PADKOWSKA, Aleksandra, PIENIĄŻEK, Jakub Maciej, ARCISZEWSKA, Klaudia, DOBOSZ, Mateusz, BUCZKOWSKI, Jakub, MATACZYŃSKA, Anna and PAPROCKI, Michał. Overview Of The Main Viral And Protozoan Infections In Humans. Quality in Sport. 2024;32:55134 eISSN 2450-3118.
https://dx.doi.org/10.12775/QS.2024.32.55134
https://apcz.umk.pl/QS/article/view/55134

The journal has been 20 points in the Ministry of Higher Education and Science of Poland parametric evaluation. Annex to the announcement of the Minister of Higher Education and Science of 05.01.2024. No. 32553.
Has a Journal's Unique Identifier: 201398. Scientific disciplines assig589 ned: Economics and finance (Field of social sciences); Management and Quality Sciences (Field of social sciences).
Punkty Ministerialne z 2019 - aktualny rok 20 punktów. Załącznik do komunikatu Ministra Szkolnictwa Wyższego i Nauki z dnia 05.01.2024 r. Lp. 32553. Posiada Unikatowy Identyfikator Czasopisma: 201398.
Przypisane dyscypliny naukowe: Ekonomia i finanse (Dziedzina nauk społecznych); Nauki o zarządzaniu i jakości (Dziedzina nauk społecznych).

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 12.09.2024. Revised: 12.11.2024. Accepted: 13.11.2024. Published: 14.11.2024.

Overview Of The Main Viral And Protozoan Infections In Humans

Aleksandra Padkowska, Jakub Maciej Pieniążek, Klaudia Arciszewska, Mateusz Dobosz, Jakub Buczkowski, Anna Mataczyńska, Michał Paprocki

Aleksandra Padkowska
Casimir Pulaski University of Radom Faculty of Medical Sciences and Health Sciences
Chrobrego 27, 26-600 Radom, Poland
ola.padkowska@gmail.com
https://orcid.org/0009-0000-3939-7349

Jakub Maciej Pieniążek
Casimir Pulaski University of Radom Faculty of Medical Sciences and Health Sciences
Chrobrego 27, 26-600 Radom, Poland
kubapieniazek99@gmail.com
https://orcid.org/0009-0005-9063-6575

Klaudia Arciszewska
Casimir Pulaski University of Radom Faculty of Medical Sciences and Health Sciences
Chrobrego 27, 26-600 Radom, Poland
k-arciszewska@wp.pl
https://orcid.org/0009-0009-5099-6313

Mateusz Dobosz
Casimir Pulaski University of Radom Faculty of Medical Sciences and Health Sciences
Chrobrego 27, 26-600 Radom, Poland
mdobosz.mat@gmail.com
https://orcid.org/0009-0006-2407-7522

Jakub Buczkowski
Casimir Pulaski University of Radom Faculty of Medical Sciences and Health Sciences
Chrobrego 27, 26-600 Radom, Poland
j.buczkowski@urad.edu.pl
https://orcid.org/0009-0005-0309-5222

Anna Mataczyńska
Lazarski University, Faculty of Medicine
Świeradowska 43, 02-662 Warsaw, Poland
ania.mataczynska12@gmail.com
https://orcid.org/0009-0005-7643-6614

Michał Paprocki
Lazarski University, Faculty of Medicine
Świeradowska 43, 02-662 Warsaw, Poland
michalp98@onet.pl
https://orcid.org/0000-0002-9480-5090

Abstract

Both viral and protozoan infections pose a serious health risk worldwide, e.g. due to their varied intensity of symptoms - from mild to even lethal. This overview focuses on some of the most important infections caused by these pathogens that still remain a huge concern in some parts of the world. Viral and protozoan infections contribute significantly not only to morbidity, but also mortality, for the most part in regions with limited access to healthcare with low vaccination coverage. Diseases on their own sometimes are mild or even asymptomatic, but the complications or the infections during pregnancy are the reasons why those diseases still remain a huge concern because they may result in serious conditions.

Information searches were carried out in online databases, scientific and educational editions, including PubMed, Elsevier, Research Gate, Springer, CDC, WHO.

Understanding the biology, transmission routes and severity of those infections as well as pathogenesis of agents that cause them are essential for effective treatment and decline in severe cases and complications.

Keywords: Viral infections, Protozoan infections, Global health, Public health, Disease prevention

Viral infections

Influenza virus is transmitted by droplets. It is responsible for seasonal epidemics of influenza. There are three main types of influenza virus: type A, type B and type C. Type A virus is found in humans and animals, type B only in humans, and type C - in humans and pigs. Most cases are manifested by high fever and pain of bones and joints. In addition, there are often chills and headaches along with sore throat and dry cough. The period of illness usually lasts from a week to two, but complications can occur: pneumonia, laryngitis, tracheitis and bronchitis, initiation of asthma, abscess in lung or pleura, pericarditis or myocarditis, and even mental confusion, worsening dementia in the elderly, and acute disseminated encephalomyelitis (ADEM). Treatment involves taking neuraminidase inhibitors (oseltamivir and zanamivir), which stop the virus from multiplication. In many cases, symptomatic treatment is used. Prophylactic vaccinations can be taken to prevent influenza. Elderberry extract has been shown to inhibit the replication of some strains of influenza virus (Brydak 2004).

Measles virus belongs to the family of paramyxoviruses. Compared to other representatives of this family, it shows a lack of neuraminidase. In the world, 21 strains of the measles virus have been identified. The disease is spread by droplets - the incubation period lasts on average 10 days. The virus enters through the nasal cavity into the respiratory epithelium and penetrates into the blood, causing viremia. In measles, there is fever, runny nose, cough and photophobia. After multiplication in the human body, the virus again passes to the upper respiratory tract, conjunctivitis and skin. A characteristic rash appears about 14 days after the infection, lasting from 3 to 4 days. The infection results in severe, with time-abandoning, immunosuppression. After passing the disease, one is resistant to it for life (Cianciara and Juszczyk 2007).

Varicella zoster virus (VZV) causes chickenpox (varicella) most often in childhood. It is manifested by a characteristic rash. The small red bumps turn into blisters, which eventually lead to the scabs. The most common rash occurs on the face and torso, but it can also affect the whole body. In extreme cases, there may be complications in the form of varicella pneumonia, as well as neurological complications. Infection with VZV in the first trimester of pregnancy can result in the death of the fetus or its damage. In severe conditions, acyclovir is used. In adult life, the virus can become active after being latent, which manifests itself as a shingles (herpes zoster) - a disease characterized by the appearance of painful blisters and rashes, located along the course of the nerves. Complications may include corneal inflammation of the cornea and any dysfunctions associated with the attack of the cranial nerves - damage to the nerves affecting the muscles of the ocular branch (oculomotor, trochlear and abducens nerve), hearing loss (vestibulocochlear nerve), facial palsy (facial or trigeminal nerve). Acyclovir is used as a treatment for shingles (Kaslow et al. 2014).

HIV (human immunodeficiency virus) belongs to a genus of lentiviruses, a family of retroviruses. It is responsible for causing acquired immunodeficiency syndrome (AIDS). HIV attacks T helper cells, more precisely the CD4 receptor. In addition, it infects dendritic cells, macrophages, monocytes and microglia cells. The virus is transmitted through the blood and sexual route - through semen, preejaculate, secretion from the vagina and even through human milk. There are two types of virus: HIV-1 and HIV-2. Morphologically, they do not differ from each other - differences occur at the genetic level. It most likely comes from the simian immunodeficiency virus (SIV).

Infection manifests itself in the acute phase often asymptomatic or with symptoms similar to infectious mononucleosis or influenza. After the acute phase, there is an asymptomatic period - it lasts about 10 years. During this time, the number of CD4 lymphocytes drops dramatically and the immune system deteriorates. In a later period, lymphadenopathy can occur. The subsequent deterioration of immunity leads to a significant deficit of it and finally to AIDS (Collier et al. 2016).

Hepatitis B virus (HBV) belongs to the family Hepadnaviridae. There are 4 strains of the virus - adw, ayw, ayr, adr. All of them cause the same symptoms. Infection with HBV virus, indifferent whether it is an acute or chronic form, can lead to liver cirrhosis, and even hepatocellular carcinoma (HCC). This virus is transmitted through blood - contact with it and other bodily fluids. Therefore, there is an increased risk of HBV virus infection in places such as hospitals and healthcare facilities, but also in tattoo studios or when using the same sanitary items. However, HBV is not transmitted by using the same clothes, coughing, sneezing or breastfeeding. Acute HBV causes hepatitis, vomiting, jaundice and sometimes death. Chronic disease can lead to liver cirrhosis and liver cancer. Symptoms include: loss of appetite, vomiting, muscle pain, fever, often jaundice. Prevention relies on protective vaccinations. HBV does not usually require treatment; however, if necessary, drugs to stop the replication of the virus, i.e. lamivudine, adefovir or telbivudine, are used (Juszczyk 1999).

HCV virus is an enveloped virus from the family Flaviviridae. It causes hepatitis C. This, on the other hand, leads to liver cirrhosis and liver cancer. However, this virus shows sensitivity to disinfectants. The reservoir of the pathogen are people with hepatitis and carriers. The course of the disease itself is sparsely symptomatic - the average time from virus entry to evident health problems varies from 5 to 35 years. The disease most often leads to liver cancer preceded by complications such as ascites, varicose veins and bleeding from the esophagus, jaundice. WZW C is often accompanied by autoimmune diseases. Treatment is preceded by a wide range of diagnostics, including checking virus genotype, coexisting diseases, testing the function of thyroid, full blood count and liver biopsy. The treatment itself consists of taking pegylated interferon, which is administered subcutaneously, once a week. In addition, if the patient meets the requirements, boceprevir (or other protease inhibitors) and sofosbuvir can be used. Treatment with interferons can result in many side effects, including chronic fatigue, muscle and joint pain, changes in blood count and various sensitisations (Alter 2007).

Rubella virus (RuV) is a virus from the genus Rubivirus, which can be transmitted by respiratory tract secretions causing rubella both in children and adults. Symptoms of this acute infection can resemble mild measles, they typically include self-limited low-grade fever, rash and lymph node enlargement. However, infection with primary rubella virus within early pregnancy (the first trimester) is especially dangerous for the fetus, because it can lead to miscarriage or a serious medical condition (estimated 100 000 cases occur per year) - congenital rubella syndrome (CRS). Frequency of infections caused by RuV have declined in countries with high vaccination coverage, yet they are still a concern in Africa and Southern Asia as well as in Japan. Complications of both infection with RuV and vaccine preventing it include among others arthralgia and arthritis (Das and Kielian 2021, Kenbayashi et al. 2023, Winter and Moss 2022, Bayer 1980).

Children should be given two doses of MMR (measles-mumps-rubella) vaccine - first at 12 to 15 months and the second one at 4 through 6 years. However the second dose may be administered ealier in certain circumstances such as residing in high-risk areas for measles infection (Herrera et al. 2015).

Mumps virus (MuV) belongs to the Paramyxoviridae family. It causes mumps, which is an acute, highly contagious disease transmitted through droplets and saliva, which contains the virus 7 days before characteristic swelling of the parotid gland. It is most typical for children between 5 to 10 years old. Symptoms in the prodromal stage can include swelling of the salivary glands (most common the parotid glands, it may be unilateral or bilateral), fever, headache, sore throat and ear infection. Nevertheless this infection is asymptomatic in approximately 30% of children. Patient is infectious for 9 days after the parotid swelling. Mumps can be a severe illness due to its serious complications that can occur: inflammation of the testicles (orchitis) or ovaries (oophoritis), mastitis, pancreatitis, aseptic meningitis, cerebrospinal fluid (CFS) pleocytosis or even unilateral sensorineural deafness and encephalitis. They are more frequent in adults than among children.There is a vaccine for children that prevents the disease (MMR - measles, mumps, rubella). Its effectiveness in the United Kingdom is rated as 87,8% after the first dose and 94,6% after the second one (Franjić 2024, Khan et al. 2024, Yung et al. 2011).

The isolation of the polio virus, belonging to enteroviruses within the Picornaviridae family, occurred 100 years ago, during an experiment that stimulated further research of the virus in laboratories around the world. 50 years of work resulted in vaccines, and after this event, the interest in the pathogenesis of the virus waned. Then research on the molecular biology, genetics and structure of the polio virus began. There are three serotypes of the virus, and each of them causes paralysis. The cellular receptor is the glycoprotein CD155. The virus, after entering the body, inhabits the mucous membrane of the throat and intestine. Virions are transmitted mainly via fecal-oral route. There is a transient viremia with classic symptoms, i.e. sore throat, fever, malaise. The replication of the virus in e.g. brown adipose tissue or muscles can increase the probability of the pathogen entering the OUN. After entering it (about 1-2% of infected people), it replicates in the motor neurons of the spinal cord, brain stem or motor cortex. Attack of spinal cord neurons results in muscle paralysis. However, thanks to vaccines, the virus has been eradicated, which at the same time brings humanity closer to the global eradication of polio (Racaniello 2006).

Protozoan infections

Plasmodium is a genus of protozoans transmitted by mosquitoes of the genus Anopheles. Four species (Plasmodium ovale, Plasmodium vivax, Plasmodium falciparum and Plasmodium malariae) can cause malaria in humans. This occurs by entering the bloodstream by a female mosquito’s bite, from where the Plasmodium enters the liver and spleen, and then in another form attacking the red blood cells. Plasmodium vivax contributes to about 80% of malaria cases, but it is the Plasmodium falciparum (15% of malaria cases) that is the most dangerous to humans - causing up to 90% of deaths caused by this disease. Clinical symptoms include seizures with bouts of high fever and sweating every several dozen hours (depending on the species of protozoa causing the disease), nausea, vomiting, fatigue, pain of muscles, joints, abdomen and head, and sometimes diarrhea. In people with malaria, hemolytic anemia, retinal injury, and jaundice can also occur.

Symptoms usually appear 7 to 14 or 30 days after protozoa infection (also depending on the species). Malaria in the worst cases can lead to death, as well as to various complications such as severe anaemia, thrombocytopenic purpura, nephrotic syndrome, liver or spleen enlargement, various bleeding disorders and e.g. kidney failure. One can get infected primarily in warm countries in equatorial and subtropical climates, but at the moment there is no preventive vaccine for people traveling to these areas. Instead, it is recommended to use antimalarial drugs and protective measures against mosquito's bites (e.g. by spraying appropriate insect repellents) (Mendis et al. 2001, Despommier et al. 2021).

Entamoeba histolytica is a parasite of animals, including humans. It causes a disease called amoebiasis, also called amoebic dysentery. This protozoa destroys the epithelium of the large intestine. Sometimes it can be found in the liver and lungs. Infection is followed by ingestion of cysts (most often with food or due to lack of hygiene). Cysts die at temperatures below -5 degrees Celsius and above 40 degrees Celsius. The pathogen, after entering the body, moves through the digestive system to the small intestine - there it divides resulting in trophozoites, which attack the intestinal epithelium. Over time, they mature into a precyst, moving at the same time toward the external environment, eventually forming a cyst, excreted together with feces. The disease can have a variety of courses - from completely asymptomatic, through infection with severe symptoms, chronic disease, up to the extra-intestinal form, which, if not treated, can result in death. In the treatment of amoebiasis there are used antiprotozoal drugs - chloroquine, emetine and imidazole derivatives, e.g. metronidazole. People returning from tropical and subtropical zones are highly at risk of infection. In order to prevent it, stool testing is performed. In addition, basic rules of disinfection, personal hygiene or drinking water's protection from contamination with feces are observed (Andrzejewska-Golec 2004, Kadłubowski 1999).

Protozoa from the genus Cryptosporidium cause diseases of the digestive system. One species contributes to infection in humans - Cryptosporidium parvum, which attacks the intestines causing cryptosporidiosis. Among its symptoms there are primarily watery diarrhea and slightly higher than normal body temperature. One can get infected by this protozoa through the digestive system (in this form vomiting may occur) or respiratory system (characteristic symptoms are having shortness of breath and coughing) as a result of contact, for example, with the water contaminated with feces (Sponseller 2014).

Giardia intestinalis resides in the duodenum and rectum in humans. One can get infected through contact with human feces - most often transmitted by hands (hence the belonging to the so-called diseases of dirty hands) or contaminated water. It is characterized by the appearance of smelly stools, elevated body temperature and pain of the abdomen and the area of the gallbladder. Giardia lamblia acts destructively for the intestines - destroys the intestinal villi by multiplying and creating millions of cysts. Treatment consists of taking metronidazole, which effectively eradicates the protozoa (Dziubek 2003).

Toxoplasma gondii causes zoonosis in humans - this protozoa is naturally present in animals. It affects the behavior of rodents, causing them to avoid predators (e.g. cats). Humans become infected by eating unwashed vegetables containing cysts or by eating undercooked meat. T. gondii has also been shown to affect human behavior; people infected with T. gondii have a tendency to present dangerous behavior and impulsive actions, as well as being susceptible to drugs and other stimulants (Furmaga 1983).

Trichomonas vaginalis is a parasite that in humans occupies the reproductive system (vagina or prostate gland) and urinary system (urethrae). It occurs almost twice as often in women than in men. It causes trichomoniasis, which is a disease transmitted through sexual contact or through the use of other people's underwear, body wash sponges or towels. Symptoms of this disease include frequent urination, pain in the urethra or during sexual intercourse, dysuria, as well as, in women, the appearance of yellow-green discharge from the vagina with a very unpleasant odor, but about 70% of infected people show no symptoms. Trichomonas vaginalis in the human body increases the likelihood of being infected with HIV and HPV, and in men it can lead to the development of prostate cancer. Treatment of trichomoniasis relies on antibiotherapy, most often with metronidazole. This is especially important in women, because untreated, the protozoa can stay in the female body for a very long time, while in untreated men their health improves (CDC 2015, Vos et al. 2012, Secor et al. 2014).

Discussion

Viral and protozoan infections present significant global health challenges due to their capacity to cause widespread morbidity and mortality. Both types of pathogens have complex life cycles, pathogenicity and mechanisms of infection. Viral infections are characterized by their rapid replication within host cells, which can result in both acute and chronic health issues, spreading rapidly in densely populated areas. In contrast, protozoan infections, often spread through vectors or contaminated water, are more prevalent in regions with inadequate sanitation and limited healthcare access.

Effective prevention is crucial in mitigating the effects of these infections. For viral infections, vaccines have proven to be one of the most effective tools in reducing the cases and severity of many diseases. In the case of protozoan infections, improving sanitation, vector control, and access to clean water are critical measures. Public health initiatives that emphasize hygiene and early detection also play a key role in lowering transmission rates.

In summary, addressing viral and protozoan infections requires a comprehensive approach that includes scientific innovation, public health interventions, and international collaboration. By focusing on prevention, treatment, and widespread access to healthcare and vaccinations, the global community can make significant strides in reducing the impact of these infectious diseases (Murray et al. 2020, Greenwood et al. 2012, WHO 2019).

Disclosure:

Author's contribution:

Conceptualization: Aleksandra Padkowska, Jakub Maciej Pieniążek, Klaudia Arciszewska; Methodology: Aleksandra Padkowska, Mateusz Dobosz, Anna Mataczyńska; Software: Mateusz Dobosz, Aleksandra Padkowska; Check: Michał Paprocki, Jakub Buczkowski, Aleksandra Padkowska; Formal analysis: Klaudia Arciszewska, Jakub Maciej Pieniążek; Investigation: Aleksandra Padkowska, Anna Mataczyńska; Resources: Jakub Maciej Pieniążek, Klaudia Arciszewska, Michał Paprocki; Data curation: Jakub Maciej Pieniążek, Jakub Buczkowski, Klaudia Arciszewska; Writing - rough preparation: Aleksandra Padkowska, Jakub Maciej Pieniążek; Writing - review and editing: Jakub Maciej Pieniążek, Klaudia Arciszewska, Aleksandra Padkowska; Visualization: Aleksandra Padkowska, Klaudia Arciszewska, Jakub Maciej Pieniążek; Supervision: Aleksandra Padkowska, Jakub Maciej Pieniążek; Project administration: Aleksandra Padkowska, Mateusz Dobosz;
All authors have read and agreed with the published version of the manuscript.

Funding statement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Institutional review board statement

Not applicable.

Informed consent statement

Not applicable.

Data availability statement

Not applicable.

Conflict of interest statement

The authors declare no conflict of interest.

References

1. Brydak LB. Grypa i jej profilaktyka, Poznań: Termedia, ISBN 83-916594-9-6, 2004.
2. Cianciara J, Juszczyk J. Choroby zakaźne i pasożytnicze. Lublin: CZELEJ, ISBN 978-83-60608-34-0. 2007.
3. Kaslow RA, Stanberry LR, Le Duc JW. Viral Infections of Humans: Epidemiology and Control. Springer US; 2014. doi:10.1007/978-1-4899-7448-8
4. Collier L, Oxford J, Kellam P. Human Virology. Oxford University Press, ISBN 978-0-19-871468-2, 2016.
5. Juszczyk J. Wirusowe zapalenia wątroby. Warszawa: PZWL, ISBN 83-200-2322-X, 1999.
6. Alter MJ. Epidemiology of hepatitis C virus infection. World Journal of Gastroenterology. 2007;13(17):2436-2441. doi:10.3748/wjg.v13.i17.2436

7. Das PK, Kielian M. Molecular and structural insights into the life cycle of rubella virus. Pierson TC, ed. J Virol. 2021;95(10):e02349-20. doi:10.1128/JVI.02349-20
8. Kanbayashi D, Kurata T, Kaida A, et al. Shedding of rubella virus in postsymptomatic individuals; viral RNA load is a potential indicator to estimate candidate patients excreting infectious rubella virus. Journal of Clinical Virology. 2023;160:105377, pp. 1336-1346. doi:10.1016/j.jcv.2022.105377
9. Winter AK, Moss WJ. Rubella, Seminar. 2022;399:10332. doi:10.1016/S0140-6736(21)02691-X
10. Bayer AS. Arthritis related to rubella: A complication of natural rubella and rubella immunization. Postgraduate Medicine. 1980;67(5):131-134. doi:10.1080/00325481.1980.11715453
11. Herrera OR, Thornton TA, Helms RA, Foster SL. Mmr vaccine: when is the right time for the second dose? J Pediatr Pharmacol Ther. 2015;20(2):144-148. doi:10.5863/1551-6776-20.2.144
12. Franjić S. Mumps is Transmitted by Droplets. Med Discoveries, 2024, 3.2: 1119.
13. Khan SR, Srivastava S, Kumar S, et al. Recent mumps resurgence in India: general childhood vaccination is needed. Infectious Diseases. 2024;56(7):586-588. doi:10.1080/23744235.2024.2355274
14. Yung CF, Andrews N, Bukasa A, Brown KE, Ramsay M. Mumps complications and effects of mumps vaccination, England and Wales, 2002–2006. Emerg Infect Dis. 2011;17(4):661-667. doi:10.3201/eid1704.101461
15. Racaniello VR. One hundred years of poliovirus pathogenesis. Virology. 2006;344(1):9-16. doi:10.1016/j.virol.2005.09.015
16. Mendis K, Sina B, Marchesini P, Carter R. The neglected burden of Plasmodium vivax malaria. „Am J Trop Med Hyg". 64. 1-2 Suppl, s. 97-106, 2001. PMID: 11425182
17. Despommier DD, Griffin DO, Gwadz RW, Hotez PJ, Knirsch CA. "9. The Malarias". Parasitic Diseases (PDF) (7 ed.). New York: Parasites Without Borders. pp. 110–115, 2019. Retrieved November 24, 2021
18. Andrzejewska-Golec E. Materiały do ćwiczeń z parazytologii dla studentów farmacji. Łódź: Uniwersytet Medyczny: na zlec. Senackiej Komisji ds. Wydawnictw Uniwersytetu Medycznego, ISBN 83-88940-22-8, 2004.
19. Kadłubowski R. Zarys parazytologii lekarskiej: podręcznik dla studentów. Warszawa: Wydawnictwo Lekarskie PZWL, ISBN 83-200-2316-5, 1999.
20. Sponseller JK, Griffiths JK, Tzipori S. The evolution of respiratory cryptosporidiosis: evidence for transmission by inhalation. Clinical Microbiology Reviews. 2014;27(3):575. doi:10.1128/CMR.00115-13
21. Dziubek Z. Choroby zakaźne i pasożytnicze. Wyd. wydanie III uaktualnione. Warszawa: Wydawnictwo Lekarskie PZWL, s. 434–437. ISBN 83-200-2748-9, 2003.
22. Furmaga S. Choroby pasożytnicze zwierząt domowych. Warszawa: Państwowe Wydawnictwo Rolnicze i Leśne, ISBN 83-09-00671-3, 1983.
23. "Trichomoniasis - CDC Fact Sheet". CDC. November 17, 2015. Archived from the original on 19 February 2013. Retrieved 21 March 2016.

24. Vos T, Flaxman AD, Naghavi M, et al. Years lived with disability (Ylds) for 1160 sequelae of 289 diseases and injuries 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet. 2012;380(9859):2163-2196. doi:10.1016/S0140-6736(12)61729-2
25. Secor WE, Meites E, Starr MC, Workowski KA. Neglected parasitic infections in the United States: trichomoniasis. Am J Trop Med Hyg. 2014;90(5):800-804. doi:10.4269/ajtmh.13-0723
26. Murray PR, Rosenthal KS, Pfaller MA. Medical Microbiology. 9th ed. Philadelphia, PA: Elsevier; 2020.
27. Greenwood D, Slack RCB, Barer M. Medical Microbiology: A Guide to Microbial Infections. 18th ed. Edinburgh: Churchill Livingstone; 2012.
28. World Health Organization. The Global Burden of Disease. 2019. https://www.who.int/health-topics/global-burden-of-disease. Accessed April 27, 2024.