Potential Risks of Selected Pathogens in the Czech Republic

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Bachelor's thesis
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Zásady pro vypracování

1. Zpracujte z dostupných zdrojů teoretický vstup do problematiky potenciálních rizik vybraných patogenních agens.
2. Charakterizujte současný způsob opatření u vybraných patogenních agens v České republice, která snižují míru zdravotního rizika u populaci.
3. Navrhněte edukační materiály ke zlepšení povědomí o ochraně osob před závažnými nemocemi.

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1. BENCKO, Vladimír. *Hygiene and Epidemiology*. Praha: Karolinum, 2020. ISBN 978-80-246-4313-7.
2. *Krizové řízení při nevojenských krizových situacích, ochrana obyvatelstva, kritická infrastruktura: modul A; C; I. 2*. Praha: Ministerstvo vnitra, 2021. ISBN 978-80-7616-097-2.
3. ROZSYPAL, Hanuš. *Základy infekčního lékařství.* Druhé, upravené vydání. Praha: Univerzita Karlova, nakladatelství Karolinum, 2023. ISBN 978-80-246-5443-0.

Další odborná literatura dle doporučení vedoucí bakalářské práce.

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ABSTRAKT

Bakalářská diplomová práce se zaměřuje na popis aktuální epidemiologické situace v České republice a vyhodnocuje potenciální rizika globálních vlivů na šíření patogenních agens, jakožto původců infekčních nemocí.

Teoretická část práce se věnuje základním charakteristikám infekčních chorob a jejich původcům. Dále jsou zmíněny principy epidemiologické surveillance a krizového řízení při šíření infekčních nemocí. Nedílnou součástí teoretické části práce je rešerše odborných zdrojů, která pomohla operacionalizovat jednotlivé globální vlivy, které mohou ovlivňovat šíření nemocí.

Praktická část popisuje aktuální epidemiologickou situaci v České republice metodou syntézy informací z oficiálních národních zdrojů. Pomocí kvalitativní analýzy vybraných parametrů je identifikováno aktuálně nejvíce rizikové patogenní agens v České republice. Patogen je dále podroben multikriteriální analýze rizik, jejímž podkladem jsou odborné zdroje z vědecké databáze Web of Science.

Výsledkem hodnocení epidemiologické situace v České republice je výběr infekčních chorob s narůstající incidencí a vyhledání relevantních argumentů, které vysvětlují negativní trend. Rešerše oficiálních zdrojů rovněž poskytuje informace ke konkrétním principům a dopadům posuzovaných globálních vlivů na veřejné zdraví v České republice. Multikriteriální analýza rizik potvrdila vliv 4 z 5 globálních vlivů na šíření vybraného onemocnění a poukázala na největší riziko, kterým je v tomto případě antibiotická resistence.

Klíčová slova: epidemiologické hodnocení, infekční nemoci, globální vlivy

ABSTRACT

This bachelor's thesis focuses on the description of the current epidemiological situation in the Czech Republic and evaluates the potential risks of global influences on the spread of pathogenic agents, as the causative agents of infectious diseases.

The theoretical part of the work is devoted to the basic characteristics of infectious diseases and their causative agents. The principles of epidemiological surveillance and crisis management during the spread of infectious diseases are also mentioned. An integral part of

the theoretical part of the work is the scrutiny of professional sources, which helped to operationalize individual global influences that can affect the spread of diseases.

The analytical part describes the current epidemiological situation in the Czech Republic using the method of synthesis of information from official national sources. The next method is the qualitative analysis of selected parameters. The output of the analysis is the identification of the currently most high risk pathogenic agent in the Czech Republic. The pathogen is then subjected to a multi-criteria risk analysis based on expert resources from the scientific database Web of Science.

The result of the evaluation of the epidemiological situation in the Czech Republic is the selection of infectious diseases with increasing incidence and the search for relevant arguments that explain the negative trend. The search of official sources also provides information on the specific principles and impacts of assessed global influences on public health in the Czech Republic. Multicriteria risk analysis confirmed the influence of 4 out of 5 global influences on the spread of the selected disease and pointed to the biggest risk, which in this case is antibiotic resistance.

Keywords: epidemiological assessment, infectious diseases, global influences

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I hereby declare that the print version of my Bachelor's thesis and the electronic version of my thesis deposited in the IS/STAG system are identical.

CONTENTS

INTRODUCTION

With the discovery of vaccination and subsequently the discovery of antibiotics in 1928, it seemed that the era of deaths caused by infectious diseases was finally over (Votava, 2001). The enormous progress meant millions of lives saved and at the same time it provided an impetus for greater development of non-infectious epidemiology. However, this period did not last for long, and new viral infections and even bacterial strains with resistance to antibiotics began to appear. Active epidemiological surveillance and the associated rapid dealing with emerging infections have proven to be essential in maintaining public health.

In the Czech Republic, this activity is carried out at a very high level mainly by institutions established under the Ministry of Health (National Institute of Public Health, Institute of Health Information and Statistics, Hygienic Stations), under the Ministry of Agriculture (State Veterinary Administration, Food Inspection) and other components of the state apparatus (Státní zdravotní ústav, 2024). These institutions process data from mandatory reports and performed inspections. The data are listed in non-public registers, the public has only selected outputs and ready-made analyses. Nevertheless, there is relatively large scope for assessment of the epidemiological situation and possible risks, for example by a qualitative analysis from available official sources.

Although current medicine and allied fields are at a very high level, the recent SARS-CoV2 pandemic has shown that the risk of the unstoppable spread of diseases and the problems of insufficient capacity to treat are still a problem of the 21st century. The recent pandemic has also demonstrated the deep connection between the spread and treatment of disease with social and natural phenomena. Continuous evaluation of the epidemiological situation regarding to other seemingly non relevant influences is key to preventing emergence or stopping the disease’s spread early on.

The research question of the bachelor’s thesis is uttered as: can current global influences affect the incidence of selected infectious diseases in the Czech Republic?

The main aim of the bachelor's thesis is to describe current epidemiological situation in the Czech Republic and evaluate the risks of global influences on the spread of selected pathogenic agents in the Czech Republic.

The partial aim of the bachelor´s thesis is to prepare an educational material to improve awareness of infectious diseases.

Methods to achieve the aim are the research of relevant sources, qualitative analysis, multicriterial risk analysis and synthesis of results.

The author of the thesis has chosen this topic because of a broad concept that combines multidisciplinary knowledge and at the same time responds to current issues. The benefit of the work may be a different concept of evaluating the epidemiological situation, which is not based on the analysis of numerical data, but on the contrary, provides a broad overview of knowledge from the professional literature in accordance with the principles of evidence-based medicine.

I. THEORY

1 RESEARCH STRATEGY

The aim of the bachelor's thesis is to define and describe potential risks of selected pathogenic agents in the Czech Republic in the context of current problems of public health (global influences which affect public health). The research problem relates to the increasing incidence of less common infections in the Czech Republic and little-known aetiology of their emergence, which may also include global problems that affect the public health situation.

Based on the research problem a PICO analysis was carried out, which produced following results:

- **P (population):** residents of the Czech Republic, vulnerable individuals (especially children, the elderly, and people with low immunity).
- **I (intervention):** public health problems which could affect the incidence of infectious diseases.
- **C (comparison):** interventions in public health and crisis management in public health.
- **Outcome:** determination of the influence of public health problems on the risk of occurrence of selected infectious diseases in the Czech Republic.

The PICO analysis determined the following research aims:

The main aim of the literature research work is to identify and describe potential influences that could affect the occurrence and spread of pathogenic agents which lead to incidence of infectious diseases.

The aims of the literature research work were operationalized into key words: infectious diseases AND public health AND spread factor OR emergence factor. These key words were applied into research work, whose goal was to find the main general factors influencing the spread of infectious diseases in the population.

Firstly, databases of scientific sources were selected for the research activity. For these purposes online databases freely accessible to students of the Tomáš Bata University in Zlín were chosen. Due to the largest range of accessible resources and the user-friendly search functions The Web of Science and Scopus databases were chosen. Inclusion criteria were set for sources from 2014 - 2024 to ensure the most up-to-date knowledge was consulted. Furthermore, only resources from peer-reviewed journals and with an open access

approach were included. Exclusion criteria were set ~~as~~ to exclude sources in languages other than Czech and English, qualification theses, duplicate sources, and irrelevant sources.

Table 1 Research strategy

Database	**Web of Science**
Key words	• Infectious diseases OR pathogenic agents AND public health AND spread factor OR emergence factor
Results	• 206 results • 4 relevant sources
Database	**Scopus**
Key words	• Infectious diseases OR pathogenic agents AND public health AND spread factor OR emergence factor
Results	• 2 392 results • 6 relevant sources

The conducted research work and following selection of sources brought 10 relevant articles. Those articles contributed to answering the research question: what general factors related to the field of public health affect the spread of pathogenic agents and therefore the emergence of infectious diseases.

Research work revealed recurring factors influencing the emergence and spread of infectious diseases. Factors that were repeated 2 times or more in scientific sources were included in the analysis of this bachelor's thesis.

The following factors are listed: climate change, misinformation, antibiotic resistance, migration, and human-animal interference.

Table 2 Results of research work – review

Tittle	Year of publication	country	Type	Factors
Heat waves accelerate the spread of infectious diseases	2023	China	Original study	• Climate change
Understanding misinformation infodemic during public health emergencies due to large-scale disease outbreaks: a rapid review	2023	Germany	review	• Misinformation • Disinformation
Antimicrobial Resistance: A Growing Serious Threat for Global Public Health	2023	Malaysia USA Saudi Arabia	review	• Antibiotic resistance
Whether Urbanization Has Intensified the Spread of Infectious Diseases—Renewed Question by the COVID-19 Pandemic	2021	China	Original study	• Urbanization • migration
Ecological Barrier Deterioration Driven by Human Activities Poses Fatal Threats to Public Health due to Emerging Infectious Diseases	2019	China	review	• migration • climate change • human/animal interferences
Implications of human activities for (re)emerging infectious diseases, including COVID-19	2020	Japan	review	• Globalisation • Migration • Climate change • Antibiotic resistance • Human-wild animal interface • Behaviour changes
Emerging Challenges and Opportunities in infectious Disease Epidemiology	2019	USA	review	• Antibiotic resistance
Analysing the link between public transport use and airborne transmission: mobility and contagion in the London underground	2018	UK	Original study	• migration
Interplay between epidemic spread and information propagation on metapopulation networks	2017	Japan	Original study	• Awareness • Misinformation • Disinformation
Understanding and predicting the global spread of emergent infectious diseases	2015	Germany	Original study	• migration

There were identified and established major global issues that affect the spread of infectious diseases by this process. The practical part of this bachelor's thesis is focused on risk analysis of these global issues in the Czech Republic. The exact methodology is listed in the practical section.

2 PATHOGENIC AGENTS AND THEIR RELATIONSHIP WITH INFECTIOUS DISEASES

Pathogens from Greek *pathos – suffering* and *gen - producer* (Casadevall, Pirofski, 2014) are organisms that may cause a disease to their hosts (Balloux, Dorp, 2017). The word pathogen has been used commonly since the late 1800s and it is used in relation to infectious diseases as their originators (Casadevall, Piforski, 2014). Therefore, the main risk of pathogenic agents is their potential to cause infectious diseases in a varied range.

Infectious diseases from *lat. infectus-insert* (Silva, 1997) differ from other diseases by external agents or their toxic products that are the etiological cause of the disease. There is a typical transmission from another person, animal, plant, or reservoir. The transmission path can be direct or indirect with an intermediate host. Infectious diseases are therefore also called contagious or communicable diseases. However, this definition may not be suitable for all cases. An infectious pathogen may be just the trigger of the disease and may no longer be present in the host when the disease is fully developed. On the contrary, some pathogens can be the trigger of the disease, although in their normal state they are part of the natural microbiota of healthy individuals (natural colonization of the organism) (Straif-Bourgeois et col., 2014).

The infectious process plays a key role in the pathogenesis of the disease. The main elements of this process are an external pathogenic agent, a susceptible individual (host) and the environment in which the agent and host meet (Rozsypal, 2023). In some literature, this process is also called the epidemiological triangle. While in other literature, this process is described more generally as the most important factors for the spread of infection: the source of infection, the route of transmission and the susceptible individual (Bencko et al., 2019). All definitions emphasize these three basic aspects to the spread of the disease.

However, other factors can be added to the infectious process, and they can significantly affect the emergence of the disease, route of transmission and further spread of the disease. These selected influences will be specifically addressed in the following chapters.

Infectious diseases can be divided according to the original habitat of the causative agents. Diseases transmissible from human to human are called anthroponoses. Zoonosis is a disease whose source of infection is an animal and sapronoses are an atypical species,

whose source of infection is an inanimate substrate (soil, water, decomposing organic residues, etc.) (Rozsypal, 2023). Each category of the listed diseases is caused by a diverse spectrum of pathogenic agents, belonging to all developmental stages of living organisms or organic substances.

2.1 Infectious disease agents

The characteristics of pathogenic organisms play an important role in the spread of diseases. In modern epidemiology, the following characteristics of pathogens are considered: Virulence (the ability to cause disease depending on the number of pathogenic particles) and pathogenicity (the ability to cause disease depending on the characteristics of the pathogen as such). Within pathogenicity, the following other associated properties can be observed, toxicity (ability to harm the host), invasiveness (ability to enter the host), adherence (adhesion to the host), penetration (ability to penetrate the host's cells or overcome immunity strategies, especially antiphagocytic mechanism) and the ability to spread quickly and multiply (Bednář, 1996; Kayser et col., 2005).

On the broadest scale, specific causative agents of diseases are organic substances. Thanks to our current understanding of microbiology agents, such as prions or viruses that cannot be clearly classified as living microorganisms, are known. The list of infectious disease agents is therefore as follows (Straif-Bourgeois et col., 2014; Kayser et col., 2005):

- subcellular biological entities – prions and viruses,
- prokaryotic microorganism – chlamydia, rickettsia, mycoplasmas, bacteria, and their toxins, archea,
- eukaryotic microorganisms – fungi and protozoa,
- animals – helminths and arthropods.

The following part will focus on each category of these agents.

2.1.1 Subcellular biological entities

These entities are the smallest known agents which can affect infectious disease. Their size is under 200 nm and are observable by electron microscope (Kayser et. col., 2005). Subcellular biological entities are viruses, prions, and viroids, but only viruses and prions can cause human or animal infectious disease, therefore viroids cause only plant diseases.

a) Prions

The full name for prions is proteinaceous infectious particles. It follows that prions are agents composed of a protein molecule. This molecule in its physiological, not pathological form, is a natural part of the brain and it is important for sleep and long-term memory (Rozsypal, 2015). Prions are pathological forms of the protein that cause degenerative changes in the central nervous system by changing the spatial arrangement of molecules in their surroundings (Kayser et. col., 2005; Rozsypal, 2023).

Current medicine describes five diseases caused by prions: Gerstmann-Straussler-Scheinker disease, Fatal familial insomnia, Sporadic fatal insomnia, Kuru disease and Creutzfeldt-Jakob disease (CJD), in veterinary medicine known as bovine spongiform encephalopathy (BSE). The last disease is the most common infection caused by prions, but still, it is a very rare disease (Krombholz, 2014). Current incidence (not prevalence) of CJD is approximately 1 patient per million people (Krombholz, 2014; Rozsypal, 2023).

Emergence of CJD is possible in 3 forms: Autoimmune form, hereditary form and the most important for infectious epidemiology, interpersonal transmission. This form of transmission is often caused by iatrogenic damage during transplantations, from contamination of surgical instruments. Another form of transmission is ingestion of poorly prepared food (poorly prepared beef from cows infected by BSE). The disease manifests as progressive dementia with a long incubation period that can last many years. After the onset of symptoms, myoclonus and ataxia occur. Diagnosis is difficult and depends on a combination of neurological examination with imaging techniques and laboratory analysis of cerebrospinal fluid. CJD has an inauspicious prognosis (Rozsypal, 2023; Krombholz, 2014). Incidence of CJD in the Czech Republic was 36 cases in 2023 (Státní zdravotní ústav ČR, 2024), but in the late 1980s and 1990s there was ~~a~~ large outbreak of the disease in the United Kingdom from infected beef, that caused the deaths of 178 people (The University of Edinburgh, 2024). The CJD epidemic outbreak led to more accurate food and veterinary controls, that have also proved useful for when other zoonotic diseases have occurred (Bird flu, Foot and Mouth Disease etc.).

b) Viruses

Viruses are non-cellular organisms composed of a DNA or RNA chain and a protein envelope (capsid). Some viruses contain an additional lipid envelope. The lipid envelope may play an important role in the ability to spread and interact with therapeutic agents. Viruses behave as living organisms only in their host, in whose cells they are capable of reproduction either by the lytic or lysogenic cycle. A virus particle is called a virion. The number of virions required to cause disease defines virulence (Kayser et. col., 2005).

Viruses that attack humans are divided into 28 families according to their characteristics (genome, capsid morphology, envelope, etc.). The most well-known of them are, for example, retroviruses (HIV) or coronaviruses (SARS-CoV2) (Siegel, 2018).

The SARS-CoV-2 virus, which causes the disease Covid19, is one of the most epidemiologically significant viruses that society has faced in recent years. SARS-CoV2 is a circular-shaped enveloped RNA virus with a distinct envelope which resembles a crown (Yao et. col., 2020). The primary and secondary attack rate of SARS-CoV2 varies between 40-50 % in households, with the highest attack rate value achieved by the Omicron variant (42.7 %) (Baker et. col., 2022; Madewell et col. 2022; Rothan, Byrareddy, 2020).

Symptoms of Covid19 could be very variable, but primarily respiratory problems prevail. The Centers for Disease Control and Prevention (2024) currently describes 11 main symptoms: fever or chills, cough, shortness of breath or difficulty breathing, fatigue, muscle or body aches, headache, new loss of taste or smell, sore throat, congestion or runny nose, nausea or vomiting, diarrhoea.

The incubation period depends on the variant, but symptoms may appear from 2 to 19 days after exposure to the virus. The transmission route is typical for respiratory diseases, i.e., droplet transmission through the air, touching contaminated surfaces, or interpersonal contact. Diagnosis of Covid19 is based on clinical image and antigen or more accurate PCR testing. The disease may have very mild development but can also cause serious health issues with chronic consequences, known as ‘Long Covid’ (Centers for Disease Control and Prevention, 2024; Rothan, Byrareddy, 2020). The incidence of Covid19 in the Czech Republic was 175 433 cases in 2023 (Státní zdravotní ústav ČR, 2024).

2.1.2 Procaryotic organisms

Procaryotic organisms are probably the oldest living organisms on planet Earth. Procaryotic organisms have a single cell, without an ability to build tissue structures, but still capable of connecting into chains or clusters. The cells are composed of a procaryotic nucleoid (one haploid molecule of DNA freely stored in the cytoplasm) and plasmids, ribosomes, cytoplasmatic membrane, cell wall, capsule, or outer membrane. Some cells may have attachment (pili, flagellum) or chloroplasts (cyanobacteria). Procaryotic organisms are classified as: bacteria, rickettsia, archaea, chlamydia, and cyanobacteria. The cyanobacteria are not directly pathogenic for humans (cyanobacteria chemicals may cause allergic reactions or digestive problems) and therefore they are not so important regarding infectious epidemiology (Clark, Pazdernik, 2013; Kayser et. col., 2005).

a) Bacteria

Bacterial cells are between 0.3 and 5 μm in size and have three basic forms: cocci, straight rods, and curved or spiral rods. Microbiologists have described about 5500 species of bacteria to date, but it is predicted that hundreds of thousands of species exist on Earth. Not every bacterium is pathogenic to humans or animals, many live in an environment without the need for a living host. Bacteria are capable of their own metabolism and reproduction by division. The evolution of bacteria is dependent on random genetic mutations or recombination (conjugation, transformation, or transduction by using a bacteriophage). A very important ability of bacteria is sporulation – a process of adaptation for survival in adverse conditions. Spores (results of sporulation) can survive for long periods of time in certain environments or surfaces and still can become active and cause infections (Kayser et. col., 2005).

Characteristics are often used for bacterial classification, namely their shape, cluster type and cell wall. Cocci, rods, spirals are identified, next, according to the type of chain or cluster, diplococci, tetracocci, streptococci, staphylococci and sarcina are further distinguished (Votava, 2001). The next most commonly used differentiation of bacteria is by Gramm staining, which verifies the cell wall thickness. Using this procedure, the bacteria can be identified as either gram-negative or gram-positive (Kayser et col., 2005; Votava, 2001).

The best way to treat bacterial infections is to use antibiotics. Due to the overuse of these drugs and the continuous evolution of bacteria, some of them are beginning to develop

antimicrobial resistance. Antimicrobial resistance is one of the biggest health threats for the future and could lead to the uncontrolled spread of infections (Centers for Disease Control and Prevention, 2022).

One of the most serious diseases caused by a resistant strain of bacteria is an infection by Methicillin-resistant Staphylococcus aureus (MRSA). It is most commonly a nosocomial infection that occurs in health care providers, medical facilities, wards, and operating rooms. Colonization without clinical manifestation is common in up to 40% of the population and is part of the human microbiota. Clinical manifestations range, depending on the route of transmission and the immune condition of the host, from a mild infection of the skin and soft tissues to an acute invasive disease (pneumonia, osteoarticular infections, toxic shock syndrome) with high lethality (Turner et col., 2019; Lee et col., 2018). The diagnostic method is primary microbiological with use of clinical samples (sputum, blood, deep tissues, discharge, swabs) to phenotypic method testing (cultivation and reaction of the sample to the marker antibiotic) or non-phenotypic methods (use of modern spectrometry). Preventive screening of MRSA occurrences in medical facilities is very important. Laboratory testing of samples from the environment, patients and even healthcare providers should be standard hygienic-epidemiological practice in all healthcare facilities (Lee et col., 2019; Peterson, Diekema, 2010). Incidence of MRSA infection (accessible statistic is only for 'Toxic shock syndrome') in the Czech Republic was 8 cases in 2023, but another clinical manifestation may have a greater incidence (Státní zdravotní ústav ČR, 2024). MRSA infection is one of many examples of the increasing risk of antimicrobial resistance.

b) Rickettsiae

The organism is by the structure very similar to bacteria. Rickettsiae exist in size 0.3 – 1 μm and in some literature is divided to following branches: Rickettsia, Ehrlichia, Coxiella, and Bartonella. Rickettsiae are obligate intracellular parasites, which attack cells of reticuloendothelial system, and they could be transmitted only by living vectors (lice, ticks, fleas, etc.). In the past, rickettsiae were classified as a bacteria, nowadays scientists believe that rickettsia could be a separate branch of a predecessor of bacteria (Baron, Walker, 1996; Kayser et. col, 2005). Rickettsiae causes two groups of diseases: spotted fever (Rocky Mountain spotted fever, Boutonneuse fever etc.) and typhus (Epidemic typhus, Murine typhus) (Kayser et col., 2005). Fever diseases are typical with rapid high increase of fever, headache, and sometimes atypical pneumonia. Symptoms of Typhus diseases include high

fever and headache, but typically exanthema occurs. Both types of diseases could be lethal, but they can be cured by antibiotic therapy (Rozsypal, 2023; Nicholson, Paddock, 2023). Diseases of Rickettsiae are more common in exotic countries, so the Czech Republic has a very low incidence. The Czech offices for disease surveillance monitor only Q fever and item named 'other rickettsiosis' with in total 7 cases in 2023 (Státní zdravotní ústav ČR, 2024). It can be assumed, that the cases were imported from abroad, so the incidence is caused by migration.

c) Chlamydiae

Similar as Rickettsiae, Chlamydiae are obligate intracellular parasites. Chlamydiae have the ability to reproduce only in certain human host cells, so their metabolism is like viruses, because they behave as a living organism only in a host. Nevertheless, their size is bigger than viruses and ranges-between 0.3 μm – 1 μm. Some species of Chlamydia are in a normal amount a natural part of human microbiota, while some species can cause infections. The life cycle of Chlamydiae exists in two stages: elementary bodies (infectious, nonreproductive) and initial bodies (non-infectious, reproductive) (Kayser, 2005).

The main branches of diseases caused by Chlamydiae are urogenital infections, trachoma (conjunctivitis), pneumonia and psittacosis (also called ornithosis). The most often type of the infection are the urogenital, that are transmitted by intercourse. The most important disease is psittacosis, transmitted as a zoonosis by birds, cats or sheep. Psittacosis's symptoms are like influenza, high fever or pneumonitis with hepatomegaly and splenomegaly. Chlamydiae react well to antibiotics, but the course may take at least two weeks. Incidence of Chlamydiae infections (general infections, conjunctivitis by chlamydia, psittacosis) in the Czech Republic was 1822 cases in 2023 (Státní zdravotní ústav ČR, 2024).

d) Archea

Archea organisms have a different cytoplasmatic membrane, cell wall, genome, and some metabolic processes than bacteria cells. The organisms live in extreme conditions (for example deep-sea volcanic plumes) (Kayser et col., 2005) and they are not important for infectious epidemiology. Although some studies shows that some species of Archea participate in human or animal intestine microbiota (Samuel, Gordon, 2006).

2.1.3 Eucaryotic organisms

Eucaryotic organisms have the most developed cell, which can coexist as a single cell, cluster, or complex tissues. Eukaryotic cells have different nucleus, cytoplasmatic membrane, and cell organelles (ribosomes, endoplasmic reticulum, Golgi apparatus, mitochondria, lysosome etc.) which are typical for a plant (they also contain for example vacuoles and chloroplasts) or animal cell (Kayser, 2015). Epidemiologically significant are primarily fungal and protozoic diseases. Infections caused by multicellular organisms (Enterobiasis etc.) usually do not cause a severe health threat in the Czech Republic.

a) Fungi

The greatest awareness and interest regarding fungi in infectious epidemiology was brought about by the popular series 'The last of Us', which caused a fear of fungal infections. Currently more than 50 000 fungi species are known, but only approximately 300 can cause disease in humans. Fungal infection occurs usually because of immunodeficiency (Kayser et. col., 2005).

Infections caused by fungi could be listed as diseases of the skin and nails, diseases of urogenital and digestive tract (candidiasis), fungal eye infections, health care-associated fungal meningitis, mycetoma (granulomatous inflammation of the lower limbs) and respiratory diseases caused by inhalation of fungi or their spores (Coccidioidomycosis, Aspergillosis etc.). The most common diseases are candidiasis and skin and nail fungal infections, that are not usually serious and do not lead to severe health damage. Infections related to fungal inhalation are not very common in the Czech Republic, but they are typical for endemic places, especially in particular states in the USA (Centers for Disease Control and Prevention, 2020). However, climate change may lead to emergence of these infections in Czech Republic as well. Recorded incidences of fungal infections in the Czech Republic was 358 cases (Dermatophytosis, another surface mycosis, Pneumocystis) in 2023 (Státní zdravotní ústav ČR, 2024).

b) Protozoa

Protozoa are a very important group of potentially pathogenic organisms. This group of organisms has a fully developed eukaryotic single cell that can be free living or parasitic. A lot of parasitic protozoa have a complex cycle of development that includes various hosts, and their spread is often connected to a vector (Kayser et col., 2005). Protozoic agents may

cause an alimentary infection, that are a serious problem for public health in developing countries without the correct hygienic practices or without access to clean drinking water. Other protozoa are dependent to animal species – which act as vectors, that can carry protozoic cells (for example mosquito of Anopheles species). Climatic change can lead to the spread of invasive non-native species with protozoic infections to currently unaffected areas.

Probably the most serious and expanded disease caused by protozoa organisms is Malaria. Epidemiological data from World Health Organisation (WHO, 2023) states that there were an estimated 249 million cases and 608 000 deaths caused by malaria in 85 countries in the year 2022.

Malaria is caused by a protozoic parasite g. plasmodium that needs two hosts for its life cycle – a mosquito and a human. The mosquito sucks infected blood, and its digestive system allows the first form of protozoa (gametocytes) to evolve to the secondary form with a sexual phase of multiplication (sporozoites). The mosquito again sucks the blood of a healthy host and infects them by its saliva. The new human host is infected in the blood and liver, where sporozoites evolve to the adult phase (merozoites) and attack erythrocytes. This process leads to erythrolysis (Center for Disease Control and Prevention, 2020; Rozsypal, 2023). The incubation period of Malaria is usually 10 – 15 days after the mosquito bite. The most common symptoms are tiredness and fatigue, impaired consciousness, multiple convulsions, difficulty breathing, dark or bloody urine, jaundice, abnormal bleeding, nausea and later the very typical periodic fever. Diagnosis is provided by clinal image and laboratory diagnostic (evidence of plasmodia, PCR testing), therapy is based on antimalarial drugs and symptomatic therapy. Prevention of Malaria consists of mosquito reservoirs disposal, using physical and chemical equipment against mosquitoes (nets, clothing, repellents etc.) and antimalarial prophylaxis (chemoprophylaxis, vaccine) (WHO, 2023). Another important disease caused by protozoa that occurs even in the Czech Republic is Toxoplasmosis, that is dangerous primarily for pregnant women, and Leishmaniosis, which is also as Malaria transmitted by phlebotomists, and its visceral form can be lethal (Rozsypal, 2023). All the mentioned diseases are observed by Czech health office statisticians and all of them can be affected by migration, urbanisation, and climate change. Incidence of Malaria in the Czech Republic was 42 in 2023, Toxoplasmosis 84 cases in 2023 and Leishmaniosis 2 cases in 2023 (Státní zdravotní ústav ČR, 2024).

c) Animals

The last and the most developed group of pathogenic agents are parasitic animals. Parasitologists simply describe two main branches: helminths (parasitic worms) and arthropods (parasitic "insects", that can be considered as a disease on its own or can be a vector for another disease) (Kayser et col., 2005). From the epidemiological point of view arthropods are the most important and historically well-known vector of serious diseases (plague, epidemic typhus etc.). In the Czech Republic, less serious but more widespread are helminth's infections by ringworms, nematodes, tapeworms, or fluke. Prevention is very simple – good hygienic practise, access to clean water, correct preparation of food. The incidence of the most common helminth´s disease (enterobiasis) was 1043 cases in 2023. Arthropods are represented by scabies and pediculosis disease and there were 9 127 recorded cases in 2023 (Státní zdravotní ústav ČR, 2024). The very low incidence of pediculosis (60 cases) may be caused by cases going unreported.

2.2 Spread mechanisms and progress of infectious diseases

The mechanisms of the spread of particular infectious diseases are dependent on the type of disease. Generally, there are five types of disease differentiated by the method of transmission (Polanecký, Göpfertová, 2015; Bencko et al., 2019):

- Respiratory diseases can affect all or part of the respiratory tract, and they are usually spread by droplets in either the air or surfaces. Respiratory diseases, depending on how virulent they are, may be the most dangerous, with the most rapid spread through a susceptible population because of this mechanism of spreading.
- Alimentary diseases usually affect the digestive tract, or sections of it, but it is not a condition. The principle of the spread of alimentary diseases is transmission by contaminated food or water. This type of disease is most common in developing countries, with poor hygienic standards or poor access to clean drinking water and can have very serious consequences to public health. This does not mean, however, that these diseases are not common in the Czech Republic, as there can be contamination from poorly prepared food at home or in public restaurants. The most common alimentary disease worldwide is campylobacteriosis with an estimated incidence around 1.5 million cases every year (Centers for Disease Control and Prevention, 2021). Spread of these diseases can be quite easily stopped, by

finding the pathogenic agent and stopping the transmission path. Alimentary diseases do not have a pandemic potential in the Czech Republic due to access to clean water, strict food regulations and primary epidemiology-hygienic surveillance.

- Sexually transmitted diseases affect a wide spectrum of human systems, starting with the urogenital to the immune and others. This type of disease is also epidemiologically important, especially in developing countries, but transmission can be easily stopped. The main risk of these diseases are non-manifested patients or carriers who can spread the disease. Responsible sexual behaviour is therefore the best prevention.
- Arthropods transferred are diseases in which external parasites play a role (lice, fleas, mosquitoes etc.). Similar to sexually transmitted diseases, these infections may affect practically all human systems. These diseases are very significant in developing and tropical countries, where they can cause a lot of serious health issues. In the Czech Republic, there are not many cases. But there is a historical precedence of plague transferred by fleas in the middle of the 14th century and the beginning of the 18th century (Svoboda, 1995).
- Sapronosis are the last category of diseases classified by method of transfer. These diseases survive and reproduce in non-living substrate and susceptible individuals can become infected by direct contact through damaged or broken skin, mucous membranes or by ingestion. A typical example of sapronosis is tetanus (Bencko et. al., 2019; Polanecký, Göpfertová, 2015).

In infectious epidemiology several specific indicators are considered that indicate lethality, effectivity of spread by reproduction number or infectivity by attack rate of infectious disease (Kretzchmar, Wallinga, 2010).

- Lethality is the proportion of dead sick people to the total number of all sick people.
- Reproduction number (infectiousness index) is the amount of people who can get infected by one sick individual.
- Attack rate expresses the number of sick from the total number of susceptible persons exposed to the pathogenic agent (Kretzchmar, Wallinga, 2010).

The higher the reproductive number and attack rate, the faster the spread of the disease. In both indicators, the incubation period and transmission routes play an important role. Every infectious disease has hugely variable incubation periods

and symptoms that may manifest themselves very differently depending on the individual host. However, there are general aspects that describe almost every disease and follows the infectious process which has been described previously.

Contagion is possible by 2 means of transmission: direct and indirect. Direct transmission is via contact (touching, saliva exchange, intercourse, biting, scratching), via droplet route (talking, coughing, sneezing), via transplacental route and perinatally (during birth). Indirect transmission requires a mediator between the source of infection and the host. The mediator could be a contaminated vehicle (surface, equipment), vector (mosquito, fleas), or alimentary vehicle (food, water) (Bencko et al. 2019; Straif-Bourgeois et al., 2014). In some literatures further division of types of indirect transmission are mentioned – biological transmission (biological vector is needed) and mechanical transmission (biological vector is not necessary, but may occur) (Van Seventer, Hochberg, 2017).

Infectious pathogenic agent can enter a host by ingestion, inhalation, inoculation (intrusion directly into blood stream) and tissue contact. The response of the host depends on the immune system, virulence, infectious dose, and pathogenicity. A host´s organism is protected by physiological barriers (skin, mucous membranes), immune system and the last defence is inflammation (Rozsypal et al., 2023; Bencko et al., 2019).

Before the infection is fully manifested and established there are 2 stages of disease which are recognised: the incubation period (the time before first symptoms occur) and the stage of prodromal, nonspecific symptoms. After the disease is fully manifested there are the stages of disease manifestation, convalescence, and recidivism (not always present). The infection may be manifested by symptoms as inapparent (without symptoms, but infested), partly manifested (subclinical – atypical symptoms, abortive – weak symptoms), clinical form of infection (all or most of the symptoms are typically manifested) (Bencko et al., 2019; van Seventer, Hochberg, 2019). An individual host as a source of the disease may be in all the mentioned stages of an infection. The carrier is an individual host with asymptomatic progress of disease but still can infect other individuals (Bencko et. al., 2019). Infestation is a state, when the pathogenic agent is in the host´s organism, but it does not reproduce (Rozsypal et al., 2023).

2.2.1 Main determinants of the host susceptibility

The main aspects, that increase the susceptibility of the host are malnutrition and immunodeficiency. Malnutrition is related to immunodeficiency because it may lead to morbidity and decrease the immune functions. In addition, alimentary infections that attack the digestive system may be a huge problem for individuals with malnutrition (for example diarrheal disease may have a bigger effect in nutrition lost). Immunodeficiency is typical for children without a fully developed immune system, for the elderly with comorbidities and for individuals with congenital or acquired immunodeficiency (van Seventer, Hochberg, 2017). Other factors are current lifestyle and habits (sleep, smoking, eating habits, alcoholic abuse, etc.) and mental state, because psychological influences can significantly somatise in the course of illnesses and thus negatively affect them (Bencko et al., 2019). The previous experiences of an organism with the pathogenic agent are also important, therefore one of the best prophylaxes is vaccination. Non-vaccinated individuals are exposed to a much higher risk than vaccinated persons (van Seventer, Hochberg, 2017).

3 CRISIS MANAGEMENT DURING THE SPREAD OF INFECTIOUS DISEASES

A fundamental measurement in crisis management of infectious diseases is prevention in the primordial and primary levels that contains population behaviour (healthy lifestyle, compliance with healthcare providers, accepting public health measurements etc.), and public health policy (vaccination strategy, health care providing strategy, science, and research etc.). The way of population behaviour in health topics depends on health literacy, that is generally low in the Czech Republic (Kučera, Šteflová, 2016).

The main goal of infectious epidemiology is a state of eradication, meaning there is a permanent reduction to zero in the worldwide incidence. Only smallpox is currently considered as an eradicated disease worldwide (since 1980), but there are more diseases that scientists are working to eradicate. The main principles for eradication are accessible tools for interruption of transmission of agents (for example vaccination), accessible tools for exact and specific diagnosis, no natural reservoir for the agents (pathogenic agents do not survive in vertebrates or do not amplify in the environment) (Dowdle, 1999; Straif-Bourgeois et col., 2014). A lesser state of eradication, but still the goal of epidemiologists, is state of elimination. Elimination is a reduction of the incidence in a defined geographical area. In the Czech Republic, poliomyelitis and rabies are eliminated, and the elimination of measles was very close until an outbreak in 2019 (Straif-Bourgeois et col., 2014; Český statistický ústav, 2024).

There is one major way to achieve the elimination (or even eradication) which is building an individual and collective immunity. Individual immunity consists of non-specific resistance, which is defined by the hereditary defence factors of the person (physical condition, internal body composition), natural (non-specific) immunity is based on the natural behaviour of cells (phagocytes etc.) and natural processes (cytokines, inflammatory processes etc) without a system´s knowledge of the particular pathogen. Specific immunity is related to previous experience of cells and humoral system with the pathogen. Specific immunity can be obtained by transplacental transmission or via breastfeeding, by contact with a specific pathogen (experiencing an illness) or by administration of vaccines (Bencko et. al., 2019).

Collective immunity is an optimal state when most of the population is immune to infectious disease. Effective proportion of immune persons in population ranges between

85-98 % because this amount should stop the transmission of disease to immunodeficient persons (Bencko et. al., 2019). Building the collective immunity is one of the main preventive measurements against infectious disease in the Czech Republic.

3.1 Preventive measurements in the Czech Republic

Measures against infectious diseases spread are in responsibility of worldwide institutions (World Health Organisation, Centers for disease control and prevention etc.), national institutions (Ministry of Health, National Institute of Public Health etc.) and regional institutions (regional hygienic stations).

The strategy of these institutions against infections spread are practically identical. The most important is the surveillance of infectious diseases that contains incidence, prevalence, hospitalization, and mortality reporting. For these purposes national registers of infectious diseases exist (for example ARI - Acute Respiratory Infections register, or ISIN – informational system of infectious diseases), but in emergency situations there is a crisis information system Pandemie, which helps in the rapid spread of an epidemic (ÚZIS ČR, 2024). Qualitative monitoring of diseases is also important, primarily the observation of clinical manifestation, ways of transmission and all the new scientific knowledge about the disease. Another aspect of the strategy is supporting the education of epidemiologists and increasing competences of laboratories. Specific attention requires an intervention in the centre of the infection, that is an essential mission of epidemiologists. The intervention contains searching for contacts, regulation of quarantine or isolation and epidemiological analysis (Česká společnost pro epidemiologii a mikrobiologii, 2007). The measurements are mentioned in the Czech legal norms: 258/2000 Coll. Public Health Protection Act, respectively Act No. 167/2023 Coll. amending Act No. 258/2000 Coll., on the protection of public health and on the amendment of certain related laws, as amended, and other related laws. Other legal norms are mentioned in the following chapters.

Probably the most effective strategy to achieve selected infectious diseases safely is a vaccination. Vaccination in the Czech Republic is mandatory (Decree No. 537/2006 Coll. on vaccination against infectious diseases), and it is mostly organized by vaccination calendar that starts in early childhood. Vaccination is divided by the type at regular (based on vaccination calendar), special (for medical workers etc.), extraordinary (in situations with high risk of infections), in the focus of infection, at own request (before travelling,

commercial vaccines etc.) (Geizerová, 1995). Decree No. 537/2007 Coll. commands vaccination against 9 diseases: diphtheria, tetanus, pertussis (whooping cough), invasive disease caused by Haemophilus influenzae b, poliomyelitis, viral hepatitis B, measles, rubella, mumps and in children at risk against tuberculosis.

3.2 Epidemic and Pandemic

Despite these measures, we have witnessed the uncontrolled spread of infectious diseases several times in recent years. Perhaps the most serious was the recent epidemic of SARS-CoV2, but the epidemics of bird flu, SARS, MERS, and others are also worth mentioning.

In infectious epidemiology, 4 types of incidences of diseases are identified (Bencko et al., 2019; Straif-Bourgeois et col., 2014):

- Sporadic incidences are isolated cases without any known connection to other patients.
- Endemic incidence is sporadic or local epidemy in an isolated area, usually related to increase of zoonotic diseases in natural reservoirs.
- Epidemic is incidence of disease in limited time and area but with higher incidence that is usually regular or expected.
- Pandemic is a high incidence of disease in wide area without geographical limitations.

All these types of incidences are determined by time range.

3.3 Crisis management of Epidemic, Pandemic

Crisis management in situations of epidemic and pandemic has one main goal that is stopping the epidemiology process (the transfer in the mentioned epidemiologic triangle). There are three main ways of achieving this, which should ideally be combined (depending on disease type): destroying the source of infection (isolation and treatment of the sick, destruction of environmental reservoirs – for example puddles with mosquito larvae; destruction of animal sources), destroying the etiological agent in environment - on a larger scale can be called decontamination (disinfection, disinsection, deratization, sterilization) and increasing the resistance of susceptible population (vaccination, prophylactic therapy) (Bencko et. al., 2019). It is known from recent experience, that isolation of individuals is not effective only for suspected or confirmed sick, but the general restriction of interpersonal

contact played a significant role in reducing transmission. The reason was spread from carriers, persons in the incubation period or infested persons without manifested symptoms who were not aware of previous significant contact with the infected.

Crisis management of epidemic or pandemic could be classified as preventive measures and measures in outbreak.

- **Preventive measures** consist of systematically increasing hygiene levels and health literacy of the population, vaccination, evidence and control of carriers, preventive disinfection, and border protection (controls at entry points to country).
- **Measures in epidemic/pandemic outbreak** are usually repressive and are based on the interruption of the epidemic triangle. At first, the most important is to know the pathogenic agent and dispose of exact diagnostic tools. New and ongoing occurrence of disease must be reported and monitored. Patients with significant presence of pathogenic agent must be isolated and their contacts must be in quarantine. Anti-epidemic regime requires active searching for sick and their contacts (suspected infected individuals), medical monitoring of patients and the focus of infection disinfection (or measures that leads to a higher frequency of disinfection). Passive or active immunisation or chemoprophylaxis (if they are accessible) is another method to stop the spread of disease, as is education and checking the basic hygiene processes of the population. Evaluation of these measures during and after the pandemic/epidemic is very important for development of spread and future experience (Bencko et. al., 2019).

3.4 Population protection in pandemic

The crisis management in epidemic/pandemic outbreak is always very closely connected to correct cooperation with other sectors and depends on effective synergy across integrated rescue system, industry, healthcare providers, legislators etc. The main function in crisis management in pandemic has Ministry of Health of the Czech Republic and it leans mainly on following legislative standards: the Constitution of the Czech Republic, 258/2000 Coll. Public Health Protection Act, 372/2011 Coll., on health services and conditions for their provision (Fišer, 2006), Act No. 94/2021 Coll. Act on extraordinary measures during the epidemic of the disease COVID-19 and on the amendment of some related laws and a package of crisis laws related to crisis management during pandemics. The basic

concepts for crisis management in pandemic are Security strategy of the Czech Republic and Health 2030 – Strategic framework for the development of healthcare in the Czech Republic until 2030.

The main document with specific procedures for pandemic crisis management in the Czech Republic is Pandemic Plan of the Czech Republic from 2011 that is prepared by the Commission to address serious threats to public health with potential cross-border impacts (epidemiological commission). It is the fourth edition, and the new update is still in progress, even after SARS-CoV2 pandemic (Ministry of Health, 2024). The Pandemic plan (2011) is focused on flu viruses which have the biggest pandemic potential, and it is inspired by WHO documents. The main goals of the plan are:

- strengthening the national early warning system for early detection of possible disease caused by a pandemic strain,
- rapid identification of a new variant of the flu virus in poultry, birds, or other animals,
- rapid capture of the emergence of a new subtype of influenza virus in the population,
- minimizing the spread of the new virus and preventing a pandemic, if possible,
- continuous evaluation of the epidemiological situation, analysis of incidence, acceptance of immediate anti-epidemic measures,
- securing the treatment of the sick and treatment of complications,
- ensuring the burial of the dead,
- ensuring the information of healthcare workers and the public,
- control of compliance with recommended measures,
- reducing the impact of the flu pandemic on society,
- minimizing economic losses.

A key role in crisis management of pandemic is the cooperation between government, healthcare sector, essential public services sector, media, civil organizations and associations, individuals, and their families. Government coordinates and issues a regulation, and it is represented by the central epidemiological commission. Their members are representatives from Ministry of Health, the main hygienist of the Czech Republic, representatives from Ministry of School, Police presidium, Ministry of Finance, Ministry of

Defence, Ministry of Foreign Affairs, Ministry of Local Development, Ministry of Agriculture, National Institute of Public Health, Ministry of Justice, Ministry of Transportation, Administration of state material reserves, General Directorate of the Fire and Rescue Service, Ministry of Interior, Association of Regions of the Czech Republic and Ministry of Industry and Trade (Ministry of Health, 2024). The function of the commission is to prepare measures that include the functioning of the state in all levels in limited conditions for stopping the spread of disease.

These measures apply to the healthcare sector, regions, and all citizens. Regions play an important role in crisis management in communication, declaring a state of emergency, preparing on regulation measures, providing the essential services in region etc. The health care sector further provides health care, surveillance, and education. The sector of essential public services must provide basic services for the functioning the society and the provision of basic life needs (Pandemic plan, 2011). These procedures are further concretely anchored in Type plans for crisis situations.

The components of the integrated rescue system are also involved in crisis management during pandemics and epidemics. Their task is primarily practical solutions to specific situations. During the SARS-CoV2 pandemic, they participated in patient transport, crisis communication (telephone emergency call centre 112), testing, building decontamination sites and field hospitals. Their involvement is also trained in Joint type activities: 11/IZS Bird Flu, 16A/IZS An extraordinary event with a suspected occurrence of a highly contagious disease in a medical facility or other premises, 16B/IZS. An extraordinary event with a suspected occurrence of a highly contagious disease on board an aircraft landing at Prague Ruzyně Airport (HZS, ČR, 2024). The integrated rescue system helps to apply anti-epidemic measures at the level of specific regions or at the state level.

The system of crisis management in population protection in the Czech Republic is very complex linked to many legal regulations and includes other supporting documents. Coping with the pandemic depends on adequate preparation, effective coordination of all involved components and citizens, and ongoing evaluation of measures. The recent SARS-CoV2 pandemic provided us with a lot of experience to draw on when preparing an updated pandemic plan.

4 PUBLIC HEALTH PROBLEMS IN RELATION TO THE SPREAD OF DISEASES

There are not only natural aspects that contribute on spread of pathogenic agents, a lot of social influences, often related to health policy, participate on occurrences of contagions. On local level of the Czech Republic is society mostly affected by the need for at least a partial reform of the healthcare system, including the reimbursement system. The need is related with a lack of medical staff, shortages of medications, general dissatisfaction among health professionals etc. The Czech Republic is not the only country which suffers with local troubles in healthcare, but there are global problems in global health that affect health state of population worldwide. There are a lot of variable influences, based on the previous research strategy will be mentioned the five main topics: climate change, misinformation, antibiotic resistance, migration, and human-animal interference. It is very important to mention, that all listed topics are very close related and synergic between each other.

4.1 Climatic change

Climatic change is a global problem that penetrates every aspect of life of all living organisms. Although this topic is most often related to ecological impacts, the real consequences are everywhere, including human health.

Migration of non-native species and the ability to survive in new conditions is one of the highest risks, that fears public health specialist around the world. The speed of possible migration is faster that building collective immunity and adapting the healthcare system to new or exotic diseases. Interventions in biodiversity, agriculture, or water supply due to the reaction on climatic change may result to contact with reservoir full of infectious pathogens and open a new transmission way to host by a creeping way or through natural disasters (Sabin et col., 2020).

Foreign studies brought another important view on influence of climatic change to spread of diseases that is strictly pragmatic. High temperature leads to decrease of physiological resilience and changes in human behaviour. People search places to cooling off and they gather in public places. That behaviour brings a high concentration of risk of infectious disease spread (Liam et col., 2023). Hot weather forces people to use a public traffic instead of their own movement which again concentrates people in one place (Goscé,

Johansson, 2018). Using an air-conditions in buildings or public transport also introduce a huge reservoir for infectious aerosol that may be spread in hot days (Liam et col., 2023).

Climatic change, by its own, is a negative effect, but may also bring some positives in spread of diseases. Increasing temperature, lower humidity and higher number of sunny days may inhibit virus activity, decrease virulence or even UV lighting destroy virus aerosols (Liam et col., 2023).

4.2 Migration

Migration may be considered as a very close topic to climatic change and as a result of it. Climatic change leads to motion of microorganisms, plants, animals, and people either. All of these poses a high risk of introducing diseases into a susceptible population. Almost every world pandemic was caused by migration of workers, salesmen, soldiers etc. New level of globalisation and technological progress brought an extreme risk of infectious diseases spread in extreme short time due to the travel possibilities and open borders. For example, the plaque from 14th century Black Death pandemic achieved a speed of 3-5 km/day, the bird flu, H5N1 pandemic in 2009 progressed a few hundred km/day (Brockmann, 2015). The speed of SARS-CoV2 would be even faster. The risk is getting higher by considering the risk of non-regulated mutation of some diseases for every type of susceptible population. Respiratory diseases with incubation period longer than hours are a ticking bomb in modern globalized world because these patients may spread the disease literally in many countries through interpersonal contact, surfaces, or air condition in means of public transport (Sabin et col, 2020, Goscé, Johansson, 2018). But there is another opinion, that brought Chinese study from 2021 (Yu et col., 2021). Although migration is one of the biggest reasons of infectious diseases spread, often can migration provide better health care, access to more effective medicines, or simply escape from the focus of the disease (Yu et col., 2021).

4.3 Human-animal interference

Human society coexists with animals since time immemorial which brings with it the risk of contagion for both, people, and animals too. Approximately 75 % of infectious diseases, that attacks human individuals, are zoonosis. Current studies show that climatic changes and agricultural behaviour related to these changes prepare an ideal source for new or re-emerging diseases. Animal domestication facilitates the animal-human or animal-animal transmission and offers a condition to mutation for more of susceptible hosts (Sabin et col.,

2020). Although the overspill of human and animal pathogens were always common, nowadays, in vulnerable environment full of climatic change, globalization, antimicrobial resistance etc., is the risk of new emergence very high (Lewnard, Reingold, 2019). Some opinions of epidemiologists say that HIV or Ebola virus developed from animal disease and the transmission was through poorly prepared food. They are not only haemorrhagic fevers, that case a huge fear. The attention of scientists and healthcare professionals focuses on infections from the flu virus that have a natural reservoir in flying animals (birds, bats) and which have a pandemic potential because of virus characteristic and because of easy mobility of vectors. The ecological barriers from these animals are continually destroyed by human activity, so the natural territory of animals begins to merge with urbanized and inhabited environment (Zhang et col., 2019).

4.4 Antimicrobial resistance

Resistance of pathogens to antibiotics may be one of the biggest problems of public health in coming decades. Antibiotics have saved millions of lives from infectious diseases caused by procaryotic organisms or fungi diseases and current society cannot imagine suffering or even to worry about life because of common infections or in developed countries eliminated infections as tuberculosis, gonorrhoea etc (Lewnard, Reingold, 2018). However, some predictions are relentless. Building the antimicrobial resistance has taken years and it was affected by selection pressure to the pathogens because of increasing usage of antibiotics medicine. It was not only the high usage, but also inappropriate prescribing patterns that lead to wrong application to insensitive pathogens that contributed to resistance. Another reason is very low controlled and restricted using of antimicrobials in livestock production. A high dose of antimicrobials in environment causes the need of pathogens to adapt for new conditions (Salam et col., 2023, Sabin et col., 2020).

Antimicrobial resistance is a real problem which may occur in next few years and may affect people, animals or even plants. It has been estimated, that up to 700 000 people dies every year due to antimicrobial resistance (Sabin et col., 2020). Consequences of antimicrobial resistance may be enormous in public health, food industry and society in general.

4.5 Misinformation

Misinformation are strictly social phenomena, but still very dangerous not only in connection of infectious diseases spread. Misinformation is false information that is spread without goal of manipulation of people. In contrast, disinformation is a false information created to influence the largest possible group of people (National Library of Australia, 2024). although the spread of misinformation and disinformation is now much easier thanks to modern technology, this is nothing new. False information related to public health flowed through society, for example, since the first inoculation against smallpox. But the greatest misfortune caused the Anti-vax campaigns in the 20th century, and effects of these campaigns were obvious even during the SARS-CoV2 pandemic, when people declined anti pandemic measures, vaccination or even denied the existence of Covid19 (Mesa, Franco, 2020; Rocha et col., 2023). An original study from 2017 proved that individuals with incorrect information have up to 50 % higher risk to catch the infection in pandemic than individuals with correct information (Wang et col., 2017; Chowdhury et col., 2023). Anti epidemic measures and vaccination denying are the most dangerous aspects of pathological behaviour that affect the whole society with the most vulnerable individuals. Adequate communication with people, increasing health and informational literacy and support of real professionals and scientists are the way how to prevent misinformation or disinformation spread.

The chapter listed five factors that globally influence public health and the spread infectious diseases. All of them are related and coexist in small or bigger synergy with thousands of other factors that build a complex system. Damage of public health is relatively easy and there is a huge task for society and individuals to protect it, primarily by prevention. One of the way of prevention may be a risk analysis, which is applied in this bachelor thesis.

II. ANALYSIS

5 AIMS AND METHODS OF THE ANALYSIS PART

For the realisation of the analysis part of the bachelor's thesis and achievement of set aims were chosen following methods: research of professional sources, data collection from professional sources, analysis, and synthesis.

Research of professional sources was performed from official health institutions of the Czech Republic which provide epidemiological surveillance. Data collection from professional sources was performed in databases Scopus, Web of Science, official clinical guidelines, and official clinical recommendations supported by professional societies. For analysis was used multifactor risk analysis, the exact approach of risk analysis is described in following chapters.

The research question is: can current public health problems affect the incidence of selected infectious disease that occurs in the Czech Republic?

The main aim of the bachelor´s thesis is to describe current epidemiological situation in the Czech Republic and set out diseases with the current highest risk of spread.

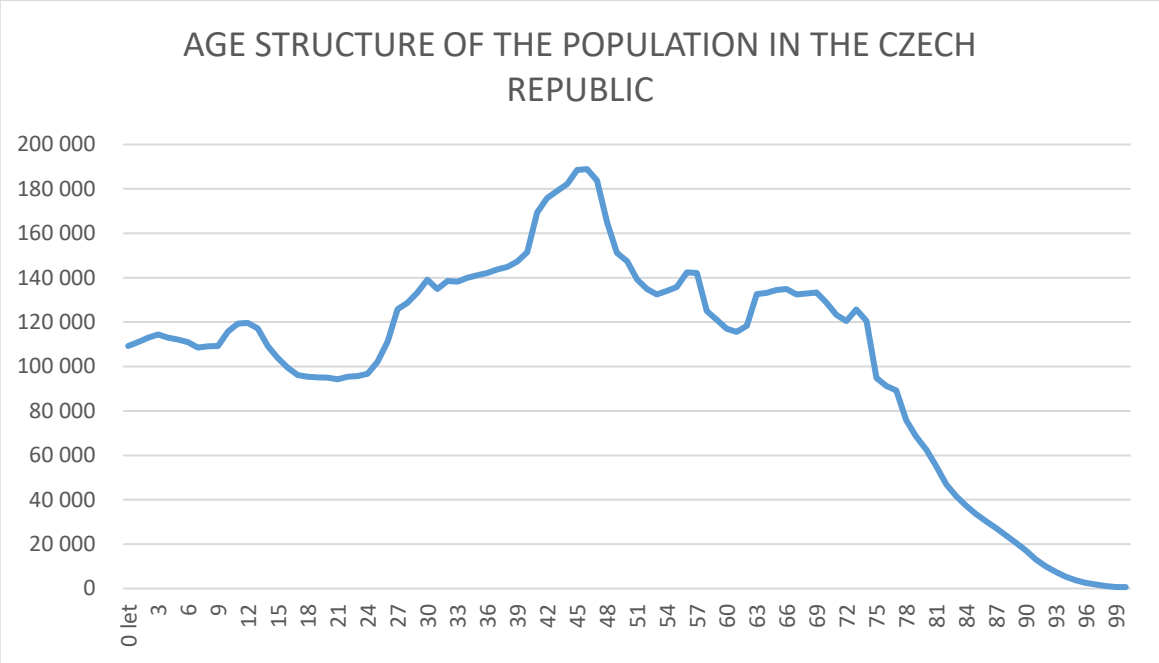
The partial aim of the bachelor´s thesis is to evaluate the risks of global influences on the spread of selected pathogenic agents in the Czech Republic

The null hypothesis is: there is no evidence in scientific sources, that assessed global influences may affect the spread of selected infectious disease.

6 ASSESSMENT OF CURRENT EPIDEMIOLOGICAL SITUATION IN THE CZECH REPUBLIC

This assessment is focused only on infectious diseases in the Czech Republic, but it is important to mention, that surveillance of non-infectious diseases is also provided and subjected to examination. Current epidemiological situation is monitored by Ministry of Health by its institutions: State health institute, Institute of health information and statistic and Hygiene stations. These institutions obtain information from health care providers based on the mandatory reporting of selected infectious diseases which are anchored in Act No. 258/2000 Coll., on the protection of public health and other legislative norms as Decree No. 306/2012 Coll. on the conditions for preventing the emergence and spread of infectious diseases and on the hygienic requirements for the operation of medical facilities and selected social service facilities and Decree No. 473/2008 Coll., on the system of epidemiological vigilance for selected infections, as amended (Decree No. 275/2010 Coll. and Decree No. 233/2011 Coll.) (Státní zdravotní ústav, 2024). Data of infectious diseases are recorded in the ISIN system (Informační systém infekčních nemocí), data of respiratory infectious diseases are in the ARI (Acute respiratory infections) and ILI (Influenza-like illness) registries. Both systems are not open to the public, but ongoing outputs are published by the State Health Institute and are available to the media and the society. These outputs and official press releases of state institutions were used to assess the epidemiological situation in the Czech Republic.

Assessment of the current epidemiological situation is focused on population on the area of the Czech Republic. The number of inhabitants in the Czech Republic was a total of 10,900,555 inhabitants as of 31st December 2023 (Český statistický úřad, 2024).



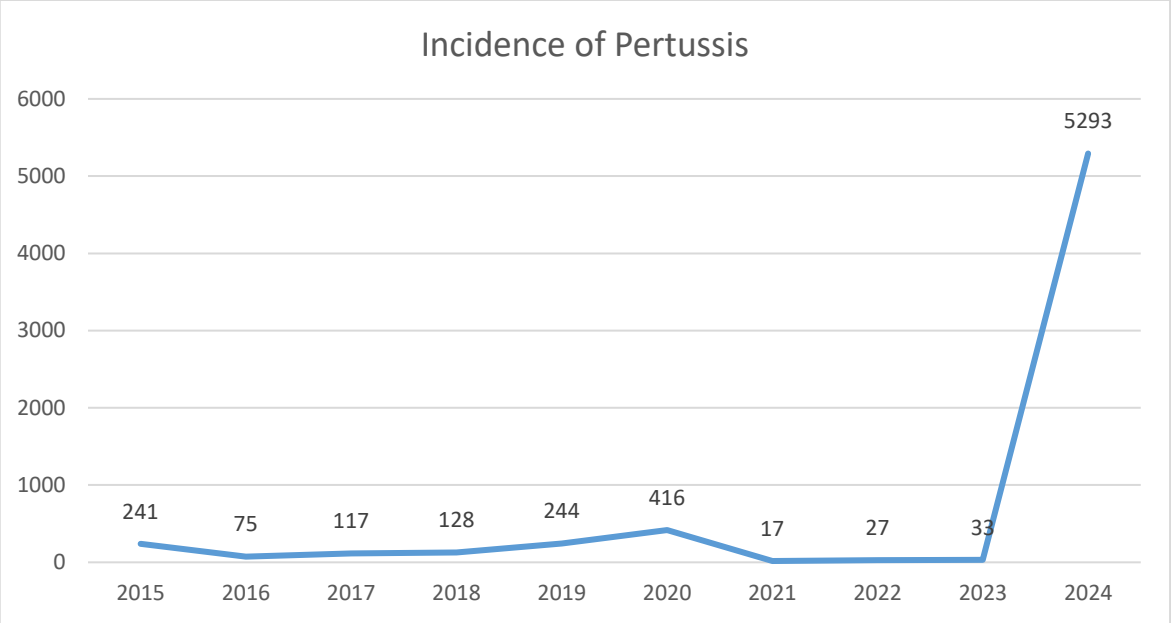
Graph 1 Age structure of the Czech population in 2021 (data from: the population census in 2021; Státní zdravotní ústav, 2024).

The Czech Republic is currently */April 2024/* after the peak of acute respiratory infections including influenza. Relative morbidity of respiratory infections range between 3000 – 1000 cases per 100 000 (Státní zdravotní ústav, 2024), influenza already decreased under epidemic threshold (Jiřincová et al., 2024). Regarding the decreasing trend in the incidence of acute respiratory diseases (according to the definition in the list of acute respiratory diseases), the author of the thesis will focus on the increasing incidence of mandatory reported infectious diseases in the statistics of the National Institute of Public Health. There was considered the most current statistic of reported infections from period of January to March 2024 compared with the corresponding period of preceding years 2015-2023.

There were selected concrete diseases (not unspecified diseases) with significant increase of the incidence in the last 3 years and also with significantly higher incidence than in 2015 – 2020 period (reason is limiting the impact of Covid19). Another inclusion criterium for assessment was incidence higher than 10 cases per examined period, except Monkey pox disease, which is epidemiologically important.

6.1 Pertussis

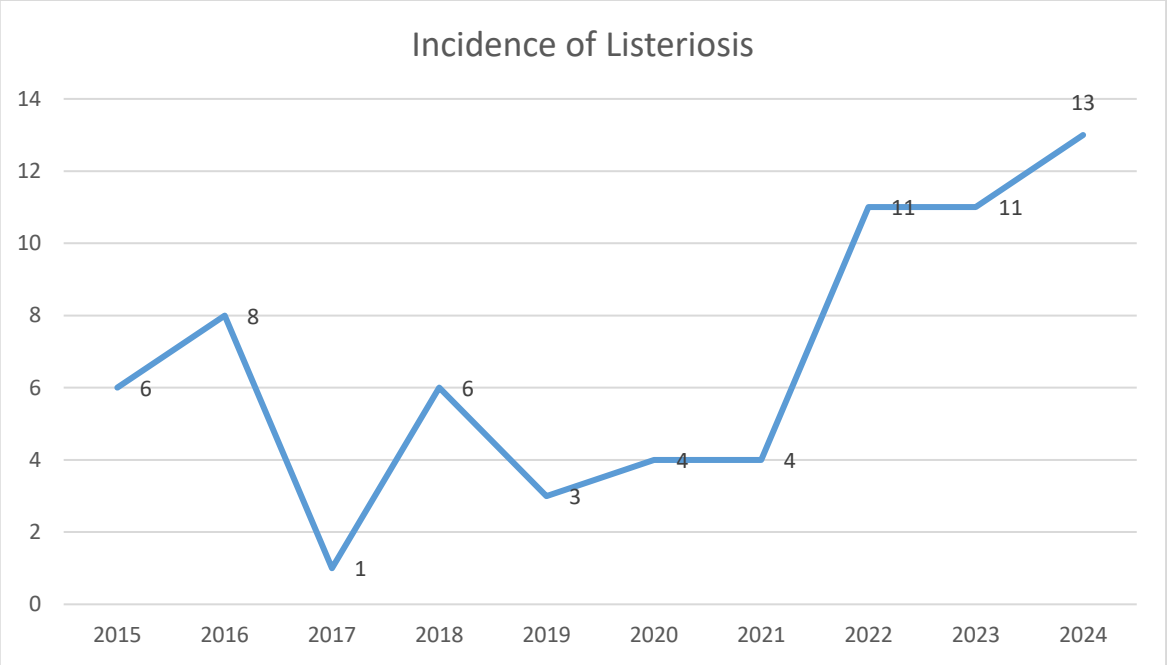
Currently, the most serious problem of infectious epidemiology in the Czech Republic is the spread of whooping cough (pertussis) and its variant parapertussis. In both cases, it is a respiratory disease that is manifested as a paroxysmal coughing of long duration. The cause of the disease is the bacterium Bordetella pertussis, or Bordatella parapertussis. Transmission takes place through droplets; the incubation period varies from 7 to 21 days. The disease occurs in 3 stages: catarrhal (non-specific symptoms), paroxysmal (cough attacks up to 20 times a day associated with cyanosis, vomiting, exhaustion, rarely even haemorrhage) and the last convalescent stage, which comes only after about 4 weeks (weakening of cough intensity, reflex cough). Diagnosis is based on the clinical image in combination with laboratory diagnosis of the presence of the pathogen or its part. Serum diagnostics are not very reliable due to the potential presence of post-vaccination antibodies (Rozsypal, 2023; Vaverková, 2013). The mandatory vaccination against pertussis was established in 1958 in the Czech Republic and currently is the vaccine included in Hexavaccine which is applied after 9th week after born and revaccinated in 1st year and 10th year of age of the child. Effectivity of the vaccination decrease in 3 – 5 years after vaccination (Vaverková, 2013). The highest risk of pertussis is therefore for infants and older people with low immunity. Especially infants are exposed to lethal consequences after contact with pertussis pathogens. The highest incidence of pertussis is currently in age group of 15-19 (Státní zdravotní ústav, 2024), but there was already a case when a 1-month-old child with pertussis died, although the Ministry of Health did not provide the causality of the death and pertussis (Šopfová, Žlábková, 2024). Epidemiological analysis describes that the main reason for the pertussis outbreak is the cessation of the circulation of the pathogen in the environment due to the SARS-CoV2 pandemic and the increase of the susceptible population. Mathematical models showed that this phenomenon allowed enough infected people to accumulate the disease that caused a mass spread of the disease (Státní zdravotní ústav, 2024). On the beginning of April Ministry of Health informed, that there will be possibility for pregnant women to get an extraordinary vaccination that protect them and their child after birth. Ministry of Health bought more than 110 000 of vaccines and will buy more for extraordinary vaccination of adults (Ministerstvo zdravotnictví, 2024).



Graph 2 Incidence of Pertussis in period January – April in years 2015 – 2024 (data from: Státní zdravotní ústav, 2024).

6.2 Listeriosis

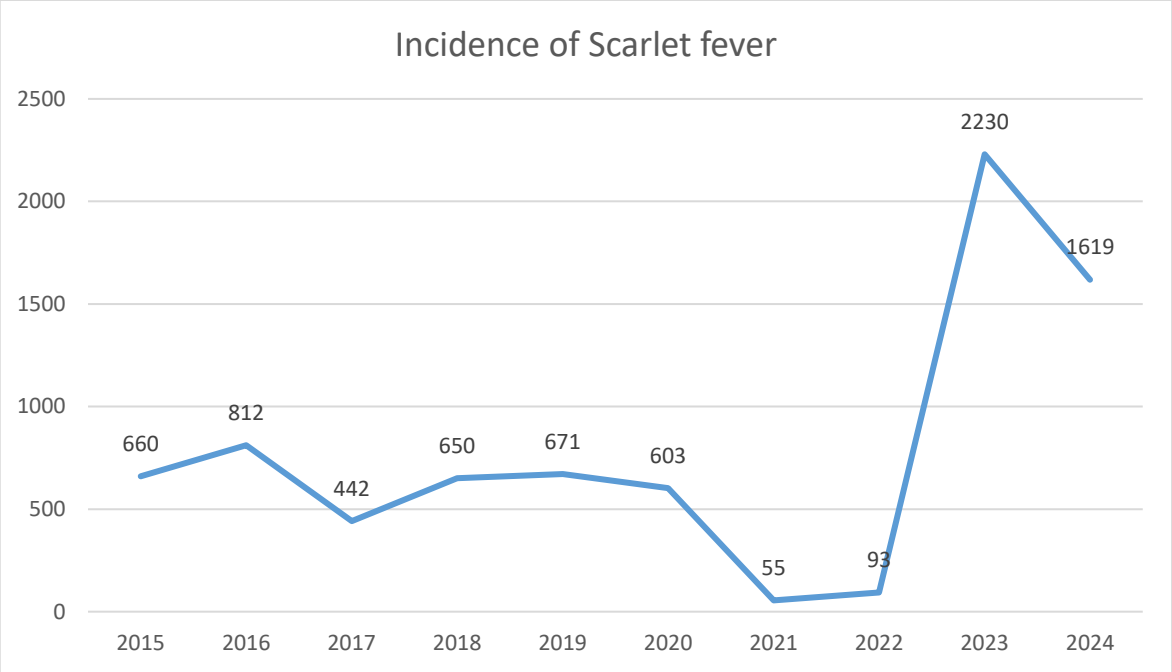
Listeriosis is an alimentary disease caused by bacterium Listeria monocytogenes. Symptoms of Listeriosis are usually flu-like symptoms, fever, diarrhoea, vomiting, headache, confusion, and seizures. Listeriosis may manifest as a gastrointestinal flu, or even as meningitis or encephalitis. Gravid women with listeriosis are in high-risk of abortion and they are the most susceptible hosts. Incubation period is usually 7 days (after ingestion of a huge amount of bacteria may last only 24 hours), diagnosis is based on laboratory cultivation and clinical image. The most common way of transmission is through contaminated food, very rarely by contact with infected animal. The risky foods are poorly cooked sausages, salami, meat, cheese, milk, and milk products. There is no vaccination against Listeriosis, and the therapy is usually antimicrobial and symptomatic (Špačková et al., 2021). National Institute of Public Health (2020) states that the increasing trend of listeriosis is in age group of 64 and more. The vehicle were usually mixed food, fish and fish products, juices, and sea food. There is not a high occurrence of transplacental transmission, what may be considered as the good news. The best prevention is therefore accurate food hygiene and education. Although the Czech Republic has slowly increasing incidence, it is still in lower level in comparison with the west Europe (Špačková et al., 2020).



Graph 3 Incidence of Listeriosis in period January – April in years 2015 – 2024 (data from: Státní zdravotní ústav, 2024).

6.3 Scarlet fever

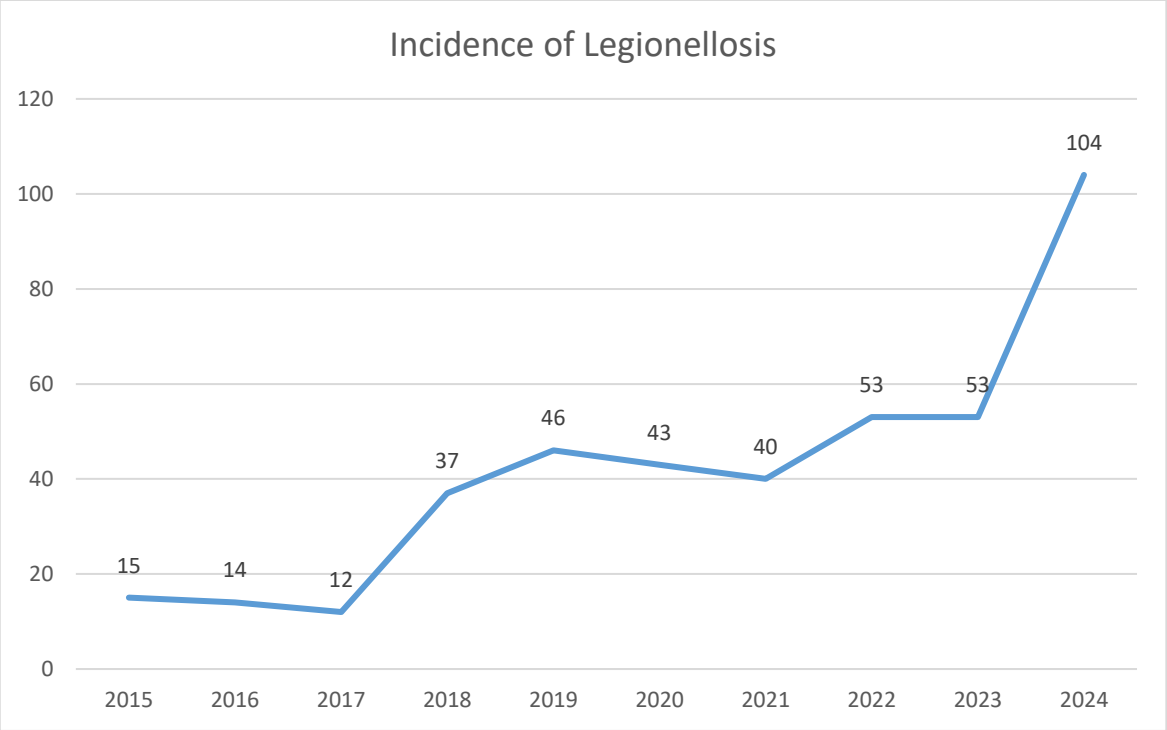
Scarlet fever also known as Scarlatina is caused by bacteria Streptococcus pyogenes. Manifestation of the disease is related to tonsilitis with specific exanthema, erythema (Filatov´s sign) and red tongue (strawberry tongue sign). Incubation period is between 2 – 7 days and the most susceptible hosts are children in age of 5-10 (Rozsypal, 2023). The disease is not usually serious, but it has invasive potential. In 2023 were 24 cases of Scarlatina that penetrated blood or cerebrospinal fluid. The invasive form of disease may result to toxic shock syndrome by streptococcus. The most effective therapy is penicillin (Státní zdravotní ústav, 2023). National Institute of Public Health has captured an increased occurrence of scarlet fever in March 2023 and the similar problem other European countries also report. The reason of increased incidence is lower immunity and more susceptible population after Covid19 pandemic. Epidemiologists suspect gradual decreasing of scarlet fever occurrence after its spread and after spread of other respiratory diseases (Státní zdravotní ústav, 2024).



Graph 4 Incidence of Scarlet fever s in period January – April in years 2015 – 2024 (data from: Státní zdravotní ústav, 2024).

6.4 Legionellosis

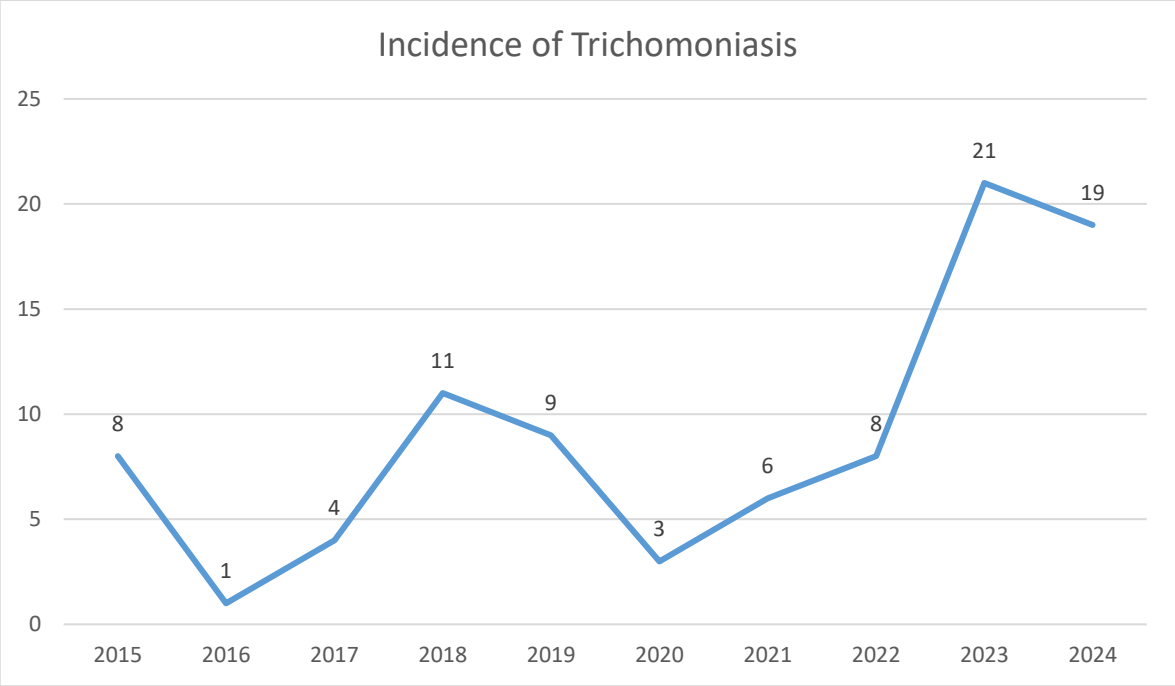
A typical example of the connection of social aspects to the spread of diseases is the increase of the incidence of legionellosis. A serious disease caused by bacteria Legionella pneumophila is manifested as a pneumonia with multisystem impairment. Reservoir of pathogens is warm water, and the transmission is caused by inhalation of contaminated water aerosols. Incubation period lasts between 2-28 days and symptoms are pneumonia in variable levels, diarrhoea and even disturbances of consciousness. The prognosis may be very serious, depending on health condition of the host. Diagnosis is based on clinical image, laboratory testing (liver and kidney damage indicators), antigen testing in urine and serology. Therapy is antimicrobial and symptomatic (Rozsypal, 2023). National Institute of Public Health warned against heating water under 50° Celsius and recommended regular short heating over 70° Celsius (this temperature is lethal for this type of bacteria) (Státní zdravotní ústav, 2023).



Graph 5 Incidence of Legionellosis in period January – April in years 2015 – 2024 (data from: Státní zdravotní ústav, 2024).

6.5 Trichomoniasis

Trichomoniasis is sexually transmitted disease caused by protozoal pathogen – Trichomonas vaginalis. Incubation period ranges between 4-28 days and the most susceptible hosts are women, men are usually (up to 90 %) asymptomatic carriers. Symptoms are related to vaginal infection with discharge, dyspareunia, and symptoms of urethra infection. Diagnosis is based on microscopic evidence or by laboratory cultivation, antimicrobial therapy is needed for both of partners (Litvik, 2019; Velčevský, Kuklová, 2008). Incidence of this type of diseases usually grows in the summer due to holidays, music festivals etc. The trend of increasing occurrence is similar in the rest of Europe and free travelling after Covid19 pandemic only supported this trend (Státní zdravotní ústav, 2023). The current incidence is already almost the same in this April as for the whole of last year, an even higher number of infected can be expected with the arrival of summer.

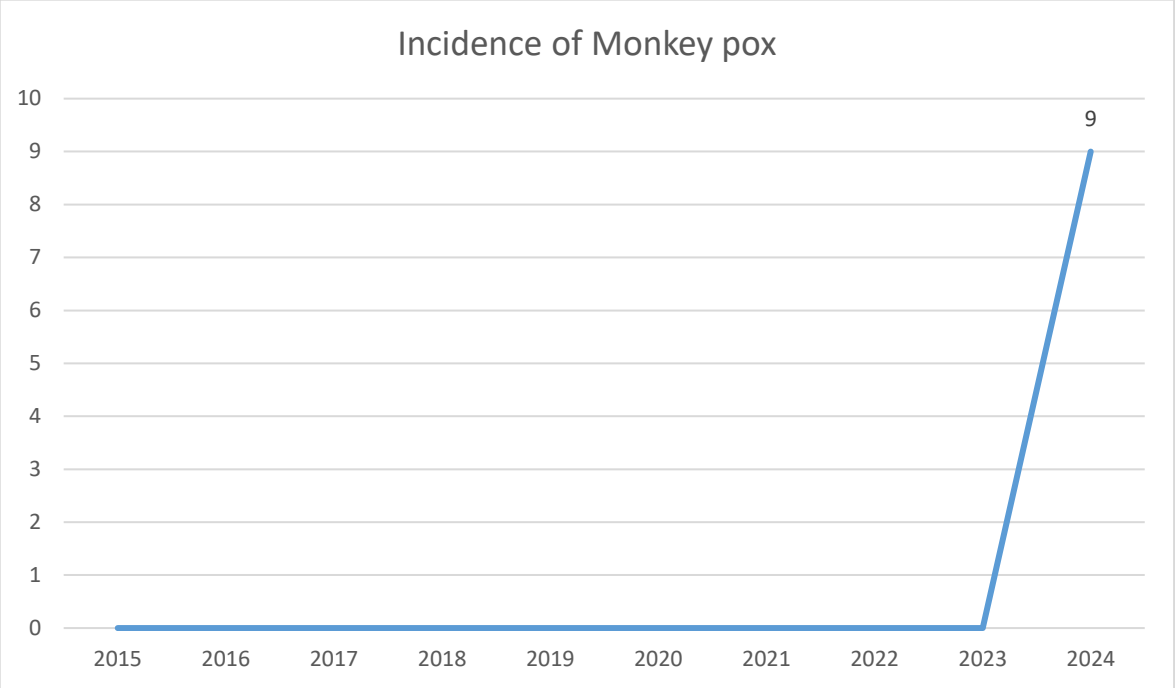


Graph 6 Incidence of Trichomoniasis in period January – April in years 2015 – 2024 (data from: Státní zdravotní ústav, 2024).

6.6 Monkey pox

Virus of Monkey pox is zoonosis which caused an epidemic in 2022. This disease is manifested by fever, headache and typical exanthema od small pimples, incubation period lasts 5-21 days. The disease came from Africa, where the transmission was proved by contact with animals. The transmission is also possible by interpersonal contact – by touching skin lesions, by droplets or even by contaminated surfaces. The epidemic of Monkey pox in 2022 were mostly in homosexual men community and it was transmitted during intercourse (Centers for Disease Control and Prevention, 2024). World health organisation in 2022 evaluated Monkey pox as a public health threat of international importance and recommended standards for anti-epidemic measures. The Czech Republic reacted and prepared a recommended standards of procedures when cases of monkeypox occur. These standards include information about disease and its epidemiology, diagnostic procedures, therapy procedures, recommendation of isolation, quarantine, epidemiological research at the focus of the disease and guidelines to transport of biological material and vaccines. Very important is also classification indicators of cases (confirmed case, probable case). The vaccination against Variola is effective against Monkey pox too.

Since 1980s there is no vaccination because of world eradication of Variola, so individuals in risk must be extraordinary vaccinated. The vaccination is recommended in Africa and for laboratory and healthcare workers. Post exposition vaccine for individuals with contact with pathogen is for consideration regarding the health condition of the individual. The last part of the standard includes the inclusion of monkeypox in the mandatory reporting of infectious diseases (Ministerstvo zdravotnictví, 2022). Currently is the epidemic in Kongo, incidence in the Czech Republic is decreasing (Státní zdravotní ústav, 2024).



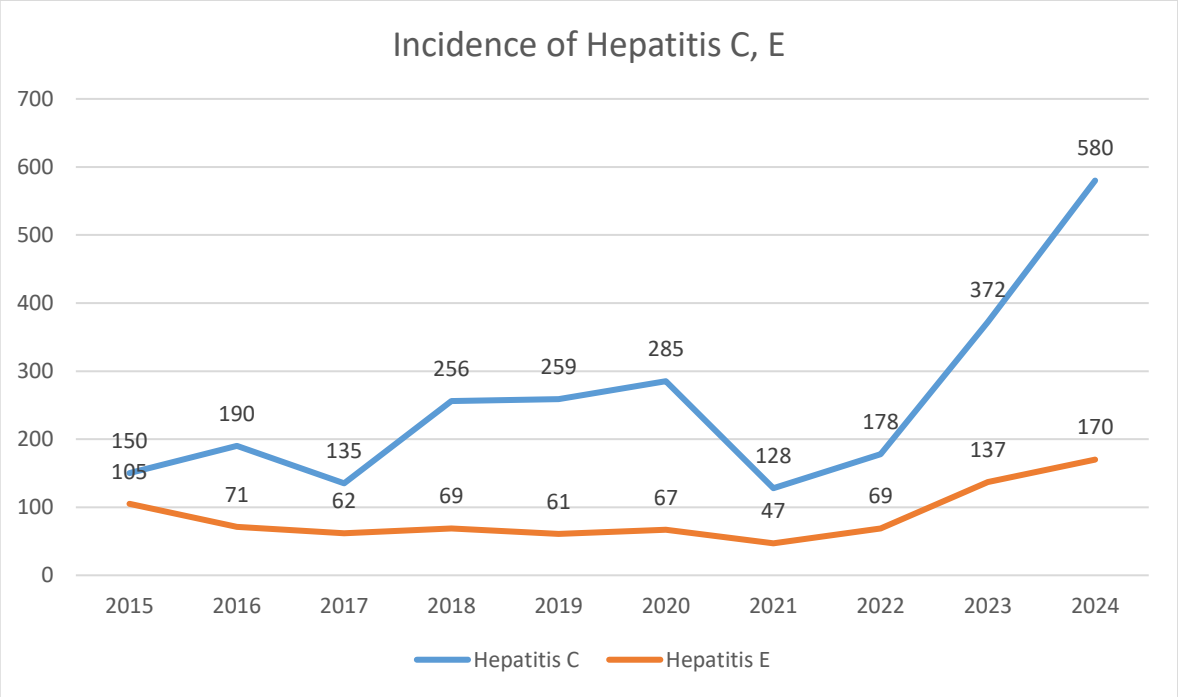
Graph 7 Incidence of Monkey pox in period January – April in years 2015 – 2024 (data from: Státní zdravotní ústav, 2024).

6.7 Infectious hepatitis C, E

Infectious hepatitis C is disease of Hepacivirus and it causes a inflammation of the liver. Incubation period is between 15 – 150 days, but average lasts 2 months. The disease is usually transmitted by blood, rarely by intercourse or transplacental transmission. The highest risk of transmission have drug users who share an syringe. Symptoms are fatigue, discomfort, abdominal pain. Prognosis is related to cirrhosis and risk of a fulminant twist in comorbidity. Diagnostic methods are serology and clinical image. Therapy is based on liver-protective regime and antiviral medication (Rozsypal, 2023). In 2023 was

established a pilot project for preventive screening of Hepatitis C across drug users who use drugs intravenously. The screening testing is provided with cooperation of low-threshold centers for drug addicts and there are used rapid antigen tests to hepatitis C antibodies from saliva or capillary blood and PCR testing. Since the beginning of preventive screening testing, a total of 124 cases were positive by saliva tests and 6 cases of PCR testing of the disease have been discovered, which was reflected in the total incidence in the Czech Republic. (Národní screeningové centrum, 2024).

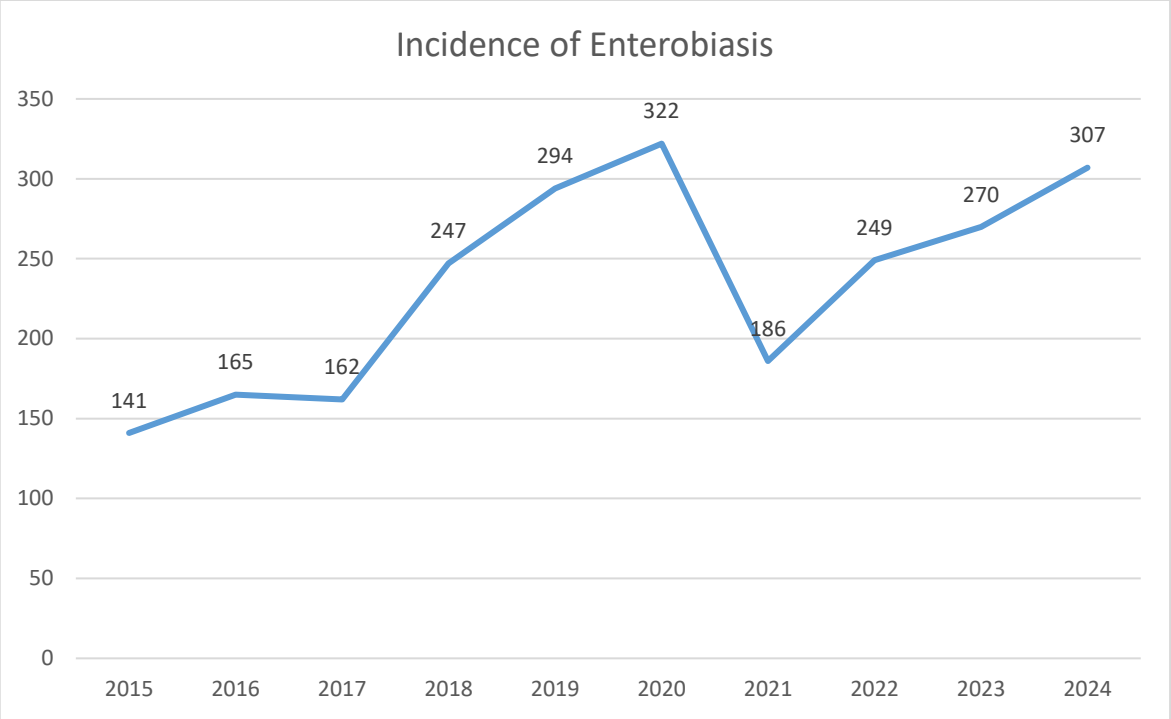
Infectious hepatitis E is mostly an alimentary disease caused by Hepevirus. Hepatitis E may be also transmitted interpersonally (fecal-oral route), as a zoonosis (from pigs, or from mollucs), rare transmission is by intercourse or by transplacental route. Incubation period is 14-60 days and symptoms are firstly prodromal (fever, flu-like symptoms, light diarrhoea) and after clinical (cholestatic form - icterus, pruritus, acholic stools; fulminant form – icterus, dyspepsia, neuropsychic symptoms and ataxia, haemorrhage). Diagnosis is based on serological examination or presence of virus in in stool by PCR method (Rozsypal et col., 2023). In the Czech Republic were rare cases in 2007 and they were mostly imported from abroad. After 2007 the incidence has started to grow. Nowadays is the incidence usually related to poorly prepared meat (pork, venison) or manipulation with meat (venison). The prevention is ingestion only accurate prepared food and accurate hygiene (Státní zdravotní ústav, 2024).



Graph 8 Incidence of Hepatitis C and E in period January – April in years 2015 – 2024 (data from: Státní zdravotní ústav, 2024).

6.8 Enterobiasis

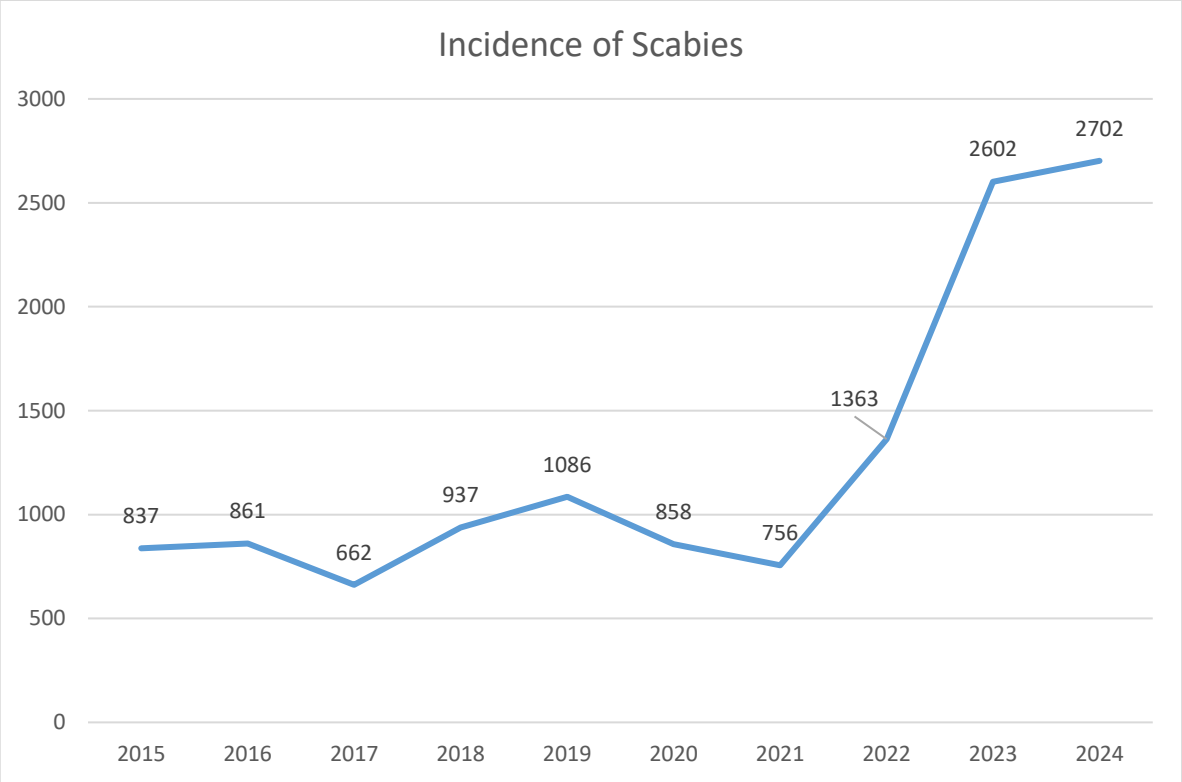
Disease caused by parasitic worms (helminths) Enterobius vermicularis which live in human colon. Enterobiasis may be transmitted alimentary but most common transmission is in interpersonal contact (fecal-oral route) mostly in children collectives. The disease is not usually severe, and symptoms are anal pruritus, rarely abdominal pain, or diarrhoea. Incubation period lasts between 4-6 weeks, depends on worm development. Enterobius vermicularis worms develop in human colon and they lay eggs in anus what causes pruritus. Hosts are forced to scratch and due this process spread the eggs to environment. Reinfection may be the complication of the disease, less common vulvovaginitis or appendicitis. Diagnosis is microscopic evidence of eggs or parasites in stool (Rozsypal, 2023). Enterobiasis is mild disease spread in children collectives which has antiparasitic therapy. The most important is prevention that is based on accurate hygiene of hands, food and regular washing of laundry. The disease is less epidemiologically severe, but in 1st quartile of 2024 will be published an article about occurrence of Enterobiasis in Epidemiology, microbiology, immunology journal (Státní zdravotní ústav, 2024).



Graph 9 9 Incidence of Enterobiasis in period January – April in years 2015 – 2024 (data from: Státní zdravotní ústav, 2024).

6.9 Scabies

Disease caused by arthropods Sarcoptes hominis is a skin infection affecting mainly homeless persons but may occur in collectives. The parasite Sarcoptes hominis lives in epidermis where deeps corridors and lays eggs. This process cause pruritus and skin exanthema. The exanthema is usually most visible on delicate skin (genitals, between fingers, underarms) but never on the face. The incubation period is 4 – 6 weeks and transmission are usually by longer skin contact, rarely by surfaces (bed, clothes etc.). Diagnosis is based on clinical image (examination of exanthema) of by microscopic evidence of the parasite. Therapy is local with anti-scabies ointment (Rozsypal, et col. 2023). The increasing incidence of Scabies commented national media, the Regional Hygienic Station of Prague describes reasons of higher incidence by migration, worse social and hygienic situation and increase of tourism (Stárek, 2024).

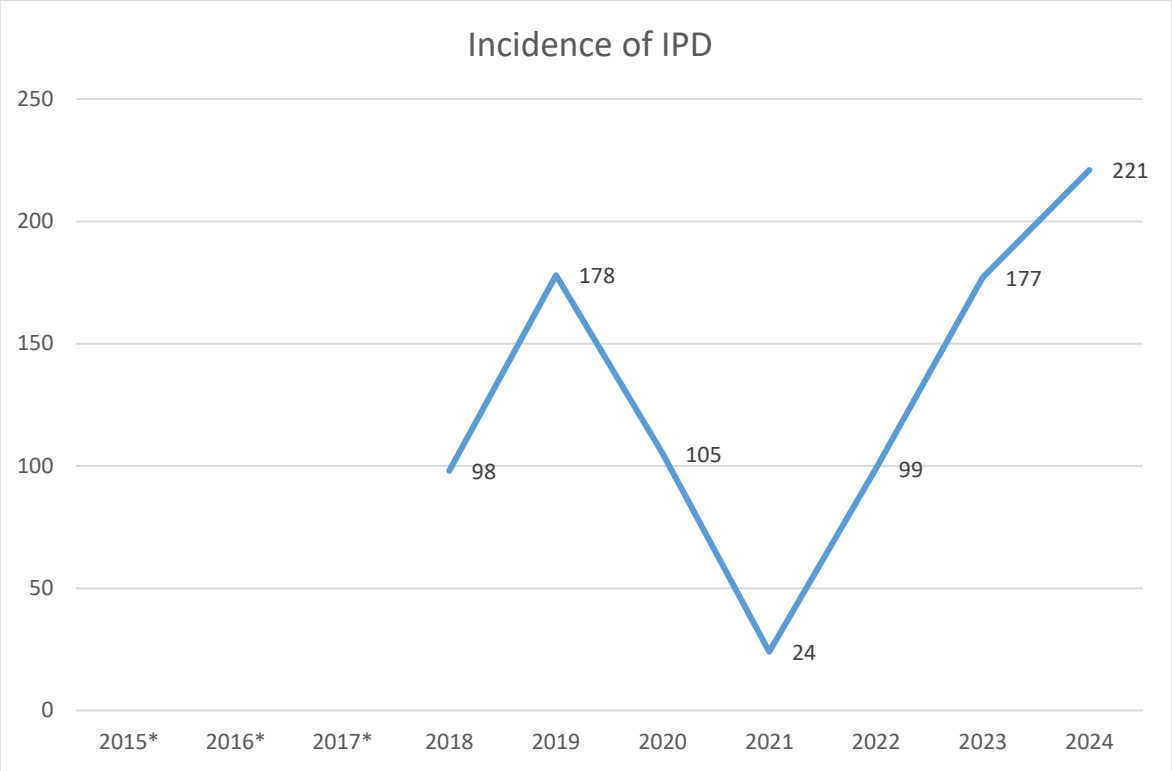


Graph 10 Incidence of Scabies in period January – April in years 2015 – 2024 (data from: Státní zdravotní ústav, 2024).

6.10 Invasive pneumococcal disease (IPD)

Bacteria Streptococcus pneumoniae usually cause otitis, sinusitis, or bronchopneumonia and may be a natural part of nasopharyngeal colonisation of healthy children. In case of susceptible host with low immunity may cause an invasive disease when bacteria penetrate blood stream or cerebrospinal fluid. These processes may lead to sepsis, serious pneumonia, or meningitis. Lethality of this type of meningitis is up to 30 %, what sort IPD as to one of the main reasons of death on infectious disease worldwide (Vančíková, 2020). Incubation period is about 1 to 3 days and main symptoms of meningitis are: fever, vertigo, petechie, and meningeal symptoms (neck stiffness, and neurological signs - Brudziński sign, spine sign, Amoss sign, Laségue sign, Kernigov sign and even disorders of consciousness). Pneumonia symptoms are fever, cough, pressure on chest. Transmission is usually interpersonal by asymptomatic carrier. Diagnosis is based primarily on typical clinical image; pathogens may be spotted in blood or cerebrospinal fluid (by cultivation or PCR method). Therapy is combination of strong antibiotics and symptomatic therapy for avoiding brain or lung damage (Rozsypal, 2023). The best prophylaxis is vaccination. Since 2010 is

covered vaccination for the most susceptible hosts: children younger than 2 years, seniors over 65 years, individual with immunodeficiency (Vančíková, 2020). The increasing incidence is a natural process after SARS-CoV2 pandemic when population has lower immunity and the occurrence of pathogen is getting back to a normal level (Kozáková et col., 2022).

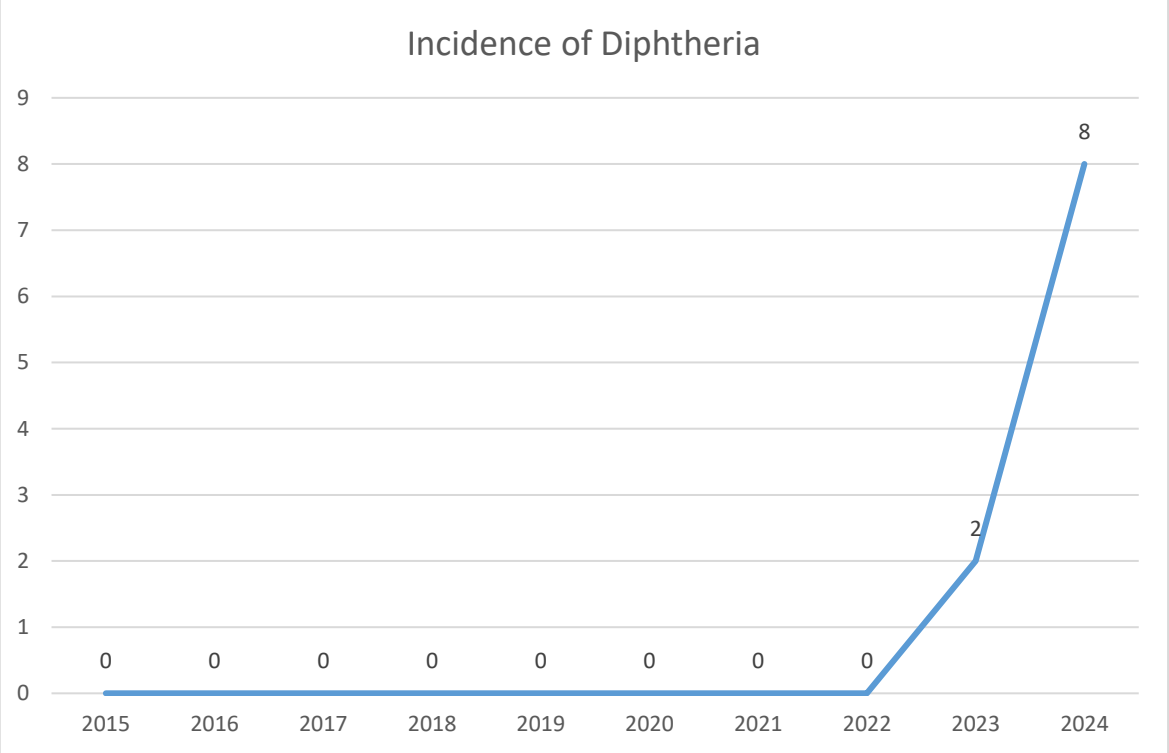


Graph 11 Incidence of Invasive Pneumococcal disease in period January – April in years 2018 – 2024; *disease was not recorded in years 2015-2017 (data from: Státní zdravotní ústav, 2024).

6.11 Diphtheria

Diphtheria is inflammatory disease of tonsils and mucous airways (rarely skin), which can damage the myocardium or cause paralysis. The originator of the disease is Corynebacterium diphtheriae, incubation period lasts between 2-4 days, transmission route is usually interpersonal by droplets, rarely by vehicle or surfaces. Symptoms are sore throat, difficulty swallowing, low fever or fever, typical sign on the tonsils (coats), swelling of the throat which may lead to choking. Therapy is antimicrobial with antidiphtherial serum (Rozsypal et col., 2023). Diphtheria is eliminated disease in the Czech Republic due to mandatory vaccination (last revaccination is in 11 years of age), but since August 2023 European Center

for Disease Control and Prevention reported cases of Diphtheria in Belgium, Germany, Netherlands, Norway, Spain, Slovakia and the Czech Republic. The very first occurrence of Diphtheria in the Czech Republic was in 2022, after 27 years of zero incidence. In 2024 there were already 8 reported cases, one patient died due to Diphtheria. European study proved low level of antibodies after vaccination in population of 40 – 59 years, but revaccination for adult population is not recommended yet. (Státní zdravotní ústav, 2024). The increasing incidence may be caused by tourism, migration, and relocation of refugees from countries with high occurrence of Diphtheria with combination of weakening of post-vaccination immunity (Fabiánová et col., 2023).



Graph 12 Incidence of Invasive Pneumococcal disease in period January – April in years 2018 – 2024 (data from: Státní zdravotní ústav, 2024).

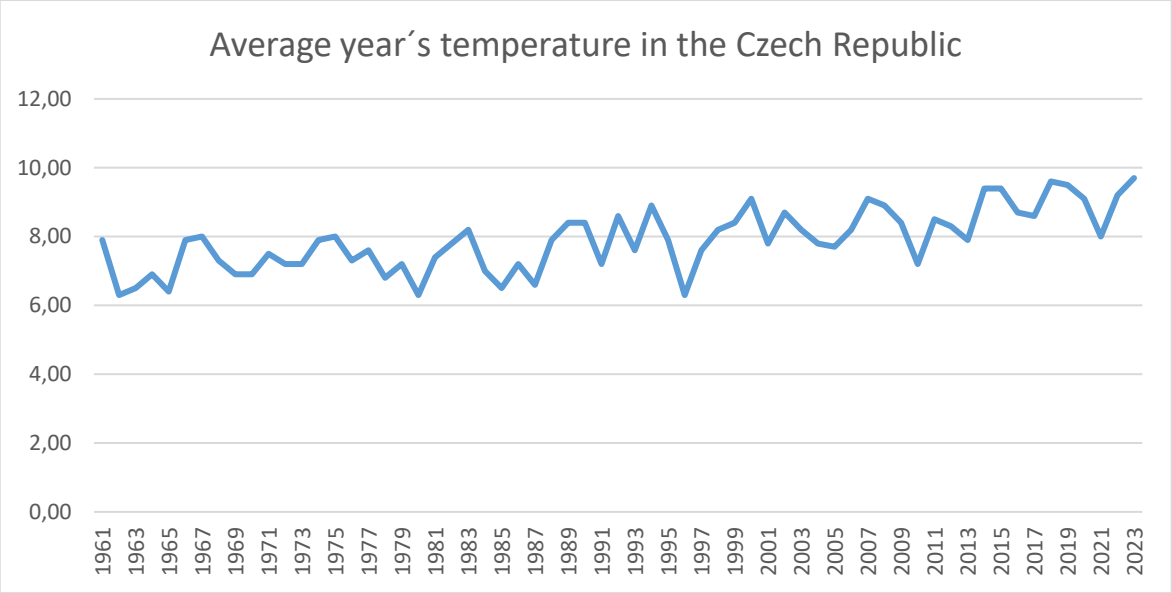
An overview of infectious diseases with an increasing incidence and their epidemiological evaluation showed that bacterial infections predominate among the diseases. The spread is mainly influenced by the reduced immunity after SARS-CoV2 and the increase of the susceptible population, other mentioned reasons are migration and the reduction of hygiene standards. However, statistics may not always be accurate. Many infectious diseases go unreported due to non-detection of the disease, especially among the less socially integrated population (homeless people, drug users etc.).

7 ASSESSMENT OF SELECTED GLOBAL PROBLEMS THAT AFFECT INFECTIOUS DISEASES SPREAD

This chapter is based on the research strategy implemented in the introduction of the bachelor's thesis. Specific global problems are assessed in the environment of the Czech Republic. The information are drawn from official available sources of national institutions (ministries, Czech Statistical Office, Czech Hydrometeorological Office, State Veterinary Administration, National Institute of Public Health, Academy of Science).

7.1 Climatic change in the Czech Republic

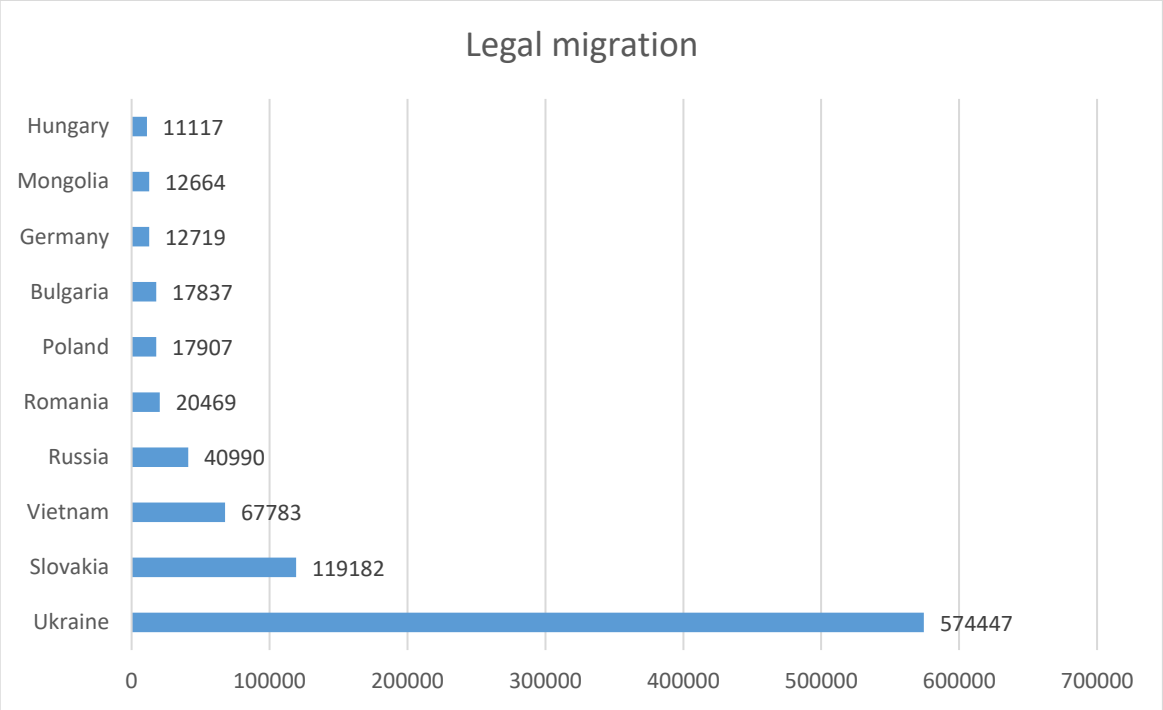
Climatic change in relation to human health in the Czech Republic is primarily connected to increasing temperature and exposure to ground level ozone. High temperatures lead to higher burden for cardiovascular and respiratory systems. Ground level ozone also state a higher burden for cardiovascular and respiratory systems and moreover may cause neural or liver damage. Higher temperatures contribute to infectious disease spread due to better conditions of infectious vectors. Especially ticks have thanks to the warm weather a longer period of activity and wider area of living. Due to mild winters ticks have moved up to 1000 meters over sea, therefore ticks are all over the Czech Republic including Jeseníky or Šumava. This may cause a higher incidence of Lyme disease and tick-borne encephalitis. Changes in temperature affect food production either, from cultivation to logistic or distribution. All these stages may be affected by higher temperature that support occurrence of parasitic insects or fungi, or even overcrowded bacteria in poorly prepared meal (Klimatická změna, 2024; Český hydrometeorologický ústav, 2024). The highest increase of temperature started in 1980s and the development is very rapid. Average temperature per year increased up to 2,03°C since 1961 (Český hydrometeorologický ústav, 2024).



Graph 13 Development of average temperature in the Czech Republic, (data from: Český hydrometeorologický ústav, 2024).

7.2 Migration in the Czech Republic

Migration, i.e. the movement of people across geographical areas with the aim of temporary or permanent settlement is a huge topic in whole Europe, especially after conflict in Ukraine. The problematics of migrants and refugees is not only related to infectious diseases and potential low level of postvaccination immunity, but also to language barriers, cultural differences, and different level of health literacy.

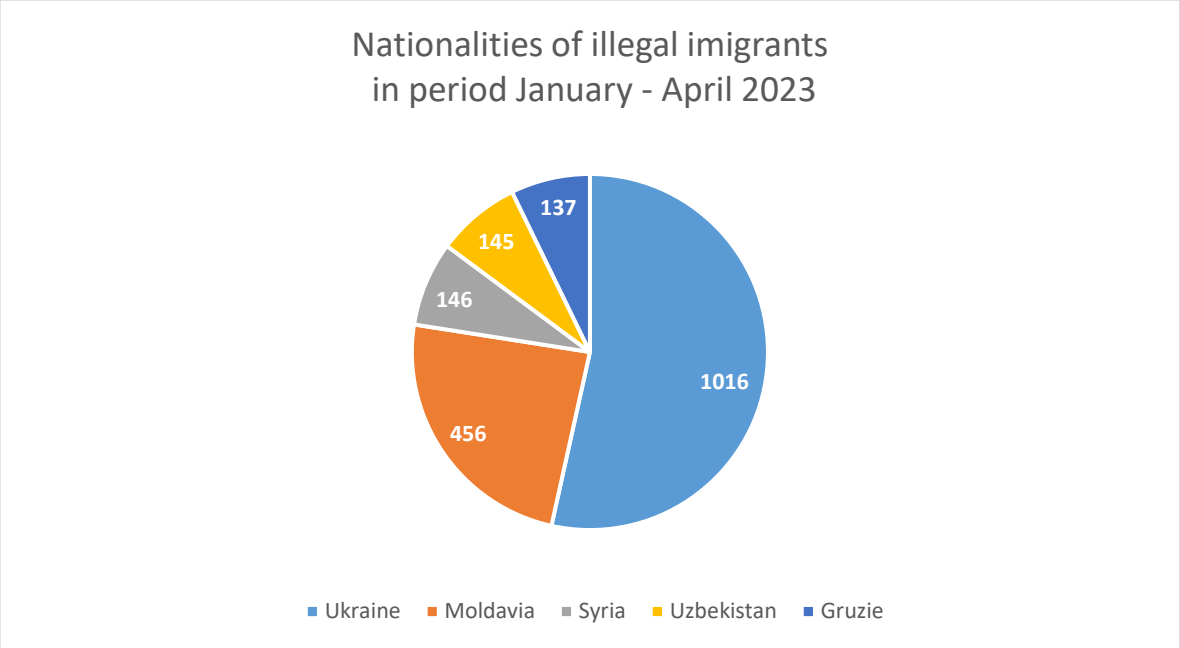


Graph 14 Legal migration to the Czech Republic in 4th quarter 2023, (data from: Ministerstvo vnitra, 2024).

The largest share (54 %) of migrants are Ukrainians. National Institute of Public Health monitors these specific circuits of diseases in relation with Ukraine: multi-resistant strains, measles, rubella, mumps, tuberculosis, hepatitis B and C, HIV, poliomyelitis, tetanus, and diphtheria. Although Ukraine has similar vaccination program as the Czech Republic, mandatory vaccinations are hepatitis B, tuberculosis, measles, mumps, rubella, diphtheria, tetanus, pertussis, poliomyelitis, haemophilus influenzae B (Ministry of Health of Ukraine, 2024), the Czech society of vaccinology recommends revaccination of Ukraine refugees on listed diseases (Česká vakcinologická společnost ČLS JEP, 2022). The Czech ISIN register distinguishes only between Czech citizens and foreigners when entering infections. It is therefore not possible to determine the specific nationality of a patient with a specific infection. In connection with the large wave of migration from Ukraine, these refugees are being monitored separately. More detailed information can be found, for example, in the register of venereal diseases, where the patient's country of origin can also be entered. The author of the work does not have current data available from this publicly unavailable register. The data from the summary report from 2018 shows the largest share of sexually transmitted infections (average from 2009 - 2018) for nationalities: Ukrainian, Russian, Mongolian, and Vietnamese (Schebelle et col., 2020). Official sources speak of

an increase in the incidence of diseases associated with migration, especially diphtheria and scabies infections (Státní zdravotní ústav, 2024). Specific statistics on the morbidity of migrants are not available to the public.

Refugees from Ukraine are not the only who migrate from other countries to the Czech Republic. Surveillance of infectious diseases among migrants holds European Centre for Disease Prevention and Control, which cooperates with Czech institutions. The control of migrants can be provided if control authorities know about them. There are still a lot of cases of illegal migration which require strict border control in cooperation with the police and other armed forces. Available statistic of the Czech Police from January – April 2023 states 2 550 individuals who illegally crossed Czech borders or illegally resided in this area (Urban, 2023). The Czech Republic currently deals about the EU Asylum and Migration Pact which may affect policy of migration and refugees and also may secondarily affect public health.



Graph 15 Nationalities of illegal immigrants to the Czech Republic (data from: Urban, 2023).

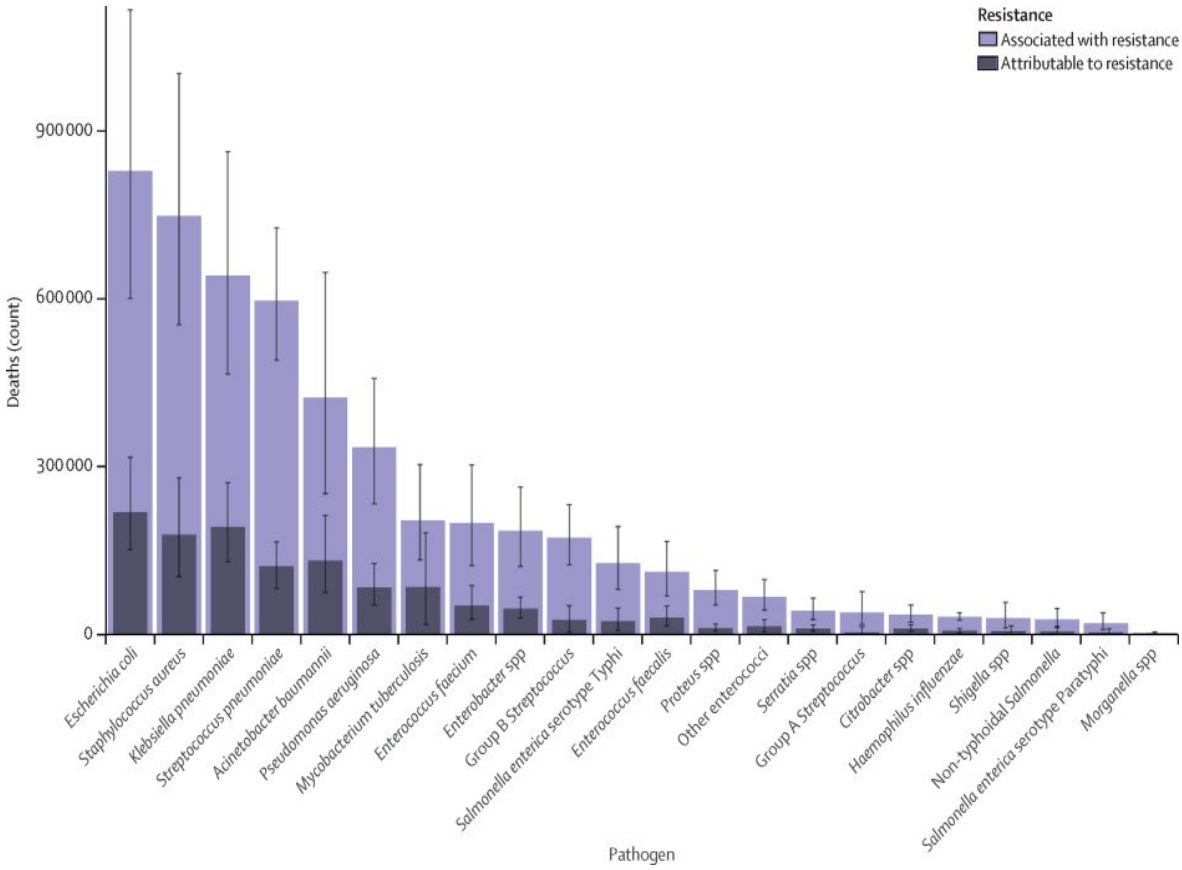
7.3 Human – animal interference

Human-animal interference monitors except National Institute of Public Health also Ministry of Agriculture and The State Veterinary Administration. The State Veterinary

Administration inspects the condition and welfare of farm animals, wild animals (venison) and, together with the State Food Inspection, also the quality of food. The most common zoonosis that may occur in the Czech Republic are campylobacteriosis, salmonellosis, infectious hepatitis E, listeriosis, tularaemia, Q-fever, echinococcosis, and trichinosis. The State Veterinary Administration provides regular microbiological controls and holds surveillance among infectious diseases spread between animals (African swine fever) or by animal-human route (Bird flu). There are other diseases which must be considered, and which are not transmitted from domesticated animals. In 1997 the Czech Republic achieved status of Rabies free country, but in surrounding countries is the occurrence of Rabies still reported, so vigilance is important. Not only regular inspections of breeding animals, but also sufficient environmental hygiene can prevent the emergence and spread of diseases through human-animal interference. Therefore, it is worth mentioning, for example, leptospirosis, which is transmitted by small rodents (Šatrán, Duben, 2024).

7.4 Antimicrobial resistance

Resistance to antibiotics is increasing problem even in the Czech Republic, where is the regulation of antimicrobial therapy on relative high level. There is a work group for monitoring of antimicrobial resistance which monitors current situation and trends of this phenomena by cooperation with microbial laboratories. There are 3 projects in which is the Czech Republic involved: monitoring of antimicrobial resistance of respiratory diseases; monitoring of antimicrobial resistance of diseases of urinary tract, and European Antimicrobial Resistance Surveillance Network (Státní zdravotní ústav, 2024). Since 2009 is in the Czech Republic provided National antimicrobial program, that includes measures against overuse of antibiotic medicine in human and animal medicine and their regulation. The National antimicrobial program brings guidelines for accurate using of antibiotics and Action plan with specific steps for the established period. The program is coordinated by Central coordinating group, and it is established by the Ministry of Health (Státní zdravotní ústav, 2024; Akční plan Národního antibiotického programu ČR, 2019). In the Czech Republic are the most common deaths due to antimicrobial resistance related to pathogens: Escherichia coli, Staphylococcus aureus and Klebsiella pneumonia (Žemličková, 2023; Murray et col., 2022). Exact statistics was not found.



Graph 16 Pathogens resistant to antimicrobial therapy worldwide* (©Murray et col., 2022). *available data from the Czech Republic was not found

7.5 Disinformation

SARS-CoV2 pandemic and following conflict in Ukraine in combination of developing online technologies provided a breeding ground for the spread of disinformation even in the Czech Republic. The threats of disinformation on public health are not examined enough in the Czech Republic, but it may be suspected, that antivax and anti-system moods lasts until nowadays. National Health Institute and Ministry of Health invested resources to the fight with Covid19 disinformation and tried to support accurate public meaning about vaccination and anti-epidemic measures. There are not exact results of this campaign, but press releases confirmed a positive impact (SeznamZprávy.cz, 2022). Ministry of Interior monitors and collects disinformation that occur in Czech environment and at their websites focus especially on health disinformation. There are listed the most common disinformation topics about vaccination: Vaccines are unreliable or ineffective; vaccines are dangerous; the vaccinated are dangerous for those around them; Russian and Chinese vaccines are discriminated against for political reasons (Ministerstvo vnitra, 2024).

However, disinformation about vaccination are not phenomena of 21st century, the origin goes back to the first vaccination against smallpox and further to a manipulated study on the effect of vaccination on autism in children. There also contributed restrictions on the whole-cell pertussis vaccine due to concerns about side effects, even vaccination saved thousands of lives. But mistrust of vaccinations, especially new vaccinations, and the pertussis vaccine, may persist in the Czech Republic (Janda, Škovránková, 2003).

The research question if assessed current public health problems can affect the incidence of infectious diseases in the Czech Republic is answered. Although at first it might seem that most of the assessed global effects on public health may not directly affect the Czech Republic, the opposite is true. All the mentioned problems contribute to the spread of infectious diseases and their management. At the same time, it is crucial to assess the emergence of infectious diseases in the context of other external influences, which undoubtedly include the mentioned global problems.

8 MULTI-CRITERIA RISK ANALYSIS

For the determination of the real effect of the assessed global factors on specific disease there was chosen a method of multi-criteria risk analysis. The methodology steps of analysis are following:

1. **Selection of the most risky disease in current situation in the Czech Republic.**

   Author of the thesis assessed all the mentioned diseases by incidence, possible consequences of contagion, potential effects of global factors and options for limiting transmission. Of these aspects, pertussis was chosen as the most risky disease. As a respiratory disease, pertussis has the simplest route of transmission, sufficient susceptible population, extremely rapid increase in incidence, therapy is based on antimicrobial treatment, and spread is conditioned by population movement.

2. **Selection of scientific database and setting the research criteria.**

   For research will be used the database World of Science and database. Research criteria for scientific database are: peer reviewed journal, published 2014 - 2024, no qualification works, language English or Czech, open access. Results of the research work are checked with guidelines and clinical recommendations by The European Society of Clinical Microbiology and Infectious Diseases and Czech Medical Society of Jan Evangelista Purkyně whether the results are not in contradiction.

3. **Scaling of searched resources.**

   A point value (weight) was assigned to the searched resources. The ranking is following Guidelines and clinical recommendations of medical societies (3 points), reviews (2 points), original studies (1 point). No evidence of factor in sources (0 point).

4. **Searching for evidence of the association of the disease with the assessed global factor.**

   In sources must be clearly mentioned association of specific assessed factor with the disease. The association can be with spread, progress, or the therapy of the disease.

5. **Scaling the result and entering it into the matrix.**

Every evidence will be recorded into matrix with value of the source. No evidence = zero value.

6. **Matrix evaluation.**

   After research all the found sources, and after recording into the matrix, the values are summed. The item with the highest total represents the highest risk for the spread of an infectious disease.

8.1 Results of the research work

Below are the results from research from the Web of Science database.

Research 1 (Climate change)

- Key words: pertussis OR whooping cough AND climate change
- Results: 618; 0 mentions in guidelines or clinical recommendations
- Relevant sources: 2

Results

1. The original study proved the influences of higher temperature and humidity to easier transmission of Pertussis (Zhan et col., 2020).
2. The review described that seasonal patterns, temperature, and humidity play an important role in transmission (Kilgore et col., 2016).

Research 2 (Migration)

- Key words: pertussis OR whooping cough AND migration
- Results: 575, 0 mentions in guidelines or clinical recommendations
- Relevant sources: 0

Research 3 (Human – animal interference)

- Key words: pertussis OR whooping cough AND human animal interference

- Results: 576, 0 mentions in guidelines or clinical recommendations

- Relevant sources: 1

Results

1. The review states that the Bordetella pertussis developed from Bordetella bronchiseptica which is a pathogenic agent of other mammals (mice, swine, or baboons) (Trainor et col., 2015).

Research 4 (Antimicrobial resistance)

- Key words: pertussis OR whooping cough AND antimicrobial resistance
- Results: 552, 0 mentions in guidelines or clinical recommendations
- Relevant sources: 3

Results:

1. The original study describes an increasing antimicrobial resistance on macrolides (antibiotics of first choice in the treatment of pertussis) and describes the specific genetic mutation of pathogenic agents that cause the resistance. The resistant strain is reported mostly in China as an endemic occur (Ivaska et col., 2022).
2. The review describes an occur of antimicrobial resistant strain of Pertussis mostly in China, but there were reported cases from USA, Japan, Taiwan, Iran, Finland, France, United Kingdom, and Czech Republic (Feng et col., 2021). Mapa
3. The review states that antibiotic resistance may play a key role in emergence of pertussis and may affect results of treatment and spread (Cimolai, 2022).

Research 5 (Disinformation)

- Key words: pertussis OR whooping cough AND disinformation
- Results: 576, 0 mentions in guidelines or clinical recommendations
- Relevant sources: 1

Results

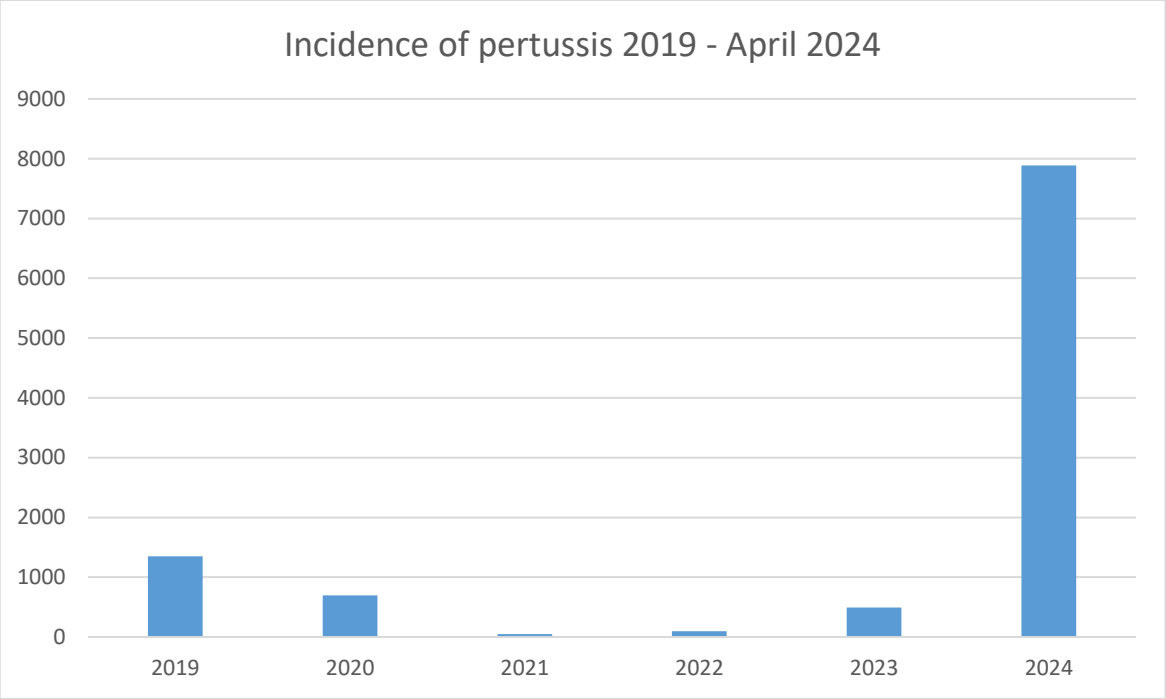
1. Original study in its text alerts about the consequences of anti-vax movement action after some side effects of the whole-cell vaccine against pertussis. The movement caused a fear of vaccine that led to decreasing of vaccination rates (Esposito et col., 2019).

Table 3 Matrix of Multi-criteria risk analysis

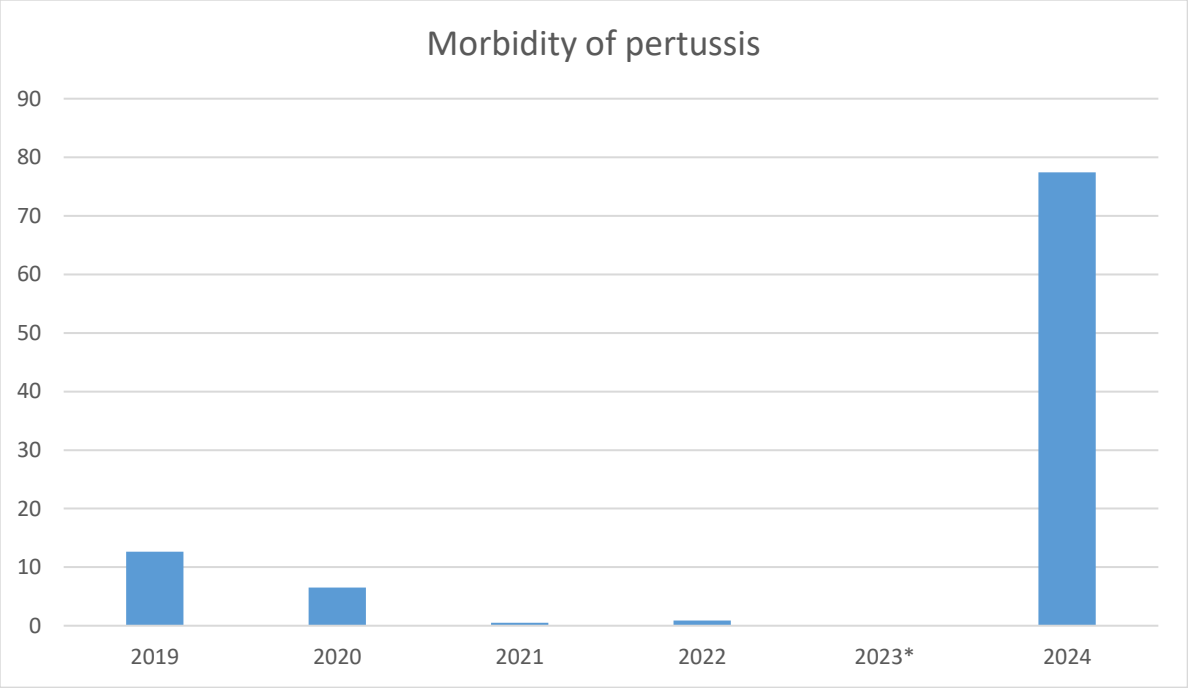
Threat	Evidence in original study (x1)	Evidence in review (x2)	Evidence in clinical guideline (x3)	Total points
Climate Change	1	2	0	3
Migration	0	0	0	0
Human-Animal interference	0	1	0	2
Antimicrobial resistance	1	2; 3	0	5
Disinformation	0	0	0	0
Total of relevant sources	**2**	**4**	**0**	**Sources in total 6**

8.1.1 Qualitative description of the results of multi-criteria analysis

Before starting the risk analysis, the disease with the greatest risk potential for the Czech Republic was selected. The risk of the disease was assessed by the following parameters: incidence over the last 3 years, the way the disease spread, applicable preventive measures, attack rate, size of the most susceptible population and lethality.

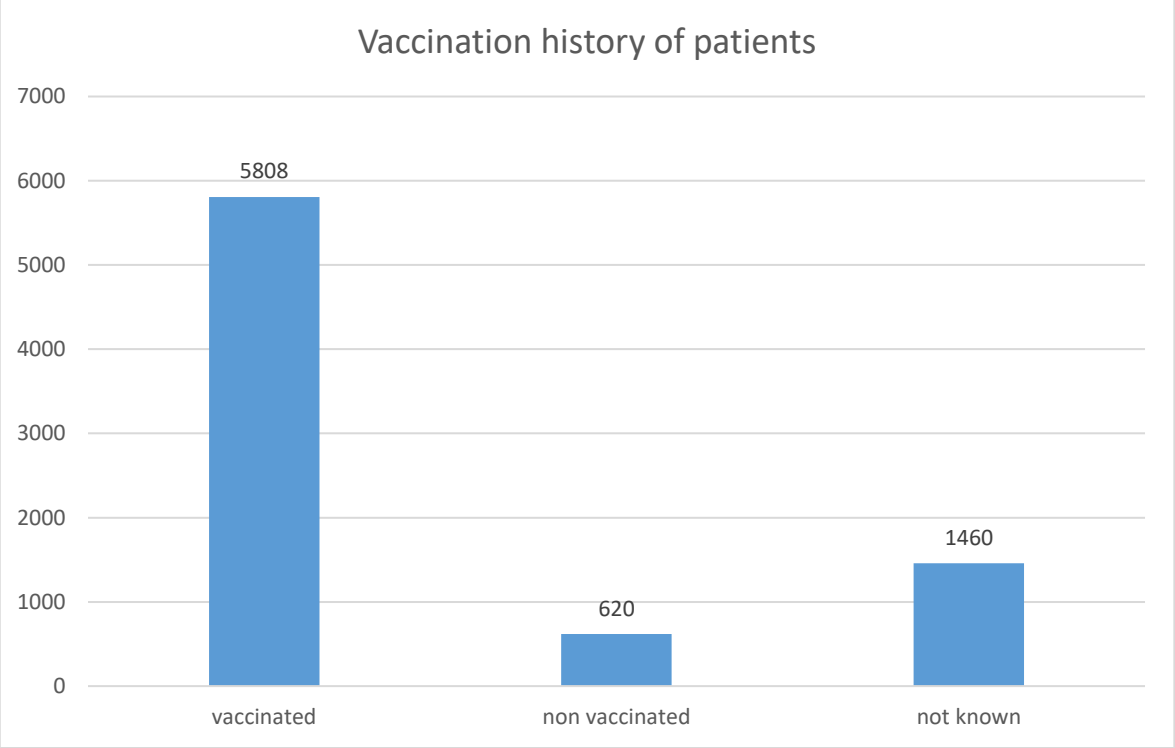


Graph 17 Incidence of pertussis in years 2019 – 2024 (April 2024) (data from: Státní zdravotní ústav 2024; Fabiánová et kol., 2023).



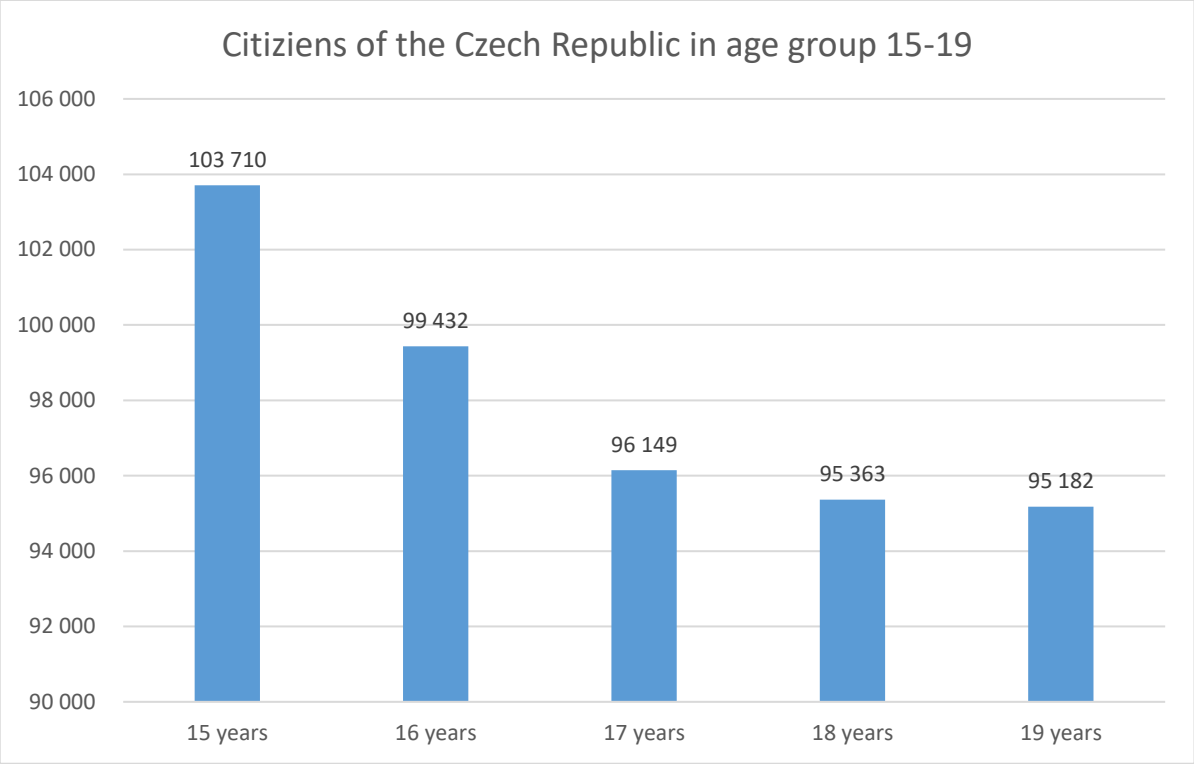
Graph 18 Morbidity of pertussis per 100 000 in years 2019 – 2024 (April 2024) (data from: Státní zdravotní ústav 2024; Fabiánová et kol., 2023). *Data from 2023 are not available

The transmission of pertussis comes from the main characteristic of the disease that is respiratory. Bordetella pertussis survives only in human hosts; therefore, the transmission is only interpersonal. Studies showed that manifested disease is not necessary for the transmission, for susceptible host is risky a prolonged close contact with an asymptomatic patient, vehicle transmission is less probable as well as a chronical form of disease (Trainor et col., 2015). Attack rate of pertussis may achieve up to 90 % and non-cured patients may be infectious up to 3 weeks (Blechová, 2010). The best measure against pertussis is preventive vaccination, which is mandatory in European Union (Evropský informační portal o očkování, 2024) but the natural immunity waning is after 5-10 years. National Institute of Public Health reports prevailing incidence of vaccinated patients with pertussis. Only 16 cases of pertussis occur in foreigners/refugees (Státní zdravotní ústav, 2024.)



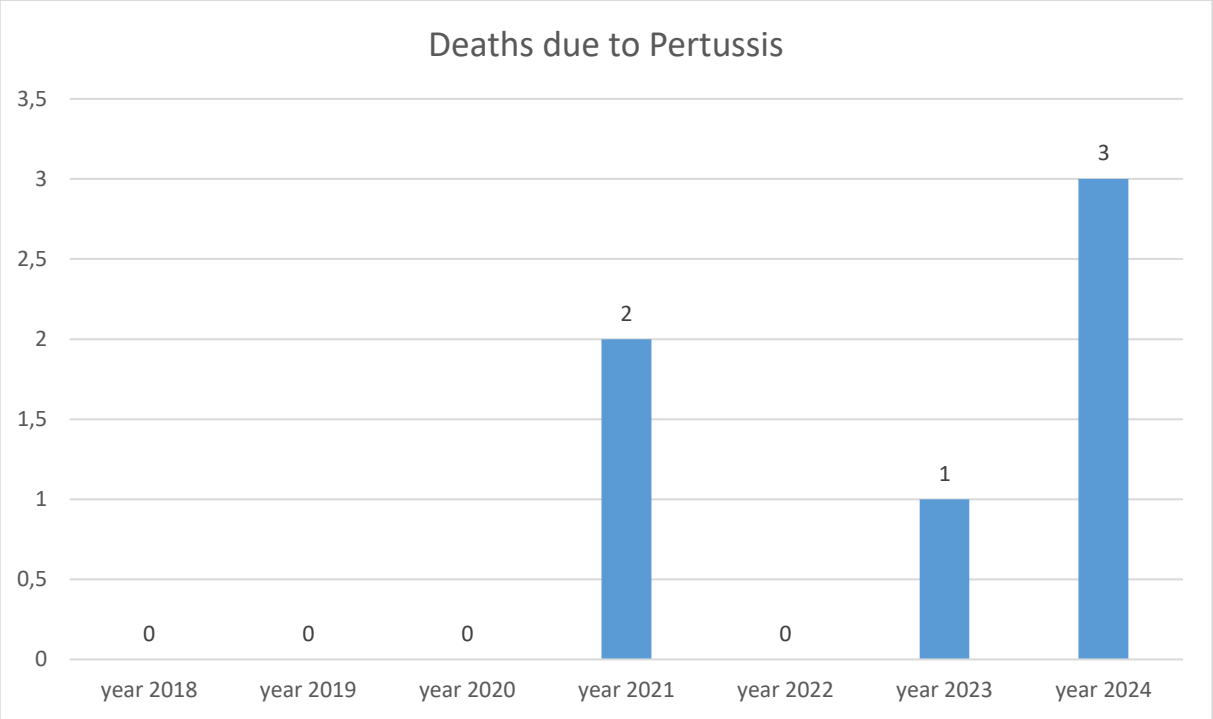
Graph 19 Vaccination history of patients with pertussis in period January – April 2024 (data from: Státní zdravotní ústav, 2024).

The most susceptible population for pertussis is infants and people over 65 of age, but current statistics reports the highest morbidity in age group 15-19 (2 420 cases) (Státní zdravotní ústav, 2024).



Graph 20 Citizens of age group 15 -19 (data from: Český statistický úřad, 2021).

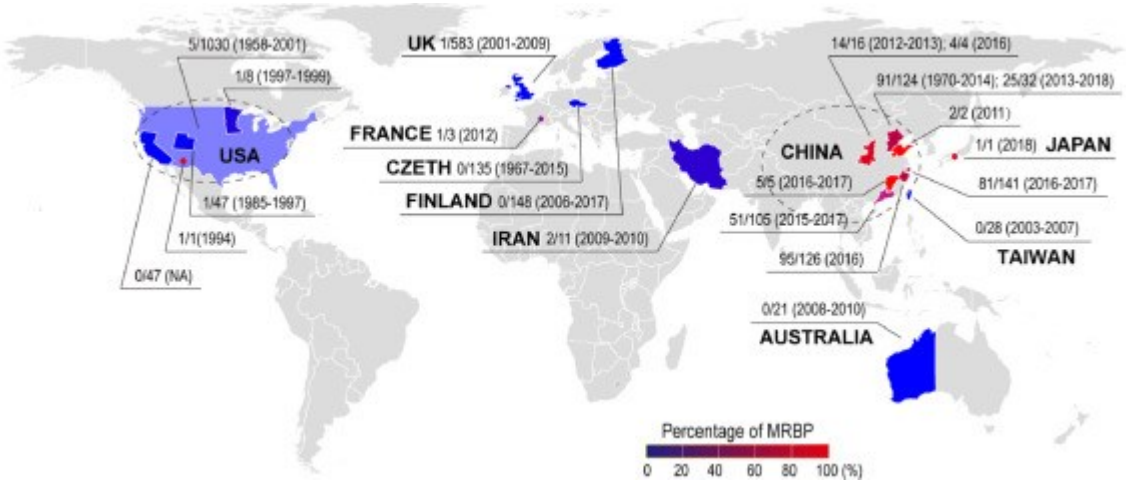
Lethality of pertussis is reported between 1.2 % - 3.0 % depending on host and his health condition and age. In the highest risk are newborns before vaccination and elderly with comorbidities and waned immunity (Wang et col., 2021). There were rare deaths due to pertussis, but since January 2024 already died 3 persons because of the disease. Two persons died in adult age (62, 84 years), on person died in age of 1 month (Státní zdravotní ústav, 2024).



Graph 21 Deaths due to Pertussis 2021 – January 2024 (data from: Státní zdravotní ústav, 2024).

The description of the current status of the disease was the basis for subjecting it to a risk analysis. The aim of the analysis was to provide evidence between global factor of disease spread (climate change, migration, human-animal interference, antimicrobial resistance, disinformation) to the spread, development, or treatment of the pertussis.

The research work provided evidence in 2 sources that climate change affects the spread of the disease due to higher temperature and higher humidity which provides better conditions for droplets in the air. On the contrary, there was not found any evidence of effect of migration to pertussis spread. Calderon et col. (2014) described that mobility of patients through different medical centers causes a huge spread to susceptible hosts in healthcare facilities, although this type of mobility is different than migration. Surprisingly the human-animal interference was mentioned in one researched source in relation to development of animal disease to strictly human. Scientists nowadays use animal models (in vivo) to examine disease spread and treatment (Trainor et col., 2015). As a high risk were assessed the antimicrobial resistance, that is currently a threat with pertussis resistant strain. The research work brought important information about macrolide-resistant strain of pertussis that occurred in the Czech Republic.



Picture 1 Map of macrolide-resistant B. pertussis worldwide (©Feng et col., 2021).

The antimicrobial resistance was mentioned in 3 sources with the biggest impact in total. This problem may be assessed as the current highest risk for pertussis due to the analysis.

The last assessed global factor was occurrence of disinformation in the pertussis disease topic. Although there are a lot of studies, which are related to disinformation and their impact to vaccination policy, there was not found any source focused just on pertussis. Only one review secondary described problems with side effects of whole-cell vaccination that led to fear of vaccination and supported anti-vax movements against vaccination at all, but it was not explicitly mentioned (Esposito et col., 2019).

The established hypothesis: there is no evidence in scientific sources, that assessed global factors may affect the spread of selected infectious disease **is refuted**.

Comprehensive research of scientific sources also brought an answer to the question of why there is now an enormous increase in the incidence of pertussis. The main reason is waning immunity after mandatory vaccination and accumulation of this susceptible host in population in a sufficient amount that lead to reaching an epidemic threshold. Other reasons are genetic shift under selective pressure and wrong diagnosis. Barriers of patients to vaccination may generally be an insufficient knowledge, lack of transportation, work commitments or fear or needles (Forsyth et col., 2018).

9 DESIGN OF AN EDUCATIONAL MATERIAL FOR A MEDICAL AMBULANCE

Education from lat - *educo,educare - to raise, to cultivate,* is process of achieving a new knowledge and experience. Education plays an important role of healthcare for accurate compliance of patient with healthcare providers (Krátká, 2016). As in other sectors of healthcare, education is also crucial in infectious epidemiology. Compliance of hygiene rules and precaution against disease on an individual level plays an important role in the spread of diseases. Education in healthcare is usually based on communication between patient and healthcare provider which is the most important part of education. However, there are another communication channels that help to healthcare providers with education. One of the easiest ways of sharing educational information are printed materials which are commonly used. The benefits of printed materials are low cost, low cost, possibility to take information home pictorial representation and reduction of burden for healthcare providers. But nevertheless, printed materials should never completely replace the education of the patient by the doctor, only should be considered as supplement. As same as oral education, the education by printed materials should be brief, should describe essential issues and use comprehensible language without medical terms (Špaténková, Králová, 2009; Venglářová, 2007; Zlámal, 2009).

Printed materials are also a huge part of PR and marketing in medicine. Marketing strategy may be considered as a like as educational strategy and aims – support the motivation of patients to action. For the effective catch, materials should be graphically attractive, brief and storytelling (Zlámal, 2009).

Author of the bachelor´s thesis focused on the design of printed materials for GP´s to their patients as a support to their education about pertussis and printed materials (posters) to waiting rooms about prevention of infectious disease. Printed materials for GP´s education are for patients to bring it at home with basic information and contact on GP. The poster is for awareness, experience and automate the hygienic standards. The design and content of the materials comes from previous research, and it is focused for 2 types of patients and generally for public:

a) **Patients in high risk** (elderly, pregnant women) with the aim of motivation to vaccination. Size A5. Printed material can be available directly in the waiting room or in the general practitioner's office. The GP should educate the at-risk population

about the risks of pertussis and offer preventive vaccination. Information, including the contact for a general practitioner, is summarized in graphic form on a small leaflet. The flyer contains a minimum of text but is built on a visually attractive and expressive flat design.

b) **Patients who were already diagnosed** with Pertussis. The aim of the materials is to summarize the basic rules how to behave with pertussis. Size A5. Patients can receive this material from the doctor after the diagnosis in person, or it can be sent to them electronically. This leaflet serves to automate individual measures and at the same time provides emergency contact to a doctor in case of worsening symptoms. This material is also instructive for persons sharing a household with a sick person or for caring non-medical people.

c) **People (visitor´s) in GP´s waiting room**. The aim of the third material (poster) is to experience and automate hygienic standards. Size A0. This poster is intended for passive education of patients who are waiting for treatment at a general practitioner. The poster summarizes the basic hygiene and anti-epidemic rules, which is based on the conducted research. The information in the poster is abbreviated, written in non-expert language, and supplemented with illustrative images.

Both types of materials for patients are in Czech and English language mutation in case of foreign patient. The poster is in Czech language because it is dedicated just for Czech environment. For preparing the materials was used a free software Canva. The materials are in Appendix P I, P II and P III.

Picture 2 Design of educational materials for GP's ambulance (source: author's, 2024).

DISCUSSION AND CONCLUSION

The aim of the bachelor's thesis was to qualitatively describe the current epidemiological situation in the Czech Republic and to point out the possible risks of pathogenic agents in connection with the dangerous spread of infectious diseases.

The first part of the work provided the theoretical background for subsequent research and analysis of the current situation in the Czech Republic. The theoretical background is devoted to the characteristics of infectious diseases and their agents, crisis management during epidemics, pandemics, and the principles of the spread of diseases as well as measures leading to the prevention of spread. An integral part of the theoretical part of the work was also research of professional literature, where the main global influences that can affect the spread of infectious diseases were searched. The global influences were identified as: climate change, migration, human-animal interference, antibiotic resistance and misinformation. The analysis of available official sources revealed that the Czech Republic is affected by all the mentioned factors and specific cases were also mentioned.

Furthermore, the analysis found that the Czech Republic is currently affected by risky pathogenic agents of all groups: **non-cellular** - viruses of Hepatitis C and E, Monkey pox**;** **prokaryotes** - bacteria causing Pertussis, Diphtheria, IPD, Scarlet fever, Legionellosis; **protozoa** – Trichomoniasis and even **eukaryote** - Aenterobiasis and Scabies.

The highest risk in the Czech Republic was assessed in Pertussis due to current incidence and characteristics of the disease. Pertussis was therefore subjected to a multi-criteria risk analysis, where the potential impact of global influences on the spread of this disease was evaluated. The risk analysis revealed the biggest problem in antimicrobial resistance. It was even found that the Czech Republic is one of ten countries where the occurrence of a strain resistant to antibiotics was recorded. On the contrary, there was no evidence in any source that population migration was responsible for the increased incidence of pertussis. The main reasons of Pertussis spread are accumulation of susceptible hosts due to post vaccinal immunity waning and due to last Covid19 pandemic.

Limits of the analysis were limited access to original data about patients (available were only statistics of incidence and morbidity or ready-made epidemiological analyses with graphs without original data). The biggest limit of the risk analysis was low number of

keywords and only one scientific database that was used. For a better assessment of the situation, a combination of evidence-based medicine (research from scientific sources) and the personal experience of experts on the topic would certainly be ideal.

The official institutions in the Czech Republic carries out epidemiological surveillance at a very high level, including regular processing and publication of epidemiological analyses. In order to properly understanding the processes contributing to the occurrence and spread of diseases, it is necessary to assess the entire social and natural context, to which multidisciplinary qualitative analysis can also contribute. Comprehensive information from all areas of human existence and an understanding of their synergy are crucial for crisis management in crisis situations of an epidemiological type.

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LIST OF ABBREVIATIONS

ARI Acute Respiratory Infections registry

BSE Bovine Spongiform Encephalopathy

Coll. Collection of Law

CJD Creutzfeldt-Jakob disease

DNA deoxyribonucleic acid

etc. et cetera – and other similar things

GP General practitioner

HIV Human immunodeficiency virus

HZS Hasičský záchranný sbor České republiky (Fire Rescue service of the Czech Republic)

i.e. id est - that is

ILI influenza-like illness

IPD Invasive pneumococcal disease

ISIN Informační systém infekčních nemocí - information system of infectious diseases

lat. Latin

MERS Middle East respiratory syndrome coronavirus

MRSA Methicillin-resistant Staphylococcus aureus

PCR Polymerase Chain Reaction

RNA Ribonucleic acid

SARS Severe Acute Respiratory Syndrome

ÚZIS Ústav zdravotických informací a statistiky - Institute of Health Information and Statistics of the Czech Republic

WHO World Health Organisation

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APPENDIX P I: PRINTED MATERIAL FOR PATIENTS IN RISK (CZECH AND ENGLISH VERSION).

PROTECT YOURSELF

FROM WHOOPING COUGH

Are you over 60 years old? You are eligible for vaccinations. Protect yourself and your loved ones.

Are you pregnant? You are eligible for vaccinations. Protect yourself and your unborn baby.

Do you suffer with fever and paroxysmal cough?

Limit contact with others and visit your GP.

name of the GP
contact
e-mail
workdays

APPENDIX P II: PRINTED MATERIAL FOR PATIENTS DIAGNOSTED WITH PERTUSSIS (CZECH AND ENGLISH VERSION).

SDĚLIL VÁM LÉKAŘ, ŽE MÁTE

ČERNÝ KAŠEL?

- Držte se doporučení lékaře, spolupracujte s hygieniky.
- Sdělte lékaři, s kým sdílíte domácnost.
- Telefonicky kontaktujte osoby, se kterými jste byl(a) v blízkém kontaktu za posledních 10 dní (především těhotné ženy a starší osoby).
- Omezte osobní kontakt s ostatními, zůstaňte doma.
- Užijte veškerá předepsaná antibiotika, nezanechte užívání po zlepšení příznaků!

Při zhoršení příznaků kontaktujte svého lékaře!

jméno lékaře
telefon
e-mail
ordinační hodiny

HAVE YOU BEEN DIAGNOSED WITH WHOOPING COUGH?

- Follow your GP's advice, cooperate with hygienists.
- Tell the GP who you share the household with.
- Contact by phone people with whom you have been in close contact in the last 10 days (primarily pregnant women and the elderly).
- Limit personal contact with others, stay at home.
- Take all prescribed antibiotics, do not stop taking after symptoms get better!

Contact your GP if symptoms get worse!

name of the GP
telephone contact
e-mail
working days

APPENDIX P III: PRINTED MATERIAL PUBLIC ABOUT AN INFECTIOUS DISEASES PREVENTION (CZECH VERSION).

JAK SE CHRÁNIT PROTI INFEKČNÍM NEMOCEM?

01 - Hygiena a zdravotní opatření

- dodržujte pravidelnou hygienu rukou
- vyhýbejte se kontaktu s nemocnými
- dodržujte pravidelná očkování
- před cestou do zahraničí se informujte o možném očkování a ochraně před exotickými nemocemi

02 - Stravovací návyky

- ovoce a zeleninu před konzumací vždy umyjte
- nekonzumujte potraviny s prošlou lhůtou trvanlivosti či s podezřelým zápachem a konzistencí
- nekonzumujte jídlo z nedůvěryhodných zdrojů a restaurací
- živočišné produkty konzumujte pouze dostatečně tepelně upravené

03 - Bezpečný kontakt se zvířaty

- po kontaktu se zvířaty si vždy umývejte ruce
- vyhýbejte se nemocným zvířatům
- vyhýbejte se kontaktu s volně žijícími zvířaty
- kontrolujte bodnutí po hmyzu, používejte repelenty

04 - Bezpečné užívání antibiotik

- léky na předpis užívejte vždy pouze na doporučení lékaře
- dodržujte předepsanou dobu užívání i přes vymizení příznaků
- poraďte se se svým lékařem o užívání probiotik

05 - Spolupráce s lékaři a odborníky

- držte se doporučení lékařů v prevenci i léčbě nemocí
- informace o nemocech konzultujte s ověřenými odborníky
- nenechte se ovlivnit neověřenými zprávami na internetu

kontakt na ambulanci