positive “risk” peaks were observed – at screening rollout (2011–2013) and during the pandemic window (2020–2021). This phased profile aligns with the expected dynamics following implementation of organized screening (lead-time and depletion of the preclinical pool with subsequent stabilization) [18].

Stage-specific interpretation in context of the literature.

1. Pre-screening (2005–2010). Concurrent declines in CR and ASR with an almost unchanged case count indicate a moderate reduction in age-specific incidence in the absence of external interventions – a typical “pre-reform” background in which behavioral and clinical-diagnostic factors shape risk while demography exerts a weak countertrend. Globally, this matches evidence that CRC variation is strongly tied to age structure and exposure to risk factors [17].

2. Early rollout (2011–2013). We observe a classic screening-related surge: ASR increases and the risk component dominates against a moderate contribution of age structure – an established pattern at the start of organized CRC screening (heightened detectability and a shift in time-to-diagnosis). International reviews and network meta-analyses document short-term increases in detection after adoption of organized programs, particularly with FIT/iFOBT and expanded colonoscopy capacity [14, 18].

3. Program stabilization (2014–2019). Declining ASR alongside a modest rise in CR and a negative risk component indicates attenuation of the initial screening effect and demographic predominance. Similar profiles are reported in settings with mature programs, where further increases in crude incidence are largely demographic while the risk component stabilizes or declines. For Kazakhstan, earlier studies documented upward trends in recorded cases across all regions with substantial roles for demography and risk, consistent with our component decomposition [10].

4. Pandemic impact (2020–2021). The 2020 drop and partial recovery in 2021 feature a positive risk component over 2020–2021, yet levels remained below pre-pandemic benchmarks; this mirrors international series showing sharp reductions in screening/endoscopy in 2020, diagnostic delays, and a partial rebound in 2021 based on systematic reviews, SEER-based analyses, and multi-site studies [7].

5. Post-pandemic recovery (2022–2024). A flat ASR with a modest rise in CR and near-exclusive demographic contributions indicates exhaustion of the catch-up effect and return to baseline detectability; analogous plateaus after 2021–2022 are reported in large health systems as screening coverage stabilizes [16].

Implications for policy and practice.

(1) **Sustaining screening resilience.** Ensure reserve endoscopy capacity and flexible pathways (broader use of home-based iFOBT) to buffer shocks during crises.

(2) **Focus on ages 50–79.** These cohorts account for the bulk of cases; resource allocation should follow the region-specific demographic profile.

(3) **Component-based monitoring.** Routine decomposition into **size/structure/risk** should become a KPI for oncology services, allowing separation of true risk changes from demographic artifacts and correct interpretation of rising CR with stable/declining ASR.

(4) **Population communication.** Post-COVID compensation does not warrant over-diagnosis; stable coverage and targeted outreach to groups who missed screening in 2020–2021 are key.

Strengths and novelty. (i) Nationwide scope and a long observation window (2005–2024); (ii) a formal **component (decomposition) analysis** with phase-specific periodization, enabling quantitative separation of demography from risk; and (iii) explicit positioning against international screening trends and COVID-related disruptions. Unlike aggregate trend summaries, our approach elucidates the **mechanisms** and **temporal structure** of change.

Limitations. Potential variation in registration completeness across country/years and heterogeneity in screening quality metrics (coverage, FIT positivity, colonoscopy completion, stage distribution), as well as lack of individual-level risk factors. The COVID period may have involved patient selection and stage delays, potentially biasing short-term estimates. These limitations are typical for national registries and are discussed in the international literature on pandemic effects on oncology indicators.

Conclusions. In Kazakhstan's rectal cancer incidence dynamics, **demography** is the principal determinant of the increase in crude rates, while **risk changes** manifest in phases—at screening initiation and during compensatory recovery after the pandemic. This configuration is consistent with global evidence and underscores the need for robust early-detection programs, contingency-ready capacity, and routine **component-based surveillance** to correctly interpret incidence trends.

Acknowledgments. We thank the Ministry of Healthcare of the Republic of Kazakhstan for access to aggregated registry data that made this analysis possible.

This work was supported by the Ministry of Science and Higher Education of the Republic of Kazakhstan (project No. AP23484165: "Clinical, diagnostic and morphological determinants of diseases of the large intestine in Kazakhstan: innovative approaches and solutions"). Selected findings from this study form the basis of the Candidate of Medical Sciences (Cand. Med. Sci.) dissertation of Zhansaya Telmanova, undertaken within the postgraduate programme at the I.K. Akhunbaev Kyrgyz State Medical Academy.

Author Contributions. *All authors contributed equally to the study conception and design, data acquisition and analysis, and manuscript drafting and revision. All authors approved the final version and agree to be accountable for all aspects of the work.*

Conflict of interest: *The authors declare that there is no conflict of interest.*

Publication Statement. *This manuscript has not been published previously and is not under consideration for publication elsewhere.*

Literature:

1. *Аксарин А.К., Тельманова З.Б., Орозбаев С.Т., Кожахметов С.К., Кудайбергенова И.О., Игисинов Н.С.* Оценка изменений показателей онкологической службы при колоректальном раке в Казахстане. Вестник КГМА им. И.К. Ахунбаева. 2021. С. 5-6, С. 28-34.

2. *Байдун Ф., Элшиви К., Элкерейе Й. и др.* Эпидемиология колоректального рака: современные тенденции и влияние на результаты. Curr Drug Targets. 2021;22(9):998-1009.

3. Бюро национальной статистики Агентства по стратегическому планированию и реформам Республики Казахстан. Доступно по адресу: https://stat.gov.kz/ (дата обращения: 01.10.2025).

4. *Двойрин В.В., Аксель Е.М.* Компонентный анализ динамики заболеваемости злокачественными новообразованиями (методические рекомендации). Москва, 1987. 10 с.

5. *Ferlay J., Ervik M., Lam F., et al* Global Cancer Observatory: Cancer Today. Lyon, France: International Agency for Research on Cancer. 2024. Available from: https://gco.iarc.who.int/today (Accessed 05.10.2025)

6. *Glanc S.* Mediko-biologicheskaya statistika [Biomedical statistics]. Moscow, Praktika [Practice], 1999, 460 p. [in Russian]

7. *Howlader N., Chen H.S., Noone A.M., et al.* Impact of COVID-19 on 2021 cancer incidence rates and potential rebound from 2020 decline. J Natl Cancer Inst. 2025. 117(3), P. 507-510.

8. *Liu Y., Zhang C., Wang Q., et al.* Temporal Trends in the Disease Burden of Colorectal Cancer with Its Risk Factors at the Global and National Level from 1990 to 2019, and Projections Until 2044. Clin Epidemiol. 2023. 15, P. 55-71.

9. *Matsuda T., Fujimoto A., Igarashi Y.* Colorectal Cancer: Epidemiology, Risk Factors, and Public Health Strategies. Digestion. 2025. 106(2), P. 91-99.

10. *Mauyenova D., Zhadykova Y., Khozhayev A., et al.* Trends of Colorectal Cancer Incidence in Kazakhstan. Asian Pac J Cancer Prev. 2021. 22(10), P. 3405.

11. *Merkov A.M., Polyakov L.E.* Sanitarnaya statistika [Sanitary statistics]. Leningrad, Meditsina [Medicine], 1974, 384 p. [in Russian]

12. *Morgan E., Arnold M., Gini A., et al.* Global burden of colorectal cancer in 2020 and 2040: incidence and mortality estimates from GLOBOCAN. Gut. 2023. 72(2), P. 338-344.

13. *Nogueira L.M., Palis B., Boffa D., et al.* Evaluation of the Impact of the COVID-19 Pandemic on Reliability of Cancer Surveillance Data in the National Cancer Database. Ann Surg Oncol. 2023. 30(4), P. 2087-2093.

14. *Ola I., Cardoso R., Hoffmeister M., Brenner H.* Utilization of colorectal cancer screening tests: a systematic review and time trend analysis of nationally representative data. EClinicalMedicine. 2024. 75, P. 102783.

15. *Onyoh E.F., Hsu W.F., Chang L.C., et al.* The Rise of Colorectal Cancer in Asia: Epidemiology, Screening, and Management. Curr Gastroenterol Rep. 2019. 21(8), P. 36.

16. *Star J., Han X., Smith R.A., et al.* Cancer Screening 3 Years After the Onset of the COVID-19 Pandemic. JAMA. 2025. 333(17), P. 1543–1546.

17. *Sung H., Ferlay J., Siegel R.L., et al.* Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin. 2021. 71(3), P. 209-249.

18. *Terasawa T., Tadano T., Abe K., et al.* Single-round performance of colorectal cancer screening programs: a network meta-analysis of randomized clinical trials. BMC Med. 2025. 23(1), P. 110.

19. *Xi Y., Xu P.* Global colorectal cancer burden in 2020 and projections to 2040. Transl Oncol. 2021. 14(10), P. 101174.

20. *Zhylkaidarova A., Kaidarova D., Batyrbekov K., Shatkovskaya O., Begimbetova D.* Trends of Colorectal Cancer Prevalence in Kazakhstan Related to Screening. Clin Endosc. 2021. 54(1), P. 32-37.

References: [ ]

1. Aksarin A.K., Telmanova Z.B., Orozbaev S.T., Kozhakhmetov S.K., Kudaibergenova I.O., Igissinov N.S. Otsenka izmenenii pokazatelei onkologicheskoi sluzhby pri kolorektal'nom rake v Kazakhstane. [Evaluation changes in indicators of oncological service in colorectal cancer in Kazakhstan]. *Vestnik KGMA im. I.K. Akhunbaeva.* [*Vestnik of KSMA named after I.K. Akhunbaev]*. 2021. 5-6, P. 28-34. [in Russian]

2. *Baidoun F., Elshiwy K., Elkeraie Y., et al.* Epidemiologiya kolorektal'nogo raka: sovremennye tendentsii i vliyanie na rezul'taty. [Colorectal Cancer Epidemiology: Recent Trends and Impact on Outcomes]. *Curr Drug Targets.* [*Curr Drug Targets*]. 2021;22(9):998-1009. [in Russian]

3. *Byuro nacional'noj statistiki Agentstva po strategicheskomu planirovaniyu i reformam Respubliki Kazahstan* [The Bureau of National Statistics of the Agency for Strategic Planning and Reforms of the Republic of Kazakhstan]. Available from: https://stat.gov.kz/ (Accessed 01.10.2025). [in Russian]

4. *Dvoyrin V.V., Aksel E.M. Komponentnyi analiz dinamiki zabolevaemosti zlokachestvennymi novoobrazovaniyami (metodicheskie rekomendatsii)* [Component analysis of the dynamics of the incidence of malignant neoplasms (methodological recommendations)]. Moscow, 1987. 10 p. [in Russian]

Information about the authors:

Igissin Nurbek Sagynbekuly – Doctor of Medical Sciences, Professor, Director of Research Institute of Life and Health Sciences, Professor of Higher School of Medicine, Kokshetau University named after Sh. Ualikhanov, Kokshetau, Kazakhstan; Chairman of Public Association “Central Asian Institute for Medical Research”, Astana, Kazakhstan; Member of Asian Pacific Organization for Cancer Prevention, Bishkek, Republic of Kyrgyzstan; E-mail: nurbek.igissin@gmail.com; phone +7 702 429 34 21, https://orcid.org/0000-0002-2517-6315;

Telmanova Zhansaya Bekmakanovna – Researcher of Public Association “Central Asian Institute for Medical Research”, Astana, Kazakhstan; Postgraduate student of Department of Research Management, Kyrgyz State Medical Academy named after Akhunbayev, Bishkek, Republic of Kyrgyzstan; E-mail: telmanova.zhansaya@gmail.com; phone +7 707 505 93 98, https://orcid.org/0000-0002-2364-6520;

Murzagulov Nurymzhan Abayevich – Master of Medical Sciences, Senior Lecturer of Department of Morphology, Physiology and General Pathology, Kokshetau University named after Sh. Ualikhanov, Kokshetau, Republic of Kazakhstan; Postgraduate student of Department of Research Management, Kyrgyz State Medical Academy named after Akhunbayev, Bishkek, Republic of Kyrgyzstan; E-mail: nmyrzagylov@shokan.edu.kz; phone +7 701 538 06 95, https://orcid.org/0009-0006-7705-1270;

Igissinova Gulnur Sagynbekovna - Associate Professor at the Department of Oncology, Asfendiyarov Kazakh National Medical University, Almaty, Kazakhstan; Senior researcher of Public Association “Central Asian Institute for Medical Research”, Astana, Kazakhstan; E-mail: gulnurs@list.ru; phone +7 701 757 28 30, https://orcid.org/0000-0001-6881-2257;

Turebaev Dulat Kanatovich – Professor of Department of Surgical Diseases with courses of Angiosurgery and Plastic Surgery, Astana Medical University, Astana, Kazakhstan; Researcher of Public Association “Central Asian Institute for Medical Research”, Astana, Kazakhstan; E-mail: tdk_1410@mail.ru; phone +7 701 726 90 13, https://orcid.org/0000-0003-1557-3496;

Dyakov Sergey Sergeevich – Researcher of Public Association “Central Asian Institute for Medical Research”, Astana, Kazakhstan; Postgraduate student of the Kyrgyz State Medical Academy named after Akhunbayev, Bishkek, Republic of Kyrgyzstan; Radiologist at the National Scientific Center of Traumatology and Orthopedics named after Academician Batpenov N.D. of the Ministry of Health of the Republic of Kazakhstan, Astana, Kazakhstan; E-mail: sergey_djakov@mail.ru; phone +7 702 462 22 69, https://orcid.org/0000-0001-7566-7094;

Moldagali Rustem Salkiuly – Director of Kokshetau Higher Medical College, Kokshetau, Kazakhstan; Researcher of Public Association “Central Asian Institute for Medical Research”, Astana, Kazakhstan; E-mail: rustem_taszhanov@mail.ru; phone +7 701 419 80 73, https://orcid.org/0000-0003-4406-413X;

Shishkin Ivan Yurievich – Intern of Higher School of Medicine, Kokshetau University named after Sh. Ualikhanov, Kokshetau, Kazakhstan; Researcher of Public Association “Central Asian Institute for Medical Research”, Astana, Kazakhstan; E-mail: dr.ivan.shishkin@gmail.com; phone +7 776 427 48 74; https://orcid.org/0009-0007-3620-5541;

Bilyalov Alikhan Rashidovich – Master's Student of Faculty of Natural Sciences, Department of Biotechnology and Microbiology, L.N. Gumilyov Eurasian National University, Astana, Kazakhstan; Researcher of Public Association “Central Asian Institute for Medical Research”, Astana, Kazakhstan; E-mail: bilyalov.ar.2002@gmail.com; phone +7 702 626 96 01, https://orcid.org/0009-0000-9730-4155;

Mamatov Niyazbek Nurlanbekovich – Candidate of Medical Sciences, Associate Professor, Vice-Rector for Research and Clinical Affairs, Kyrgyz State Medical Academy named after Akhunbayev, Bishkek, Republic of Kyrgyzstan; Researcher of Public Association “Central Asian Institute for Medical Research”, Astana, Kazakhstan; E-mail: drmamatov@mail.ru; phone +996 555 417 141, https://orcid.org/0000-0002-4923-847X;

Corresponding Author:

Bilyalova Zarina Aronovna – PhD, Associate Professor; Chief Scientific Officer of Public Association “Central Asian Institute for Medical Research”, Astana, Kazakhstan. https://orcid.org/0000-0002-0066-235X;

Address: Office 13, Almaty Street, Astana 010000, Republic of Kazakhstan

E-mail: z.bilyalova@gmail.com,

Phone: +7(705)146-48-88