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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНИТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНИТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman** (**Кириллица**), для текста на грузинском языке следует использовать **AcadNusx.** Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - http://www.spinesurgery.ru/files/publish.pdf и http://www.nlm.nih.gov/bsd/uniform_requirements.html
В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректура авторам не высылается, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or compu-ter-printed on a single side of standard typing paper, with the left margin of **3** centimeters width, and **1.5** spacing between the lines, typeface - **Times New Roman** (**Cyrillic**), print size - **12** (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf
In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

Articles that Fail to Meet the Aforementioned Requirements are not Assigned to be Reviewed.

ავტორთა საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე,დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx.** შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფჩხილებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

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EPIDEMIOLOGICAL TRENDS OF SALMONELLOSIS IN THE REPUBLIC OF KAZAKHSTAN: ANALYSIS OF NATIONAL DATA (2013–2024)

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Abstract.

Background: Salmonellosis remains a relevant public health problem, requiring continuous epidemiological monitoring based on reliable surveillance data.

Aim: To analyze long-term trends in salmonellosis incidence in the Republic of Kazakhstan during 2013–2024, with assessment of temporal dynamics, age-specific patterns, and laboratory confirmation indicators based on official monitoring data.

Materials and Methods: A retrospective epidemiological analysis was conducted using aggregated laboratory surveillance data provided by the Scientific and Practical Center for Sanitary and Epidemiological Expertise and Monitoring of the Ministry of National Economy of the Republic of Kazakhstan. Incidence rates were analyzed for the total population and defined age groups. Long-term dynamics were assessed using descriptive statistics, average annual change indicators, and the Cochran–Armitage trend test.

Results: During 2013–2024, salmonellosis incidence in the Republic of Kazakhstan exhibited a statistically significant long-term decline (average annual rate of change, CAGR: −4.5% per year; $p < 0.001$), accompanied by marked interannual variability. This trend was strongly influenced by a pronounced reduction in reported incidence during the COVID-19 pandemic period (2020–2021). The highest incidence rates were consistently recorded among children under 1 year of age and those aged 1–2 years, in whom statistically significant decreasing trends were observed ($p \leq 0.001$). Among children aged 3–6 years and 7–14 years, no significant linear temporal trends were identified ($p > 0.05$), indicating fluctuating incidence without a consistent directional change over time. The proportion of laboratory-confirmed cases demonstrated a statistically significant increasing trend over time ($p < 0.001$).

Conclusions: Salmonellosis incidence in the Republic of Kazakhstan demonstrates a statistically significant long-term downward trend with persistent interannual fluctuations, which should be interpreted in the context of changes in surveillance intensity and healthcare utilization during the COVID-19 pandemic. Early childhood remains the most affected age group, while the absence of significant temporal trends among preschool and school-aged children indicates stable incidence levels over time and supports the need for continued epidemiological surveillance in these populations.

Key words. Salmonellosis, incidence, epidemiological surveillance, temporal trends, age groups, laboratory confirmation, Republic of Kazakhstan.

Introduction.

Salmonellosis remains one of the most important foodborne infections and continues to pose a significant challenge to public health systems and food safety worldwide. Bacteria of the genus Salmonella are Gram-negative, facultative anaerobic members of the family Enterobacteriaceae with a high epidemic potential due to their ability to survive for prolonged periods in the environment and to contaminate water and food products [1,2]. The genus includes a large number of Salmonella enterica serovars, which determines the diversity of circulating strains and sources of infection [1,2]. From a public health perspective, it is essential to distinguish between typhoidal and non-typhoidal forms; non-typhoidal Salmonella (NTS) are responsible for the majority of acute gastroenteritis cases and foodborne outbreaks in most countries [1-3].

The foodborne transmission pathway is realized at all stages of the "farm-to-table" chain, including primary production, processing, storage, and food preparation [1,3]. Products of animal origin, particularly poultry and eggs, as well as meat and other animal products, remain the most common sources of Salmonella infection. At the same time, violations of sanitary regulations and cross-contamination during food handling play a crucial role in maintaining the risk of transmission [3,4]. Studies have demonstrated that even an adequate level of consumer knowledge does not fully eliminate the risk of salmonellosis if food-handling practices are inadequate [4]. Food handlers represent a particularly important epidemiological link, as insufficient hygiene and gaps in training increase the likelihood of food contamination and outbreak formation [5].

From a clinical and epidemiological perspective, the most significant serovars are those associated with large outbreaks and a substantial contribution to overall morbidity, including S. Enteritidis and S. Typhimurium [1-3]. Contemporary epidemiology is characterized by the emergence and spread of specific clones and variants, including the monophasic variant of S. Typhimurium, which has become one of the leading causes of infection in several countries and is frequently associated with multidrug resistance [6]. Advances in molecular epidemiology and whole-genome sequencing (WGS) have substantially improved understanding of the evolution, transmission, and global dissemination of epidemiologically important lineages, including the DT104 clone of S. Typhimurium [7,8].

The pathogenicity of Salmonella is determined by a complex set of virulence factors that enable adhesion, invasion, and survival within the host organism. Key determinants include pathogenicity islands and secretion systems, as well as other genetic elements influencing invasiveness and disease severity [2,9]. One of the most pressing contemporary challenges is the increasing antimicrobial resistance of Salmonella strains and the spread of multidrug-resistant variants, which reduces the effectiveness of standard therapy and increases the importance of prevention and control at the level of the food production chain and epidemiological surveillance [1]. Additional difficulties arise from biofilm-forming strains capable of persisting on industrial surfaces and maintaining long-term contamination, necessitating strengthened biosecurity measures and systematic monitoring of critical control points [10].

Salmonellosis has particular importance in vulnerable population groups due to a higher risk of severe and invasive disease. In children, especially in settings characterized by high population density and limited resources, significant incidence levels, seasonal patterns, and the role of specific serovars have been demonstrated, along with the influence of environmental and living conditions [11,12]. Asymptomatic carriage and prolonged fecal shedding of non-typhoidal Salmonella among healthy individuals or convalescents may play an important role in sustaining transmission within communities [12,13]. Among adults and older populations, specific risk factors and vulnerabilities have also been identified, underscoring the need for targeted food safety measures and preventive strategies [7].

In Central Asia and Kazakhstan, salmonellosis remains a relevant infectious process that requires integration of epidemiological and veterinary surveillance data. Regional studies confirm the importance of analyzing the epidemic process and improving control measures [14,15]. For the Republic of Kazakhstan, this issue has additional practical significance in the context of Salmonella circulation within the "human–animal–food products" system and documented differences in antimicrobial resistance profiles between isolates of different origins [16,17]. Several studies conducted in Kazakhstan demonstrate the prevalence and resistance of Salmonella enterica in poultry products and at industrial enterprises, highlighting the need for continuous monitoring and strengthened biosecurity measures [17-21]. Local data on the pediatric population of Almaty emphasize the importance of microbiological monitoring within the epidemiological surveillance system [9]. The improvement of preventive and anti-epidemic measures in Kazakhstan is also supported by current regulatory documents that define sanitary and epidemiological requirements and rules for monitoring infectious diseases [22,23].

Thus, salmonellosis should be considered a complex intersectoral problem at the intersection of epidemiology, food safety, and veterinary control. Key determinants include the circulation of dominant serovars, antimicrobial resistance, production-related and behavioral risk factors, and the quality of laboratory confirmation and surveillance systems [1,4,9,10,16]. In this context, an analysis of salmonellosis incidence dynamics in the Republic of Kazakhstan for the period 2013–2024, taking into account age-related characteristics, risk factors, and laboratory monitoring data, is of practical importance for refining prevention priorities and further improving the national epidemiological surveillance system [9,17,22,23].

The aim of this study was to analyze long-term trends in salmonellosis incidence in the Republic of Kazakhstan during 2013–2024, with assessment of temporal dynamics, age-specific, social and occupational characteristics of the epidemic process, as well as to examine the structure of laboratory-confirmed cases and the distribution of Salmonella spp. serotypes based on official sanitary and epidemiological surveillance data.

Materials and Methods.

Study design: The study was conducted as a retrospective descriptive and analytical epidemiological investigation with an analysis of long-term dynamic series of salmonellosis incidence indicators in the Republic of Kazakhstan. The analysis covered overall population trends as well as age-specific patterns and laboratory-confirmed cases.

Data sources:

The study was based on official data obtained through an authorized request from the Branch "Scientific and Practical Center for Sanitary and Epidemiological Expertise and Monitoring" of the National Center of Public Health of the Ministry of Health of the Republic of Kazakhstan.

Two complementary types of data generated within the national infectious disease surveillance system were used.

Case-based epidemiological surveillance data were applied to analyze the incidence of salmonellosis, age-specific and socio-professional distribution, temporal trends, and contact tracing indicators, including the number of identified contacts, examination coverage, and carriage rates among contacts.

Laboratory monitoring data were used to assess laboratory confirmation rates and the distribution of Salmonella spp. serotypes among confirmed cases (Table 4).

Although both datasets originate from the same institution, they differ in scope, purpose, and data structure and therefore are not directly interchangeable.

Study period: The observation period covered 2013–2024 for the analysis of salmonellosis incidence in the total population and age groups.

For selected analytical blocks related to laboratory confirmation, data were available and analyzed for 2014–2024, reflecting the completeness of reporting in the source database.

Object and subject of the study: The object of the study was the system of epidemiological surveillance of salmonellosis in the Republic of Kazakhstan.

The subject of the study included:

- salmonellosis incidence rates in the total population;
- age-specific incidence patterns;
- absolute numbers of registered and laboratory-confirmed cases;
- indicators of laboratory confirmation over time.

Age group classification:

Age stratification was performed in strict accordance with the officially defined reporting structure applied in national epidemiological surveillance. The following age groups were analyzed:

- children under 1 year;

Table 1. *Dynamics of salmonellosis incidence (total population of the Republic of Kazakhstan).*

Year	Incidence per 100,000	Number of cases (absolute)*	Absolute change **	Growth coefficient	Growth rate, %	Rate of increase, %
2013	8.20	1,404	–	–	–	–
2014	8.00	1,397	−0.20	0.98	97.56	−2.44
2015	7.80	1,360	−0.20	0.98	97.50	−2.50
2016	6.70	1,185	−1.10	0.86	85.90	−14.10
2017	6.10	1,099	−0.60	0.91	91.04	−8.96
2018	7.80	1,291	+1.70	1.28	127.87	+27.87
2019	5.60	1,275	−2.20	0.72	71.79	−28.21
2020	2.70	627	−2.90	0.48	48.21	−51.79
2021	2.50	380	−0.20	0.93	92.59	−7.41
2022	4.90	965	+2.40	1.96	196.00	+96.00
2023	4.70	944	−0.20	0.96	95.92	−4.08
2024	4.90	983	+0.20	1.04	104.26	+4.26
Average annual indicators (2013–2024)* **			−0.30	0.955	95.5	−4.5

***Note.** Data presented in Table 1 were obtained from national case-based epidemiological surveillance reports of salmonellosis, aggregated by age groups, provided by the Branch "Scientific and Practical Center for Sanitary and Epidemiological Expertise and Monitoring" of the National Center of Public Health of the Ministry of Health of the Republic of Kazakhstan. These data reflect registered salmonellosis cases used for calculating incidence rates per 100,000 population. The figures in Table 1 are derived from case-based epidemiological reporting and therefore differ from laboratory surveillance data presented in Table 4, which are based on laboratory diagnostic reports and use a different reporting framework and denominator.

** Incidence rates per 100,000 population shown in Table 1 were taken directly from official national case-based epidemiological surveillance reports and are presented as published. These indicators were not recalculated by the authors, as the exact population denominators used in the surveillance system are defined by national reporting methodology and may differ from general demographic estimates. Absolute numbers represent registered salmonellosis cases reported within the same surveillance framework.

*** The average annual growth rate and rate of increase/decrease were calculated as geometric means (CAGR-based), using the first and last values of the series.

Table 2. *Age-specific dynamics of salmonellosis incidence in the Republic of Kazakhstan, 2013–2024.*

Year	Children <1 year			Children 1–2 years			Children 3–6 years			Children 7–14 years			≥15 years		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
2013	28.1	99	376,611	23.6	165	727,944	11.7	154	1,363,368	4.8	97	1,968,589	7.8	889	5,726,851
2014	21.6	77	383,355	22.5	161	741,859	9.0	123	1,421,947	5.6	119	2,054,231	7.2	917	5,695,587
2015	19.0	68	395,938	18.2	133	757,519	12.5	172	1,449,370	6.7	151	2,173,380	6.8	865	5,652,048
2016	14.3	51	395,143	19.0	141	776,655	9.8	139	1,479,651	3.0	70	2,296,686	6.0	784	5,601,878
2017	17.7	63	397,601	17.6	136	788,503	9.4	138	1,511,223	2.7	64	2,419,706	5.3	698	5,553,403
2018	22.0	67	387,133	29.3	192	790,475	14.2	183	1,537,427	4.5	96	2,534,449	6.5	753	5,507,332
2019	12.0	54	394,246	17.8	197	782,791	9.8	186	1,557,543	2.7	77	2,635,989	4.8	771	5,460,923
2020	5.8	26	398,444	9.0	86	778,984	4.8	92	1,562,451	1.3	44	2,743,633	1.9	296	5,417,516
2021	12.5	37	423,283	12.7	80	790,746	4.6	185	1,572,815	1.1	26	2,931,967	1.7	177	5,374,743
2022	13.5	49	442,301	19.0	148	823,082	11.1	172	1,575,888	3.4	100	2,993,505	3.6	496	5,367,122
2023	11.6	42	401,061	18.7	152	864,968	10.1	156	1,601,186	3.8	114	3,027,059	3.4	480	5,366,924
2024	14.9	51	384,763	14.6	117	842,968	8.5	135	1,655,454	3.5	106	3,056,578	4.1	574	5,405,385

Note. For each age group, the following indicators are presented: (1) incidence rate per 100,000 population; (2) number of reported salmonellosis cases (absolute values); (3) population size of the corresponding age group for the given year. Proportion-based trend analysis was performed using these data.

· children aged 1–2 years;
· children aged 3–6 years;
· children aged 7–14 years;
· individuals aged 15 years and older.

Indicators and calculations.

The analysis included:

• incidence rates per 100,000 population, analyzed as officially reported in national epidemiological surveillance data and not recalculated by the authors. Incidence rates by occupational and social groups were obtained directly from official national epidemiological surveillance reports and are presented as reported. The denominators used for these calculations correspond to the population size of each respective occupational or social group, as defined by the national surveillance methodology. Individual denominator values were not available in the aggregated datasets provided to the authors.

• absolute numbers of registered cases;

• population size of the relevant demographic groups, used for descriptive purposes and age stratification only;

• laboratory-confirmed case counts and proportions.

For the assessment of long-term dynamics, the following indicators were calculated:

· absolute change;
· growth coefficient;
· growth rate (%);
· rate of increase (%).

Average annual growth rate was calculated as the geometric mean (CAGR) of the incidence time series using the first and last values: $K\text{ ' avg}' = \sqrt[n-1]{\frac{yin}{y1}} \times 100$. The average annual rate of increase/decrease was calculated as k" avg = K '-100. Average annual absolute change was calculated as $\Delta y\ avg = y_{in}$-y1/n-1.

The average annual absolute change was calculated as the difference between the final and initial values of the time series divided by the number of observation intervals.

The average annual growth coefficient was calculated as the nth root of the ratio between the final and initial values.

Average annual growth and increase rates were expressed as percentages.

These calculations were applied only to absolute and intensive indicators for which such analysis was methodologically justified. Relative proportions (%) were not subjected to average annual growth calculations.

Trend analysis: To assess monotonic temporal changes in proportions, the Cochran–Armitage trend test was applied. For age-specific analyses, annual incidence rates per 100,000 were derived from the ratio of the number of reported cases to the corresponding age-specific population size (case count / population), i.e., as a proportion; multiplying by 100,000 is a linear rescaling and does not affect the direction or significance of the trend. Therefore, the Cochran–Armitage test was used to evaluate whether the proportion of the population with reported salmonellosis changed monotonically over time within each age group. For laboratory surveillance data, the test was applied to laboratory confirmation rates, defined as the proportion of laboratory-confirmed cases among all cases referred for laboratory examination in a given year. The test was not applied to absolute case counts. A trend was considered statistically significant at $p < 0.05$.

The analysis included:

· Z statistic;
· χ^2 value;
· p-value.

A trend was considered statistically significant at $p < 0.05$.

Handling of missing data:

For several indicators, data for individual years were unavailable and marked as “n/a”. These missing values reflected absence of reporting rather than absence of cases.

No data imputation or substitution methods were applied. All calculations were performed only on the basis of available observed data, ensuring that long-term dynamics were not artificially distorted.

Data presentation: Study results were presented using tables and graphical materials.

Tables included absolute values, incidence rates per 100,000 population, laboratory confirmation proportions, and calculated dynamic indicators. Graphs were used to visualize long-term

Table 3. *Summary of average annual salmonellosis incidence rates and temporal trends by age group in the Republic of Kazakhstan, 2013–2024.*

Age group	Mean incidence, 2013–2024 (per 100,000)	Average annual absolute change (per 100,000)	Average annual growth coefficient	Average annual growth rate, %	Average annual increase rate, %	Z (Cochran–Armitage)	χ^2	p-value
Children under 1 year	16.08	−1.20	0.949	94.9	−5.1	−3.28	10.76	0.001
Children aged 1–2 years	18.50	−1.10	0.953	95.34	−4.66	−5.15	26.56	<0.001
Children aged 3–6 years	9.62	−0.29	0.971	97.14	−2.86	−0.71	0.50	0.48
Children aged 7–14 years	3.59	−0.12	0.972	97.17	−2.83	−1.55	2.40	0.12
≥15 years	4.93	−0.60	0.920	92.31	−7.69	−21.46	460.71	<0.001
Total population (RK)	5.83	−0.30	0.955	95.5	−4.5	−3.70	13.66	<0.001

Table 4. *Long-term dynamics of laboratory-confirmed salmonellosis cases and distribution of Salmonella spp. serotypes in the Republic of Kazakhstan, 2014–2024.*

Indicator / Type	2014	2015***	2016	2017	2018	2019	2020	2021	2022	2023	2024	Average annual absolute change	Average annual growth rate	p-value
Total salmonellosis cases referred for laboratory examination**	1397	n/a	2363	2019	1538	1163	645	500	965	944	983	−41.4 cases per year	−3.5% per year	
Laboratory-confirmed cases	1,396	n/a	1,139	1,089	1,227	1,087	625	500	955	927	981	−41.5 cases per year	−3.5% per year	
Laboratory confirmation rate, %	99.9	n/a	48.2	53.9	79.7	93.5	96.9	100.0	99.0	98.2	99.8			Z = +36,12; χ^2 = 1304,92; p < 0,001*
200039 S. Reading	n/a	n/a	6 (0.53)	1 (0.09)	n/a	3 (0.28)	1 (0.16)	1 (0.20)	n/a	n/a	n/a			
200058 S. Typhimurium	59 (4.23)	n/a	59 (5.18)	66 (6.06)	89 (7.25)	57 (5.24)	34 (5.44)	43 (8.60)	32 (3.35)	42 (4.53)	39 (3.97)			
200085 S. Heidelberg	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1 (0.10)	1 (0.11)	n/a			
300042 S. Newport (code 300042)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1 (0.20)	6 (0.63)	1 (0.11)	n/a			
301081 S. Virchow	17 (1.22)	n/a	13 (1.14)	27 (2.48)	29 (2.36)	7 (0.64)	5 (0.80)	3 (0.60)	3 (0.31)	5 (0.54)	11 (1.12)			
302042 S. Newport (code 302042)	34 (2.44)	n/a	24 (2.11)	27 (2.48)	20 (1.63)	6 (0.55)	n/a	1 (0.20)	n/a	n/a	2 (0.20)			
400000 Group D	n/a	n/a	2 (0.18)	20 (1.84)	5 (0.41)	1 (0.09)	4 (0.64)	n/a	1 (0.10)	n/a	n/a			
401030 S. Enteritidis	n/a	n/a	n/a	n/a	880 (71.72)	928 (85.37)	557 (89.12)	435 (87.00)	868 (90.89)	786 (84.80)	830 (84.61)			
401031 S. Blegdam	n/a	n/a	n/a	n/a	1 (0.08)	n/a	n/a	1 (0.20)	2 (0.21)	10 (1.08)	n/a			
401036 S. Dublin	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1 (0.10)	n/a	2 (0.20)			
600000 Rare groups	n/a	n/a	n/a	n/a	85 (6.93)	74 (6.81)	15 (2.40)	9 (1.80)	25 (2.62)	36 (3.88)	27 (2.75)			
700000 Non-typable strains	n/a	n/a	n/a	n/a	n/a	n/a	n/a	4 (0.80)	n/a	17 (1.83)	23 (2.34)			
Other / unspecified serotypes	—	—	—	—	—	—	—	2 (0.40)	16 (1.68)	—	—			

Note: n/a indicates absence of data rather than absence of cases or diagnostics. *Cochran–Armitage trend test. The laboratory confirmation rate for 2014 reflects specific reporting characteristics of the initial surveillance period and is not directly comparable with subsequent years.
**Data for "Total salmonellosis cases referred for laboratory examination" were obtained from annual laboratory diagnostic reports of the Branch "Scientific and Practical Center for Sanitary and Epidemiological Expertise and Monitoring" of the National Center of Public Health of the Ministry of Health of the Republic of Kazakhstan. These figures represent the total number of salmonellosis cases registered within the laboratory surveillance system (i.e., cases referred for laboratory examination), including both laboratory-confirmed and non-confirmed cases, and are used exclusively as the denominator for calculating laboratory confirmation rates. These data do not represent the total number of epidemiologically registered cases and are not intended for incidence calculation.
*** Laboratory surveillance data for 2015 were not available in aggregated form due to differences in reporting structure and coverage during the initial phase of the national laboratory monitoring system. Therefore, 2015 data are marked as "n/a" and were excluded from laboratory trend analyses.

trends and interannual variability of incidence indicators and were presented as line charts reflecting changes over time.

Statistical analysis:

Statistical data processing was performed using: SPSS Statistics, version 26.0; Microsoft Excel 2010.

The study employed descriptive statistics, dynamic series analysis, and trend analysis using the Cochran–Armitage test.

Ethical considerations and study limitations: The study was based on aggregated, anonymized official statistical data and did not require individual informed consent.

Study limitations included:

- incomplete data for certain years and population groups;
- pronounced interannual variability of indicators;
- fluctuations in laboratory confirmation volumes across the observation period, which may have influenced case detection levels.

The study was approved by the Local Ethics Committee of the Kazakhstan Medical University – Higher School of Public Health (protocol number to be specified).

Results.

Dynamics of salmonellosis incidence in the Republic of Kazakhstan (total population)

According to Table 1, salmonellosis incidence in the Republic of Kazakhstan during 2013–2024 demonstrated pronounced interannual variability with an overall decreasing direction. From 2013 to 2017, incidence gradually declined from 8.20 to 6.10 per 100,000 population. A temporary increase was observed in 2018, followed by a subsequent decrease in 2019–2021, reaching the lowest value in 2021 (2.50 per 100,000).

In 2022–2024, incidence levels increased compared with the minimum values but remained below those recorded at the beginning of the study period. Over the entire observation period, the average annual growth coefficient was 0.955, corresponding to an average annual rate of decrease of 4.5% per year.

The presence of a statistically significant linear temporal trend was confirmed using the Cochran–Armitage trend test, which demonstrated a significant downward trend in salmonellosis incidence over time ($Z = -3.70$; $\chi^2 = 13.66$; $p < 0.001$).

Age-specific patterns of salmonellosis incidence (Figure 1 and Table 2)

Figure 1 and Table 2 demonstrate distinct periods of increase and decrease in salmonellosis incidence across age groups in the Republic of Kazakhstan during 2013–2024.

Among children under 1 year, incidence declined from 28.1 per 100,000 in 2013 to 14.3 in 2016, increased to 22.0 in 2018, then decreased to a minimum of 5.8 in 2020, followed by a subsequent rise to 14.9 per 100,000 in 2024.

A similar pattern was observed in children aged 1–2 years, with a decrease from 23.6 in 2013 to 17.6 in 2017, a pronounced increase in 2018 (29.3), a sharp decline in 2020 (9.0), and renewed growth reaching 19.0 in 2022, followed by a decrease to 14.6 in 2024.

In children aged 3–6 years, incidence decreased during 2013–2014, increased in 2015, declined again in 2016–2017, peaked in 2018 (14.2), and reached the lowest level in 2020 (4.8), with a subsequent increase to 11.1 in 2022 and decline thereafter.

Among children aged 7–14 years, incidence increased during 2013–2015, sharply declined in 2016, rose again in 2018, decreased in 2019–2021, and increased in 2022–2023, followed

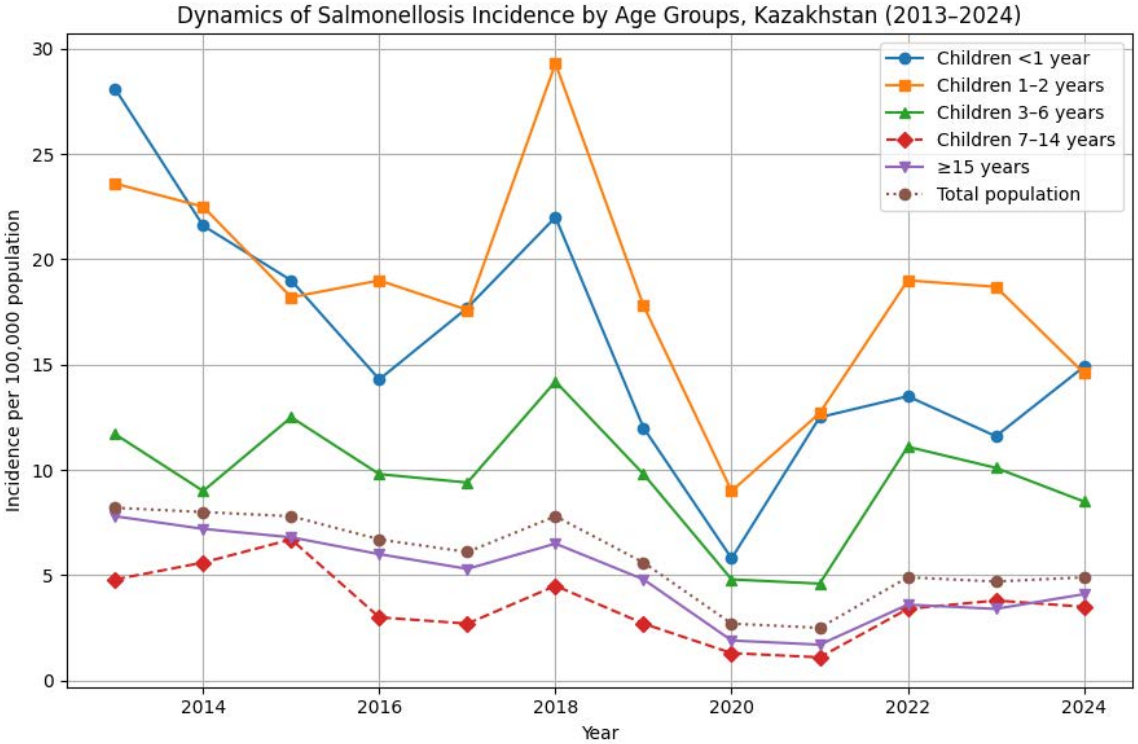

Figure 1. *Trends in salmonellosis incidence by age groups in the population of the Republic of Kazakhstan, 2013–2024.*

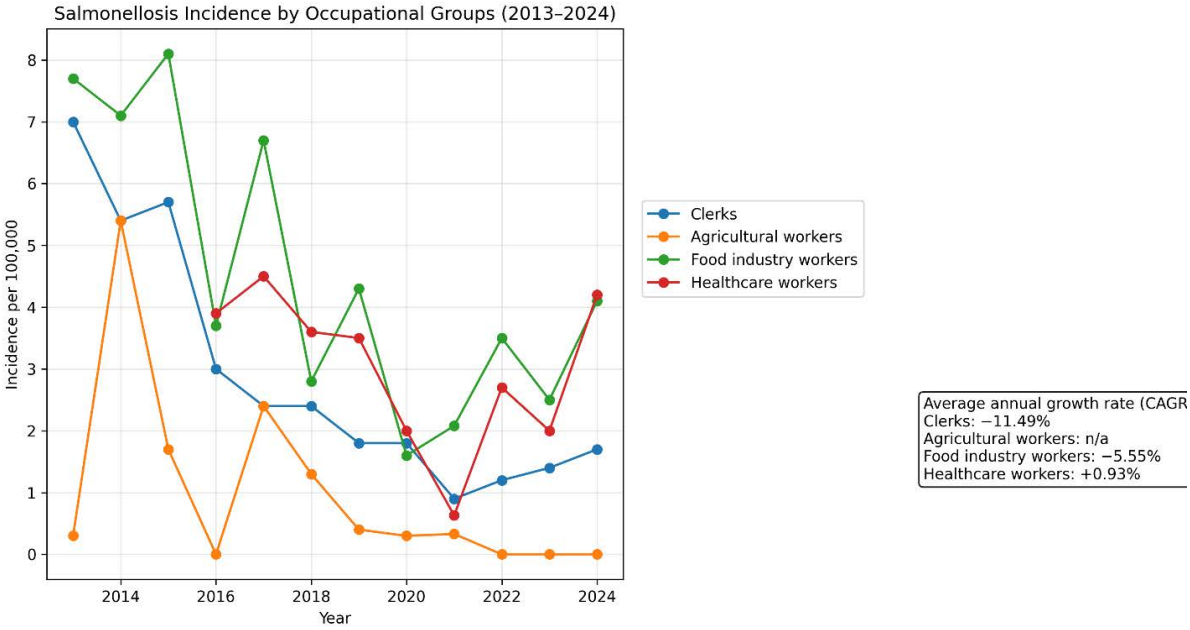

Figure 2. *Incidence of salmonellosis by occupational groups, 2013–2024 (per 100,000 population).*
Note: *The incidence rates shown reflect officially reported values calculated within the national surveillance system and may include zero values in years with no registered cases in specific occupational groups.*

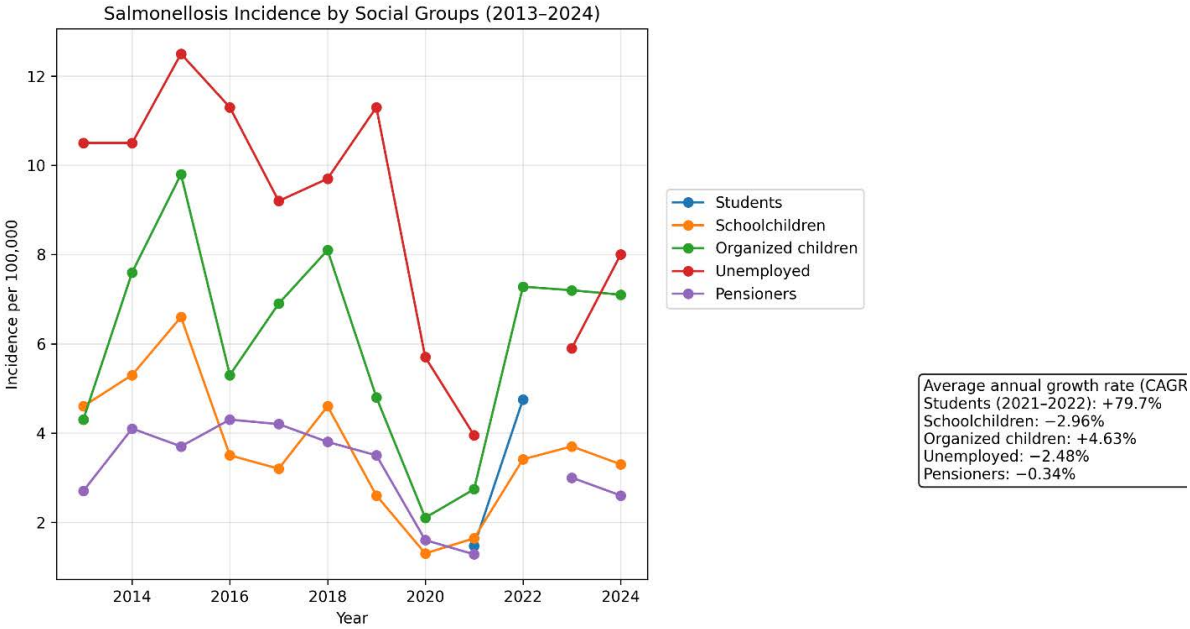

Figure 3. *Incidence of salmonellosis by social population groups, 2013–2024 (per 100,000 population).*
Note: *The incidence rates shown reflect officially reported values calculated within the national surveillance system and may include zero values in years with no registered cases in specific occupational groups.*

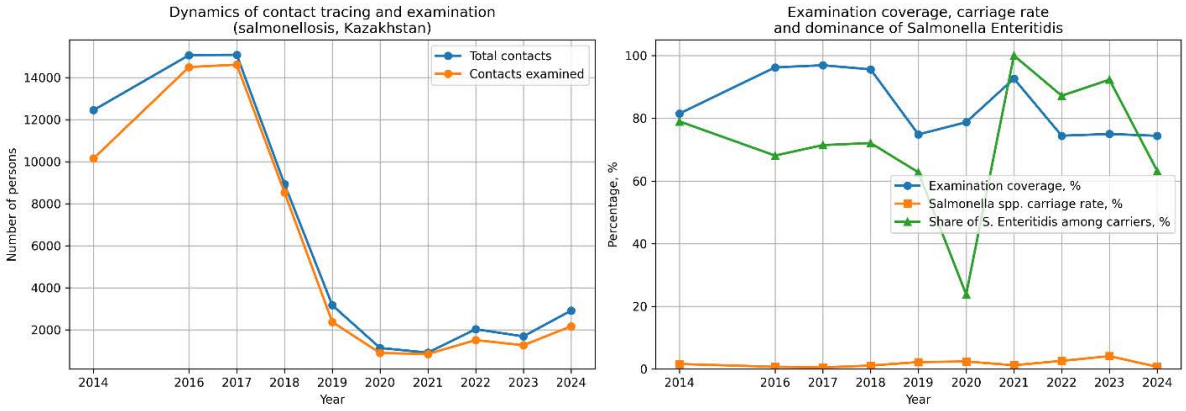

Figure 4. *Dynamics of contact tracing, examination coverage, Salmonella spp. carriage rate and dominance of Salmonella Enteritidis in Kazakhstan, 2014–2024.*

by a slight decrease in 2024.

In individuals aged 15 years and older, incidence decreased steadily from 7.8 in 2013 to 5.3 in 2017, increased in 2018 (6.5), declined to a minimum in 2020 (1.9), and subsequently increased to 4.1 per 100,000 in 2024.

Table 3 summarizes the average annual incidence levels and results of temporal trend analysis. Children under 1 year and children aged 1–2 years demonstrated the highest mean incidence over the study period (16.08 and 18.50 per 100,000, respectively). In both age groups, a statistically significant decreasing linear trend was identified (Cochran–Armitage test: $Z = -3.28$, $\chi^2 = 10.76$, $p = 0.001$ and $Z = -5.15$, $\chi^2 = 26.56$, $p < 0.001$, respectively), despite marked year-to-year variability.

Among children aged 3–6 years and 7–14 years, mean incidence levels were lower (9.62 and 3.59 per 100,000, respectively). Although average annual growth coefficients in these groups were below 1.0 (0.971 and 0.972), the Cochran–Armitage test did not reveal a statistically significant linear temporal trend ($p = 0.48$ and $p = 0.12$), indicating fluctuating incidence without a consistent directional change.

In individuals aged 15 years and older, the mean incidence was 4.93 per 100,000, with a statistically significant decreasing temporal trend ($Z = -21.46$, $\chi^2 = 460.71$, $p < 0.001$). A similar statistically significant downward trend was observed in the total population of the Republic of Kazakhstan ($Z = -3.70$, $\chi^2 = 13.66$, $p < 0.001$).

Overall, the results demonstrate that salmonellosis incidence in Kazakhstan is characterized by substantial interannual variability across all age groups, with statistically significant long-term declines confined to early childhood, adult population, and the population as a whole, while preschool and school-aged children exhibit persistent oscillatory patterns without a significant linear trend.

Figure 2 illustrates the annual dynamics of salmonellosis incidence among major occupational groups in the Republic of Kazakhstan from 2013 to 2024.

Among clerks, incidence was highest at the beginning of the period (7.0 per 100,000 in 2013), followed by a steady decline to 2.4 in 2017 and 1.8 in 2019, reaching a minimum in 2021 (0.9). In subsequent years, a gradual increase was observed, with incidence rising to 1.7 per 100,000 in 2024.

In agricultural workers, incidence demonstrated marked instability. After an increase from 0.3 in 2013 to 5.4 in 2014, values declined sharply, reaching 0.0 in 2016, and remained sporadic thereafter, with isolated low-level peaks not exceeding 0.33 per 100,000 after 2020.

Among food industry workers, incidence increased from 7.7 in 2013 to a peak of 8.1 in 2015, followed by a pronounced decline to 1.6 in 2020. After this minimum, incidence rose again, reaching 4.1 per 100,000 in 2024.

In healthcare workers, incidence data became available from 2016 onward. Values fluctuated between 3.9 in 2016 and 2.0 in 2020, decreased to a minimum of 0.63 in 2021, and subsequently increased, reaching 4.2 per 100,000 in 2024, the highest value recorded for this group.

Figure 3 presents the dynamics of salmonellosis incidence across selected social population groups from 2013 to 2024. Among schoolchildren, incidence increased from 4.6 per 100,000 in 2013 to a peak of 6.6 in 2015, followed by a decline to 3.2–3.5 in 2016–2017. A secondary increase was observed in 2018 (4.6), after which incidence decreased to 1.3 in 2020, with partial recovery to 3.3 per 100,000 in 2024.

In organized children, incidence rose from 4.3 in 2013 to 9.8 in 2015, declined to 5.3 in 2016, and increased again to 8.1 in 2018. The lowest value was recorded in 2020 (2.1), followed by renewed growth, with incidence remaining above 7.0 per 100,000 in 2022–2024.

Among non-working adults, incidence increased from 10.5 in 2013 to 12.5 in 2015, declined to 9.2 in 2017, and reached a secondary peak in 2019 (11.3). A marked decrease was observed in 2020 (5.7), followed by an increase to 8.0 per 100,000 in 2024.

In pensioners, incidence increased from 2.7 in 2013 to 4.3 in 2016, declined to 1.6 in 2020, and subsequently increased to 2.6 per 100,000 in 2024, remaining consistently lower than in other social groups throughout the study period.

Data for students were available from 2021 onward, showing an increase from 1.47 per 100,000 in 2021 to 4.75 in 2022, followed by the absence of registered values in subsequent years.

According to Table 4, the number of laboratory-confirmed salmonellosis cases decreased from 1,396 in 2014 to 981 in

2024, with the lowest value observed in 2021 (500 cases). After this decline, a moderate increase was recorded in 2022–2024.

The proportion of laboratory-confirmed cases increased markedly over time, rising from 48.2–53.9% in 2016–2017 to 79.7% in 2018 and remaining above 93% during 2019–2024. A significant increasing trend in laboratory confirmation was confirmed ($Z = +36.12$; $\chi^2 = 1304.92$; $p < 0.001$).

From 2018 onward, Salmonella Enteritidis predominated, accounting for 71.7% of cases in 2018 and 84.6–90.9% in 2019–2024. Salmonella Typhimurium remained the second most frequently detected serotype, with annual proportions ranging from 3.35% to 8.60%. Other serotypes were identified sporadically and individually accounted for less than 3% of cases per year.

Figure 4 shows the annual dynamics of contact tracing, examination coverage, Salmonella spp. carriage, and the proportion of Salmonella Enteritidis among carriers in the Republic of Kazakhstan from 2014 to 2024.

The number of identified contact persons increased from 12,447 in 2014 to a peak of 15,080 in 2017, after which a sharp decline was observed in 2018–2019 (to 8,926 and 3,164, respectively). The lowest values were recorded in 2020–2021 (1,133 and 910), followed by a gradual increase to 2,913 contacts in 2024, without reaching pre-2018 levels.

A comparable pattern was observed for examined contacts. Their number rose from 10,145 in 2014 to 14,613 in 2017, then decreased markedly to 2,368 in 2019 and 892–843 in 2020–2021, with a subsequent increase to 2,167 in 2024.

Examination coverage was high during 2016–2018 (95.6–96.9%), decreased in 2019 (74.8%), increased again in 2021 (92.6%), and subsequently fluctuated between 74.4% and 75.0% in 2022–2024.

The number of detected Salmonella carriers declined from 157 cases in 2014 to 77 cases in 2017 and 51 cases in 2019, reaching a minimum in 2021 (10 cases). In the following years, carrier detection fluctuated, increasing to 52 cases in 2023 and decreasing again to 19 cases in 2024. The carriage rate varied over time, with higher values observed in 2019–2023 and a lower value recorded in 2024.

Throughout most of the observation period, Salmonella Enteritidis predominated among identified carriers. Its share exceeded 60% in 2014–2019, decreased markedly in 2020, and increased again in 2021–2023, followed by a decline in 2024.

Discussion.

The present study demonstrated that salmonellosis incidence in the Republic of Kazakhstan during 2013–2024 was characterized by a statistically significant long-term decline accompanied by pronounced interannual variability. Over the study period, the incidence rate decreased from 8.20 to 4.90 per 100,000 population, with an average annual rate of decrease of 4.5% per year (geometric mean, CAGR-based), which was confirmed by the Cochran–Armitage trend test ($p < 0.001$). At the same time, this trend reflects a statistical tendency across the entire observation period rather than a uniform or steady decrease in incidence. However, this downward trend should not be interpreted as evidence of elimination of the epidemiological problem, as salmonellosis is a preventable foodborne infection, and the registration of cases indicates the continued presence of the pathogen in the food chain and limitations of preventive measures at the public health level.

The combination of a statistically significant declining trend with marked year-to-year fluctuations indicates instability of the epidemiological situation and a strong dependence of incidence levels on external and systemic factors. Similar patterns have been reported in international reviews, suggesting that for controllable foodborne infections, interannual variability more often reflects changes in surveillance systems, sanitary control, and behavioral factors rather than true elimination of infection sources [1,9,24].

The sharp decline in salmonellosis incidence observed in 2020–2021 coincided with the COVID-19 pandemic and reached minimum values of 2.50 per 100,000 population in 2021. Published data suggest that reductions in reported gastrointestinal infections during the pandemic were largely attributable to restrictive measures, reduced population mobility, changes in eating habits, and decreased case detection due to reallocation of healthcare resources [8,24]. Therefore, the minimum incidence levels recorded during the pandemic period should be interpreted with caution and should not be regarded as indicators of sustained epidemiological improvement or long-term reduction of disease burden.

Throughout the study period, the age-specific structure of salmonellosis incidence was characterized by a consistent predominance of early childhood as the main risk group. Mean incidence rates among children under 1 year and those aged 1–2 years were 16.08 and 18.50 per 100,000, respectively, substantially exceeding the corresponding rate among individuals aged 15 years and older (4.93 per 100,000). The predominance of early childhood as a vulnerable group has been widely described in international studies and is commonly attributed to physiological immaturity of the immune system and high dependence on feeding and caregiving conditions [6,15,24].

In the present study, a statistically significant decreasing trend was identified among children under 1 year and those aged 1–2 years ($p = 0.001$ and $p < 0.001$, respectively), despite pronounced interannual variability. This finding should be interpreted as a relative reduction in reported incidence rather than as evidence of elimination of age-specific epidemiological risks. Similar findings have been reported in other population-based studies, where declining incidence in early childhood has been primarily associated with improvements in sanitation and medical supervision rather than with elimination of fundamental epidemiological risks [8,25].

In contrast, among children aged 3–6 years and 7–14 years, mean incidence levels over 2013–2024 were lower (9.62 and 3.59 per 100,000, respectively), but no statistically significant linear temporal trend was identified (Cochran–Armitage test: $p = 0.48$ and $p = 0.12$, respectively). Persistent oscillations with recurrent increases following minimal pandemic values indicate the absence of sustained improvement in these age groups. These findings suggest that the observed interannual variability outweighs any potential long-term directional change in incidence. Given the role of organized childcare and

school settings in shaping hygiene practices and food-related behaviors, preschool and school-aged children should be regarded as priority targets for systematic sanitary education and preventive interventions, in line with findings from other studies [6,24].

Analysis of occupational groups revealed that workers in the food industry experienced comparatively elevated salmonellosis incidence in certain years, reaching 7.7–8.1 per 100,000 population. Although incidence temporarily declined during the pandemic period (to 1.6 per 100,000 in 2020), a subsequent increase was observed, reaching 4.1 per 100,000 in 2024. The presence of recurrent post-decline increases suggests persistent occupational and production-related risks and indicates that reported cases reflect not only individual susceptibility but also potential systemic deficiencies in sanitary control at various stages of food production, processing, and distribution [7,11].

Among social population groups, higher and more unstable incidence levels were observed among organized children compared with schoolchildren and pensioners. In this group, incidence rates reached 8.1–9.8 per 100,000 population in the pre-pandemic period, declined to 2.1 per 100,000 in 2020, but again exceeded 7.0 per 100,000 in 2022–2024. This pattern highlights the particular vulnerability of organized childcare settings as environments facilitating transmission of enteric infections and underscores the importance of institutional factors, including catering conditions, sanitary regimes, and hygiene education [15,24].

An important finding of the present study is the substantial increase in the proportion of laboratory-confirmed cases, from 48.2–53.9% in 2016–2017 to over 93% in 2019–2024 ($p < 0.001$). This increase reflects improvements in diagnostic practices and alignment with modern requirements of sanitary-epidemiological surveillance [14,23,26]. At the same time, increased laboratory confirmation may influence observed incidence dynamics and requires cautious interpretation of temporal trends.

Differences between the total number of salmonellosis cases registered through epidemiological surveillance and the number of laboratory-confirmed cases observed in the present study reflect the characteristics of the data sources used and do not indicate inconsistencies in the data. Epidemiological surveillance includes all registered cases based on clinical and epidemiological criteria, whereas laboratory monitoring covers only cases in which microbiological testing was performed and laboratory confirmation of the pathogen was obtained.

For example, in 2016, a total of 2,363 salmonellosis cases were registered by the epidemiological surveillance system, while only 1,139 cases were laboratory-confirmed, corresponding to a laboratory confirmation rate of 48.2%. This discrepancy indicates that a proportion of registered cases was not laboratory-tested, was tested outside the optimal diagnostic window, did not yield bacterial growth, or was classified based on clinical and epidemiological evidence alone.

During the COVID-19 pandemic period (2020–2021), epidemiological and laboratory indicators showed closer numerical alignment. In 2021, 380 cases were registered through epidemiological surveillance, whereas laboratory monitoring recorded 500 tested and laboratory-confirmed cases. This convergence reflects pandemic-related changes in surveillance priorities and reporting practices, with increased reliance on laboratory-confirmed cases.

The serovar structure of salmonellosis in Kazakhstan was characterized by stable dominance of Salmonella Enteritidis, accounting for more than 80% of laboratory-confirmed cases in recent years, with Salmonella Typhimurium consistently occupying the second position. This distribution corresponds to international and regional data [1,3,4,9,16,24,27]. Persistence of a stable serovar pattern over time indicates the continued presence of common infection sources, primarily associated with animal-derived food products, and suggests that fundamental epidemiological risks have not been eliminated.

Strengths of the study include a long observation period (2013–2024), nationwide coverage, and the use of official data from the national sanitary-epidemiological surveillance system, ensuring high completeness and reliability of registered salmonellosis cases at the population level.

Limitations.

Limitations of the study are primarily related to the characteristics of the source data. First, the analysis was based on aggregated surveillance datasets, which precluded assessment of individual-level risk factors and stratified analyses beyond the categories defined in official reporting forms. Second, incidence rates per 100,000 population for occupational and social groups were obtained directly from national surveillance reports and were not recalculated by the authors. Information on the exact denominator populations used in these calculations was not available in the aggregated datasets, limiting independent verification and standardization of these indicators. Third, incomplete data for certain years and population groups resulted in missing values, which were treated as absence of reporting rather than absence of cases and restricted the analysis of long-term dynamics for selected indicators. These missing values primarily reflect differences in reporting frameworks and transitional stages of laboratory surveillance implementation rather than true absence of cases. Finally, the absence of molecular typing data for Salmonella isolates limited the ability to assess genetic relatedness of circulating strains and to investigate transmission pathways.

Conclusion.

In conclusion, the observed declining trend in salmonellosis incidence in the Republic of Kazakhstan should be interpreted as a relative improvement in reported epidemiological indicators rather than as resolution of the problem. The findings reflect changes in surveillance intensity, diagnostic coverage, and external factors, including the COVID-19 pandemic, rather than a consistent long-term reduction in infection risk. Salmonellosis remains an indicator of vulnerabilities in the food safety system and population sanitary culture. The results support the need to shift the focus from case registration toward prevention, including strengthening food chain control, implementing systematic sanitary education of the population, and prioritizing preventive interventions in organized childcare settings and occupational risk groups.

Conflict of Interest.

The authors declare no conflict of interest.

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სალმონელოზის ეპიდემიოლოგიური ტენდენციები ყაზახეთის რესპუბლიკაში: ეროვნული მონაცემების ანალიზი (2013-2024)

ფონი: სალმონელოზი კვლავ რჩება საზოგადოებრივი ჯანმრთელობის მნიშვნელოვან პრობლემად, რაც მოითხოვს მუდმივ ეპიდემიოლოგიურ მონიტორინგს საიმედო მეთვალყურეობის მონაცემების საფუძველზე.

მიზანი: 2013-2024 წლებში ყაზახეთის რესპუბლიკაში სალმონელოზის შემთხვევების გრძელვადიანი ტენდენციების ანალიზი, დროებითი დინამიკის, ასაკობრივი სპეციფიკური ნიმუშების და ლაბორატორიული დადასტურების ინდიკატორების შეფასებით ოფიციალური მონიტორინგის მონაცემების საფუძველზე.

მასალები და მეთოდები: რეტროსპექტიული ეპიდემიოლოგიური ანალიზი ჩატარდა ყაზახეთის რესპუბლიკის ეროვნული ეკონომიკის სამინისტროს სანიტარული და ეპიდემიოლოგიური ექსპერტიზისა და მონიტორინგის სამეცნიერო და პრაქტიკული ცენტრის მიერ მოწოდებული აგრეგირებული ლაბორატორიული მეთვალყურეობის მონაცემების გამოყენებით. შემთხვევების მაჩვენებლები გაანალიზდა მთლიანი მოსახლეობისა და განსაზღვრული ასაკობრივი ჯგუფებისათვის. გრძელვადიანი დინამიკა შეფასდა აღწერითი სტატისტიკის, საშუალო წლიური ცვლილების ინდიკატორებისა და კოქრან–არმიტაჟის ტენდენციის ტესტის გამოყენებით.

შედეგები: 2013-2024 წლებში ყაზახეთის რესპუბლიკაში სალმონელოზის შემთხვევათა რაოდენობამ სტატისტიკურად მნიშვნელოვანი გრძელვადიანი კლება გამოავლინა (ცვლილების საშუალო წლიური მაჩვენებელი, CAGR: -4.5% წელიწადში; $p < 0.001$), რომელსაც თან ახლდა მკვეთრი მრავალწლიანი ცვალებადობა. ამ ტენდენციაზე დიდი გავლენა მოახდინა covid-19 პანდემიის პერიოდში (2020-2021) დაფიქსირებული შემთხვევების მკვეთრმა შემცირებამ. ინციდენტობის ყველაზე მაღალი მაჩვენებელი თანმიმდევრულად დაფიქსირდა 1 წლამდე ასაკის ბავშვებსა და 1-2 წლამდე ასაკის ბავშვებში, რომლებშიც სტატისტიკურად მნიშვნელოვანი კლების ტენდენციები დაფიქსირდა ($p \leq 0.001$). 3-6 წლის და 7-14 წლის ასაკის ბავშვებში არ გამოვლენილა მნიშვნელოვანი ხაზოვანი დროებითი ტენდენციები ($p > 0.05$), რაც მიუთითებს ცვალებად შემთხვევებზე დროთა განმავლობაში თანმიმდევრული მიმართულების ცვლილების გარეშე. ლაბორატორიულად დადასტურებული შემთხვევების პროპორციამ აჩვენა სტატისტიკურად მნიშვნელოვანი ზრდის ტენდენცია დროთა განმავლობაში ($p < 0.001$).

დასკვნები: სალმონელოზის შემთხვევები ყაზახეთის რესპუბლიკაში აჩვენებს სტატისტიკურად მნიშვნელოვან გრძელვადიან ვარდნის ტენდენციას მუდმივი მრავალწლიანი რყევებით, რაც უნდა განიმარტოს covid-19 პანდემიის დროს მეთვალყურეობის ინტენსივობისა და ჯანდაცვის გამოყენების ცვლილებების კონტექსტში.ადრეული ბავშვობა რჩება ყველაზე დაზარალებულ ასაკობრივ ჯგუფად, ხოლო სკოლამდელი და სასკოლო ასაკის ბავშვებში მნიშვნელოვანი დროებითი ტენდენციების არარსებობა მიუთითებს სტაბილურ შემთხვევათა დონეზე დროთა განმავლობაში და მხარს უჭერს ამ პოპულაციებში ეპიდემიოლოგიური მეთვალყურეობის გაგრძელების აუცილებლობას.

საკვანძო: სალმონელოზი, სიხშირე, ეპიდემიოლოგიური მეთვალყურეობა, დროებითი ტენდენციები, ასაკობრივი ჯგუფები, ლაბორატორიული დადასტურება, ყაზახეთის რესპუბლიკა.