

Incidence of urogenital candidiasis in Mexico

Reyna-Beltrán E,¹ Martínez-Camacho LE,² Tavera-Tapia A,³ Guerra-Cárdenas JE,⁴ Paz-Ávila J,⁵ Hernández-Richard EP⁶

Incidencia de la candidiasis urogenital en México

Recibido: 21 de octubre 2024

Aceptado: 7 de febrero de 2025

Abstract

Background: Urogenital candidiasis (uc) is the most recurrent fungal infection and frequently affects immunocompromised, hospitalized patients and those with comorbidities.

Objective: to evaluate the incidence of uc in the Mexican population in the previous two years (2018-2019) and the first years of the COVID-19 pandemic (2020-2022).

Materials and Methods: The design of this study was retrospective and descriptive. The morbidity of the twenty main causes of disease in Mexico was obtained through the National Epidemiological Surveillance System (SINAVE), the cumulative incidence of uc by state, and the incidence by age group of the general population from the 2018-2019 period (before the pandemic) and in the first years of the COVID-19 pandemic (2020-2022).

Results: uc was found among the twenty main causes of disease in the female population, mainly between 20-24 and 45-49 years of age. The regions of the country that showed a high percentage of humidity reported a higher incidence of uc.

Conclusions: In Mexico, uc mainly affects women between 20-49. Factors such as obesity, type II Diabetes Mellitus (DM), immunosuppression, and environmental humidity promote the appearance of uc and other opportunistic infections.

KEY WORDS

Microbiology, women's health, humidity, obesity.

Resumen

Antecedentes: La candidiasis urogenital (cu) es la infección fúngica más recurrente y afecta frecuentemente a pacientes inmunocomprometidos, hospitalizados y aquellos que presentan comorbilidades.

Objetivo: evaluar la incidencia de la cu en la población mexicana en los dos años previos (2018-2019) y los primeros años de la pandemia (2020-2022) por COVID-19.

Materiales y Métodos: El diseño de este estudio fue retrospectivo y descriptivo. Se obtuvo la morbilidad de las veinte principales causas de enfermedad en México a través del Sistema Nacional de Vigilancia Epidemiológica (SINAVE), la incidencia acumulada de la cu por entidad federativa y la incidencia por grupo de edad de la población en general del periodo 2018-2019 (previas a la pandemia) y en los primeros años de la pandemia por la COVID-19 (2020-2022).

Resultados: La cu se encontró entre las veinte principales causas de enfermedad en la población femenina, principalmente entre los 20-24 y 45-49 años. Las regiones del país que mostraron un elevado porcentaje de humedad reportaron una mayor incidencia de cu.

Conclusiones: En México, la cu afecta principalmente a las mujeres entre los 20-49. Factores como la obesidad, la Diabetes Mellitus (DM) tipo II, inmunosupresión y la humedad ambiental promueven la aparición de la cu y otras infecciones oportunistas.

PALABRAS CLAVE

Microbiología, Salud en la mujer, humedad, obesidad.

¹ Universidad Autónoma de Tampico, México. ORCID: <https://orcid.org/0000-0001-7896-0560>. ereyna@docentes.uat.edu.mx. ² Universidad Autónoma de Tampico, México. ORCID: <https://orcid.org/0000-0002-3186-873X>. ³ Universidad Autónoma de Tampico, México. ORCID: <https://orcid.org/0000-0002-5950-9341>. ⁴ Universidad Autónoma de Tampico, México. ORCID: <https://orcid.org/0000-0001-9495-024X>. ⁵ Universidad Autónoma de Tampico, México. ORCID: <https://orcid.org/0000-0003-0157-3268>. ⁶ Universidad Autónoma de Tampico, México. ORCID: <https://orcid.org/0009-0005-3874-3277>

Introduction

Genitourinary infections (GIs) are one of the main causes of medical consultation in immunocompetent and immunocompromised individuals. Of these, urinary tract infections (UTIs) are classified as the second most common type of infection in the world, and it is estimated that in adult women there is a lifetime incidence of UTIs of between 40 and 60 %, the risk of which increases with age. In young women, the risk of developing a UTI increases with sexual activity. In addition to this, misdiagnosis among GIs causes inadequate treatment and associated complications.^{1,2}

The main uropathogenic bacteria causing UTIs are *Escherichia coli* (*E. coli*), *Pseudomonas aeruginosa* (*P. aeruginosa*), *Klebsiella* spp., *Enterobacter* spp., *Proteus mirabilis* (*P. mirabilis*), *Morganella morganii* (*M. morganii*), and *Citrobacter freundii* (*C. freundii*).³ Among the fungi that cause GIs are the species of the genus *Candida* spp., causing balanoposthitis and balanitis in men, vulvovaginal candidiasis in women, and candiduria in both sexes.⁴ Vulvovaginal candidiasis (VVC) is the most common infection of all, affecting up to 75 % of women of childbearing age.⁵ Approximately 50 % of all infections caused by species of the genus *Candida* are attributed to *Candida albicans* (*C. albicans*), while the remainder is caused by non-*albicans* species: *C. glabrata*, *C. tropicalis*, *C. krusei*, and *C. parapsilosis*, among others.⁶ As a commensal, *C. albicans* resides in the skin and internal cavities such as the mouth, throat, intestine, and vagina. The pathogenicity of this fungus is related to various virulence factors such as the expression of adhesins, morphogenesis, secretion of aspartyl proteases, lipases, and phospholipases.^{7,8}

In addition to the virulence of the pathogen, the pathogenesis of VVC depends on the individual predisposition and host defense mechanisms. Some predisposing factors for developing VVC include type II Diabetes Mellitus (type II DM), prolonged use of antibiotics, a vaginal pH >5, disruption of the vaginal microbiota, use of contraceptives, genetic factors (e.g., mannose-binding lectin gene polymorphisms), and lifestyle (e.g., unprotected sex and nutrition).^{9,10}

In Mexico, the National Epidemiological Surveillance System (SINAVE) reports urogenital candidiasis as one of the twenty main causes of disease.¹¹ The states of Puebla, Yucatán, San Luis Potosí, Nuevo León, and Veracruz have registered an increase in the incidence of superficial candidiasis (one of the most common types of candidiasis). However, in some parts of the country, the status of candidiasis is unknown. Although several types of candidiasis are present in most states, the incidence will depend on the state being analyzed, since this opportunistic fungus is more prevalent in humid places.^{12,13}

The objective of this work is to evaluate the incidence of UC in the Mexican population in the previous two years (2018–2019) and in the first years of the COVID-19 pandemic (2020–2022).

Materials and methods

The design of this study was retrospective and descriptive. Data were obtained on the morbidity of the twenty main causes of disease in Mexico, the cumulative incidence of UC by state (that includes candidal and moniliasic vulvovaginitis, balanitis and urethritis due to *Candida*), and the incidence by age groups of the general population for the period 2018–2019 (before the pandemic) and in the first years of the COVID-19 pandemic (2020–2022) reported by the General Directorate of Epidemiology (Morbidity Yearbook 1984–2022),¹¹ electronic address: <https://epidemiologia.salud.gob.mx/anuario/html/index.html>. The data were processed and graphed by Excel in Microsoft Office 365 and GraphPad Prism version 8.

Results

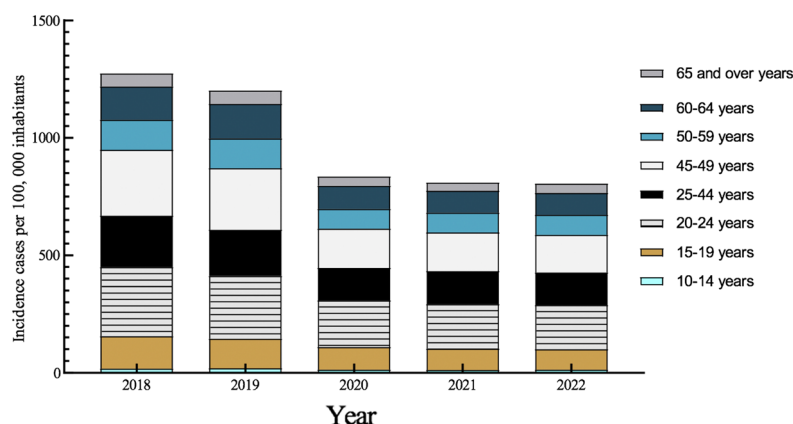
The incidence of UC was evaluated in the general population (male and female patients) reported by the SINAVE two years before the COVID-19 pandemic, in the first year, and two years after the onset (2018–2022). The main age groups affected were 20–24 years old and 45–49 years old, followed by 25–44, 15–19, and 60–64 years old. The highest incidence in the age group 10–14 years was reported in the years before the start of the pandemic (2018 and 2019) (Figure 1). In addition to this, the reported incidence per year decreased by about 20% since the beginning and the following two years of the pandemic (2020–2022), possibly due to the lack of patient attendance at medical services due to fear of COVID-19 infection, which significantly reduced the number of cases reported to the SINAVE.

UC is an opportunistic infection that mainly affects women. In Mexico, at an epidemiological level, it is considered one of the 20 main causes of disease in the female population. In 2018 and 2019, urogenital candidiasis was found in thirteenth place, after peripheral venous insufficiency. Following the start of the COVID-19 pandemic, UC ranked fifteenth as a cause of disease. For 2021 and 2022, it reached seventeenth place, after the entry of influenza into the list of the main diseases in the female population of Mexico (Table 1). Although, UC includes candidiasis of the vulva and vagina, candidal vulvovaginitis, moniliasis vulvovaginitis, balanitis, and urethritis due to *Candida*. SINAVE does not specify the number of cases corresponding to each infection.

At the state level, the incidence of UC is variable, and this may be related to various risk factors present in the population: such as overweight or obesity, type II DM, immune status, pregnancy, cancer, socioeconomic activities, and characteristics of climatic conditions such as humidity. In this study, it was found that, during the five years evaluated, the states that reported a higher incidence of urogenital candidiasis

Figure 1

Incidence of urogenital candidiasis in the general population of Mexico classified by age groups in the period 2018–2022



Source: own elaboration.

Table 1

Main causes of illness in the female population of Mexico during 2018–2022

Diseases	Cases number per year				
	2018	2019	2020	2021	2022
1. Acute respiratory infections	13,702,702	13,285,490	7,788,281	5,802,104	8,944,889
2. Urinary tract infection	3,343,709	3,347,622	2,177,244	2,252,053	2,516,920
3. Intestinal infections due to other poorly defined organisms	2,890,069	2,890,118	1,369,714	1,505,889	1,731,975
4. COVID-19	NC	NC	773,980	1,288,864	1,824,186
5. Ulcers, gastritis and duodenitis	907,112	890,704	547,949	54,5097	579,533
6. Vulvovaginitis	659,569	648,473	453,588	474,854	510,602
7. Conjunctivitis	581,284	563,608	303,134	247,819	305,559
8. Acute otitis media	439,095	443,608	287,599	230,049	269,682
9. Gingivitis and periodontal disease	731,884	714,581	264,871	378,406	591,350
10. High blood pressure	295,634	309,323	237,958	277,851	331,914
11. Obesity	445,482	428,910	234,828	313,007	524,602
12. Influenza	NC	NC	191,460	114,346	141,297
13. Noninsulin-dependent diabetes mellitus (type II)	247,154	253,278	280,235	236,352	281,972
14. Poisoning from a scorpion sting	144,094	154,422	137,945	134,966	141,050
15. Urogenital candidiasis	168,448	155,385	110,072	110,158	109,937
16. Peripheral venous insufficiency	178,070	176,793	90,188	112,947	136,437
17. Streptococcal pharyngitis and tonsillitis	114,114	171,850	88,763	75,826	124,879
18. Asthma	133,476	141,060	73,744	NC	76,681
19. Pneumonia and bronchopneumonia	NC	NC	70,565	NC	NC
20. Intestinal amoebiasis	111,473	105,336	62,312	62,261	NC
21. Depression	89,571	93,500	NC	77,168	98,864
22. Domestic violence	74,724	81,975	NC	NC	NC
23. Other helminthiasis	74,724	NC	NC	NC	NC
24. Edema, proteinuria, and hypertensive disorders in pregnancy, childbirth, and the puerperium	NC	NC	NC	62,994	NC
25. Transport accidents in motor vehicles	NC	NC	NC	NC	72,492

Source: own elaboration.

NC=Not considered among the twenty main causes of disease during the evaluated period.

were Tamaulipas, Zacatecas, Nayarit, and Veracruz compared to those that showed a lower incidence, such as Mexico City, Querétaro, Sonora, and Aguascalientes (Figure 2). The main sources that reported cases of uc were the Ministry of Health (SSA), the Mexican Institute of Social Security-Welfare (IMSS-Bienestar), the Mexican Institute of Social Security-ordinary (IMSS-ordinary), and other health institutions. The proportion of the population mainly affected remained the same over the five years, being on average 93 % for women and 7 % for men. In the latter, urogenital candidiasis is not among the twenty causes of disease.

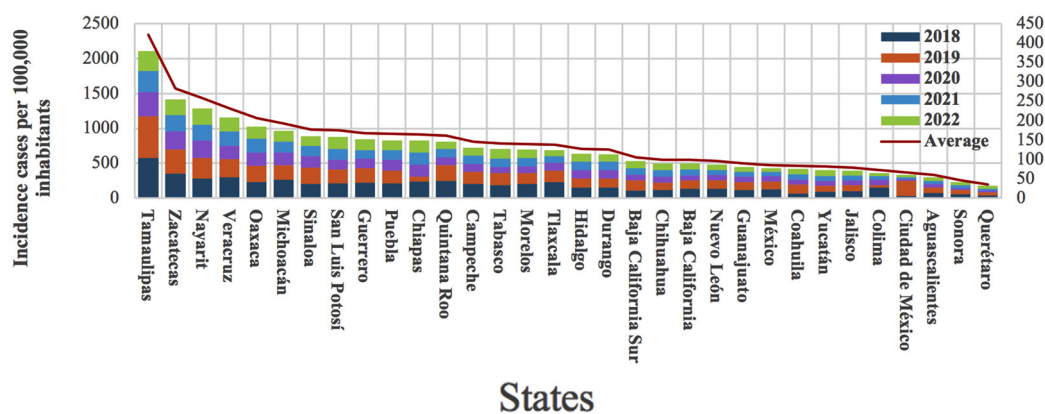
Discussion

GIs are a frequent cause of morbidity in individuals of both sexes and affects both outpatients and hospitalized patients. The microorganisms that cause these infections are mainly exogenous bacteria and fungi, as well as microbiota agents that, under predisposing conditions, can become pathogens that cause infections in the urinary and genital tracts. Some of the complications associated with urogenital infections are asymptomatic bacteriuria (AB), acute uncomplicated cystitis, recurrent cystitis, catheter-associated bacteriuria, catheter-associated UTIs, pyelonephritis, prostatitis, urethritis, pelvic inflammatory disease, and in pregnant women, complications such as premature births and, in some cases, intra-amniotic infection. During pregnancy, gynecological infections caused by *Candida spp.* have been linked to an increase in diseases and mortality in the newborn.^{14,15}

One of the main GIs that most frequently occurs in the female population is vvc. The proximity of the vagina to the outside is one of the factors that contributes to the fact that women are mainly affected by uc. In this study, the incidence of uc was analyzed in the Mexican population two years before the pandemic (2018 and 2019), at the start of the pandemic, and in the two following years (2020–2022). The population mainly affected by uc was found between 20–24 years, 45–49 years, and 25–44 years (Figure 1). The incidence in these age groups may be related to the beginning of active sexual life, alcohol and tobacco consumption, the appearance of sexually transmitted infections, hormonal therapy, and the use of intrauterine devices.^{9,10,16} In the case of the analyzed population of women aged 45–49 years, the incidence of uc could be related to the onset of menopause, since at this stage estrogen decreases, which leads to the disappearance of *Lactobacilli* that secrete lactic acid, a product of metabolism that maintains the acidic pH (<4 and >3.8) and thereby prevents the overgrowth of endogenous and exogenous microorganisms. Furthermore, low estrogen levels are associated with a thinning of the vaginal epithelium, which makes the tissue susceptible to tears and abrasions, contributing to the entry of pathogens.¹⁷ In addition to this, in the 45–49 years-old group, the appearance of comorbidities such as overweight/obesity and type II DM increases, considered risk factors for candidiasis and other infections. A study carried out on the Mexican population found a prevalence of overweight and obesity in adults of 38.3 % and 36.9 %, respectively. The authors highlight that those older adults aged 20 years or more showed a prevalence of abdominal obesity of 81 %, which was

Figure 2

Cumulative incidence of urogenital candidiasis in Mexico by state during 2018-2022.



Source: own elaboration.

associated with the appearance of chronic diseases such as hypertension, dyslipidemia, and type II DM,¹⁸ considered as risk factors for the development of fungal infections. Various authors emphasize that in both obesity and type II DM, there is an increase in proinflammatory cytokines produced by adipocytes and cells of the immune system, events that are associated with an uncontrolled immune response to opportunistic pathogens such as *Candida*.¹⁹ In a study carried out by Maftai et al.¹⁵ it was found that vulvovaginitis caused by *Candida spp.* is the most common infection in women and often increases in the first trimester of pregnancy, where it is initially asymptomatic, with *C. albicans* being the mainly isolated species and, in a lower percentage, *C. glabrata* and *C. krusei*. These types of infections increase the risk of spontaneous abortions and premature births. Furthermore, the presence of recurrent vulvovaginal candidiasis (RVVC) affects the quality of life of patients and impacts their work and social performance.^{5,20}

In 2020, the first year of the COVID-19 pandemic, UC was ranked fifteenth among the twenty main diseases affecting the female population in Mexico, compared to 2018 and 2019, which was ranked thirteenth. This may be mainly due to the decrease in patients who attended medical consultations due to fear of contagion from COVID-19, which resulted in a lower number of cases reported to the SINAVE. In the period evaluated, the first causes of illness in the population included acute respiratory infections, UTIs, and intestinal infections due to other organisms. Furthermore, starting from the first year of the pandemic, COVID-19 was ranked fourth among the main causes of disease in both the general population and the female population (Table 1). Various studies indicate that UTIs and complications associated with COVID-19 favor the appearance and recurrence of candidiasis in hospitalized patients. Some conditions that contribute to infection in these patients are the use of antibiotics, steroids, catheters, and probes. Unfortunately, the symptoms produced by *Candida* infections are like those caused by bacterial infections, making adequate and timely treatment difficult. In addition, in critically ill patients, candiduria should be considered as an indicator of possible invasive candidiasis.^{21,22}

In addition, more evidence is emerging of the role of the environment in promoting emerging and re-emerging infections, since many fungal species can grow at elevated temperatures. In a study carried out in Indonesia, it was found that 2.8 % of the population suffers from serious fungal infections each year, where the RVVC was estimated at 5 million/year in women between 15 and 50 years old and the incidence of candidemia was 26,710 cases. The authors emphasize that some of the factors that contribute to the development of these infections are the country's warm climate and tropical humidity, which favor the growth of various fungi and allergens.²³ Another characteristic that promotes the emergence of infections is the ability of fungi that infect mammals to develop thermotolerance because of climate change, which causes recurrent infections in humans. Some conditions that contribute to the survival and infectivity of pathogens are heat waves, high percentages of humidity, droughts, and floods.^{24,25} A similar behavior was reported in plant pathogenic fungi. Romero et al.²⁶ evaluated climatic factors promoting fungal disease outbreaks using the global electronic reporting system for emerging disease outbreaks (PROMED). They found that one of the main climatic conditions that favor the incidence of pathogens is humidity, 36.4 % of the publications of fungal outbreaks corresponding to the period 2014–2019 indicated that an increase in relative humidity could have influenced or was the cause of the fungal outbreaks.²⁶ These data coincide with those obtained in our study, where the states with the highest incidence of urogenital candidiasis were Tamaulipas, Zacatecas, Nayarit, Veracruz, and Oaxaca (Figure 1), which show in a large part of the territory a warm semi-humid climate with an average annual temperature of around 23° C.²⁷ We consider that the semi-humid climate could be favoring the incidence of urogenital candidiasis and other mycoses. Climate change may create environmental pressures that contribute to the emergence of new fungal diseases. For example, various studies indicate that *Candida auris* is

considered a multi-resistant pathogen in response to climate change. This fungus has a non-human environmental reservoir, and its appearance as an emerging pathogen is possibly related to the increase in agricultural and aquaculture activities, in which humans have greater contact with the agent.²⁴

uc, like other variants of infections caused by *C. albicans*, is influenced by the immune status of the individual. Some widely recognized risk factors for candidiasis and other opportunistic infections are obesity, type II DM, malnutrition, cancer, smoking, decreased estrogen, inappropriate use of antibiotics, and recurrent bacterial and fungal infections.^{9,28} Our results show that UTIs, vulvovaginitis, obesity, and non-insulin-dependent diabetes mellitus (type II) are among the twenty main causes of disease in Mexico and could favor the appearance of cases of uc, mainly in women (Table 1). Consistently, the symptoms of fungal and bacterial vaginitis are often confused, causing patients to have a misdiagnosis and a reduced quality of life.⁵

Unfortunately, few population studies show overweight/obesity and type II DM as risk factors for the development of uc. In a study carried out on 485 pregnant Mexican patients, 44.5 % presented gestational diabetes (GDM), and 92 % were overweight or obese,²⁹ regardless of whether they were patients diagnosed as healthy or with GDM, between 70 and 80 % of the evaluated population presented urinary infections, and between 18 and 24 % developed cervicovaginitis. This information contrasts with what was reported by Habak A. and Griggs R.,³⁰ who indicate that 25 % of pregnant patients can develop UTIs by not receiving treatment for an asymptomatic infection. Therefore, being overweight or obese could be contributing to the presentation of urogenital infections in the Mexican population.

Conclusions

This work shows that in Mexico, uc mainly affects the female population, which recurrently presents overweight or obesity, type II DM, UTIs, and vulvovaginitis. For all the above, it is necessary to perform more studies that demonstrate the association between comorbidities and the appearance of opportunistic diseases in the general population. Furthermore, identify the main species causing uc and their association with complications such as premature birth, abortion, recurrence of gynecological infections, and newborn mortality. In addition, promoting the detection and timely diagnosis of uc contributes to a better quality of life for the Mexican population.

Acknowledgments

The authors thank the National Epidemiological Surveillance System of Mexico for providing the country's statistical information.

Conflicts of interest

No conflicts of interest are declared.

Funding

No funding is declared.

References

1. Behzadi P, Behzadi E, Pawlak-Adamska EA. Urinary tract infections (UTIs) or genital tract infections (GTIs)? It's the diagnostics that count. GMS Hy-

- giene and Infection Control. 2019 Feb 18;14. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6449866/>
2. Medina M, Castillo-Pino E. An introduction to the epidemiology and burden of urinary tract infections. *Therapeutic Advances in Urology*. 2019 Jan;11(1):175628721983217. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6502976/>
3. Lanfranco OA, Alangaden GJ. Genitourinary Tract Infections. *Microbiol Spectr*. 2016 Aug;4(4). doi: 10.1128/microbiolspec.DMIH2-0019-2015. PMID: 27726778.
4. Obisesan OJ, Olowe OA, Taiwo SS. Phenotypic Detection of Genitourinary Candidiasis among Sexually Transmitted Disease Clinic Attendees in Ladoke Akintola University Teaching Hospital, Osogbo, Nigeria. *J Environ Public Health*. 2015; 2015:401340. doi: 10.1155/2015/401340. Epub 2015 May 7. PMID: 26064140; PMCID: PMC4438167.
5. Rosati D, Bruno M, Jaeger M, Ten Oever J, Netea MG. Recurrent Vulvovaginal Candidiasis: An Immunological Perspective. *Microorganisms*. 2020 Jan 21;8(2):144. doi: 10.3390/microorganisms8020144. PMID: 31972980; PMCID: PMC7074770.
6. Kadosh D, Mundodi V. A Re-Evaluation of the Relationship between Morphology and Pathogenicity in *Candida* Species. *J Fungi (Basel)*. 2020 Jan 13;6(1):13. doi: 10.3390/jof6010013. PMID: 31940968; PMCID: PMC7151024.
7. Cdc.gov. [accessed December, 2023]. Available from: <https://www.cdc.gov/fungal/antifungal-resistance.htm>
8. Macías-Paz IU, Pérez-Hernández S, Tavera-Tapia A, Luna-Arias JP, Guerra-Cárdenas JE, Reyna-Beltrán E. *Candida albicans* the main opportunistic pathogenic fungus in humans. *Rev Argent Microbiol*. 2023 Apr-Jun;55(2):189-198. doi: 10.1016/j.ram.2022.08.003. Epub 2022 Nov 18. PMID: 36411138
9. Gonçalves B, Ferreira C, Alves CT, Henriques M, Azeredo J, Silva S. Vulvovaginal candidiasis: Epidemiology, microbiology and risk factors. *Crit Rev Microbiol*. 2016 Nov;42(6):905-27. doi: 10.3109/1040841X.2015.1091805. Epub 2015 Dec 21. PMID: 26690853.
10. Farr A, Effendy I, Frey Tirri B, Hof H, Mayser P, Petricevic L, Ruhnke M, Schaller M, Schaefer APA, Sustr V, Willinger B, Mendling W. Guideline: Vulvovaginal candidosis (AWMF 015/072, level S2k). *Mycoses*. 2021 Jun;64(6):583-602. doi: 10.1111/myc.13248. Epub 2021 Feb 27. PMID: 33529414; PMCID: PMC8248160.
11. Yearbook 1984-2022 [accessed December 2023]. Available in: <https://epidemiologia.salud.gob.mx/anuario/html/index.html>
12. Reyes-Montes MDR, Duarte-Escalante E, Martínez-Herrera E, Acosta-Altamirano G, Frías-De León MG. Current status of the etiology of candidiasis in Mexico. *Rev Iberoam Micol*. 2017 Oct-Dec;34(4):203-210. doi: 10.1016/j.riam.2017.05.001. Epub 2017 Oct 10. PMID: 29032925.
13. Bohner F, Gacser A, Toth R. Epidemiological Attributes of *Candida* Species in Tropical Regions. *Curr Trop Med Rep*. 2021. (8): 59–68. doi: <https://doi.org/10.1007/s40475-021-00226-5>
14. Gupta K, Grigoryan L, Trautner B. Urinary Tract Infection. *Ann Intern Med*. 2017 Oct 3;167(7):ITC49-ITC64. doi: 10.7326/AITC201710030. PMID: 28973215.
15. Maftai NM, Arbune M, Georgescu CV, Elisei AM, Iancu AV, Tatu AL. Vulvovaginal Candidiasis in Pregnancy-Between Sensitivity and Resistance to Antimycotics. *J Xenobiot*. 2023 Jul 5;13(3):312-322. doi: 10.3390/jox13030023. PMID: 37489336; PMCID: PMC10366840.
16. Nelson TM, Borgogna JC, Michalek RD, Roberts DW, Rath JM, Glover ED, Ravel J, Shardell MD, Yeoman CJ, Brotman RM. Cigarette smoking is associated with an altered vaginal tract metabolomic profile. *Sci Rep*. 2018 Jan 16;8(1):852. doi: 10.1038/s41598-017-14943-3. PMID: 29339821; PMCID: PMC5770521.
17. Mohankumar B, Shandil RK, Narayanan S, Krishnan UM. Vaginosis: Advances in new therapeutic development and microbiome restoration. *Microb*

- Pathog. 2022 Jul;168:105606. doi: 10.1016/j.micpath.2022.105606. Epub 2022 May 26. PMID: 35644292.
18. Campos-Nonato, I., Óscar Galván-Valencia, L. Hernández-Barrera, C. Oviedo-Solís, and S. Barquera. "Prevalence of Obesity and Associated Risk Factors in Mexican Adults: Results of the Ensanut 2022". *Salud Pública De México*, vol. 65, June 2023, pp. s238-s247, doi:10.21149/14809.
19. Ray A, Bonorden MJL, Pandit R, Nkhata KJ, Bishayee A. Infections and immunity: associations with obesity and related metabolic disorders. *J Pathol Transl Med*. 2023 Jan;57(1):28-42. doi: 10.4132/jptm.2022.11.14. Epub 2023 Jan 15. PMID: 36647284; PMCID: PMC9846011.
20. Miró MS, Rodríguez E, Vigezzi C, Icely PA, Gonzaga de Freitas Araújo M, Riera FO, Vargas L, Abiega C, Caeiro JP, Sotomayor CE. Candidiasis vulvovaginal: una antigua enfermedad con nuevos desafíos [Vulvovaginal candidiasis: An old disease with new challenges]. *Rev Iberoam Micol*. 2017 Apr-Jun;34(2):65-71. Spanish. doi: 10.1016/j.riam.2016.11.006. Epub 2017 Apr 18. PMID: 28431891.
21. Kauffman CA, Fisher JF, Sobel JD, Newman CA. Candida urinary tract infections--diagnosis. *Clin Infect Dis*. 2011 May;52 Suppl 6: S 452-6. doi: 10.1093/cid/cir111. PMID: 21498838
22. Ahmed N, Mahmood MS, Ullah MA, Araf Y, Rahaman TI, Moin AT, Hosen MJ. COVID-19-Associated Candidiasis: Possible Patho-Mechanism, Predisposing Factors, and Prevention Strategies. *Curr Microbiol*. 2022 Mar 14;79(5):127. doi: 10.1007/s00284-022-02824-6. PMID: 35287179; PMCID: PMC8918595.
23. Wahyuningsih R, Adawiyah R, Sjam R, Prihartono J, Ayu Tri Wulandari E, Roza-liyani A, Ronny R, Imran D, Tugiran M, Siagian FE, Denning DW. Serious fungal disease incidence and prevalence in Indonesia. *Mycoses*. 2021 Oct;64(10):1203-1212. doi: 10.1111/myc.13304. Epub 2021 Jun 25. PMID: 33971053.
24. Nhadi NE, Carter DA. Climate change and the emergence of fungal pathogens. *PLoS Pathog*. 2021 Apr 29;17(4): e1009503. doi: 10.1371/journal.ppat.1009503. PMID: 33914854; PMCID: PMC8084208.
25. Gadre A, Enbale W, Andersen LK, Coates SJ. The effects of climate change on fungal diseases with cutaneous manifestations: A report from the International Society of Dermatology Climate Change Committee. *J Clim Chang Health [Internet]*. 2022;6(100156):100156. Disponible en: <http://dx.doi.org/10.1016/j.joclim.2022.100156>
26. Romero F, Cazzato S, Walder F, Vogelgsang S, Bender SF, van der Heijden MGA. Humidity and high temperature are important for predicting fungal disease outbreaks worldwide. *New Phytol*. 2022 Jun;234(5):1553-1556. doi: 10.1111/nph.17340. Epub 2021 Apr 12. PMID: 33713447.
27. Instituto Nacional de Estadística y Geografía (INEGI). Banco de indicadores. 1998 [accessed December 2023]. Available in: <https://www.inegi.org.mx/app/indicadores/?t=265&ag=28>
28. Willems HME, Ahmed SS, Liu J, Xu Z, Peters BM. Vulvovaginal Candidiasis: A Current Understanding and Burning Questions. *J Fungi (Basel)*. 2020 Feb 25;6(1):27. doi: 10.3390/jof6010027. PMID: 32106438; PMCID: PMC7151053.
29. Violante Ortiz R, Reyna-Beltrán E, Requena-Rivera CA, Tavera Tapia A. Prevalencia, factores de riesgo y desenlaces asociados a la Diabetes Mellitus Gestacional según los criterios IADPSG y NICE en México. *RECEIN [Internet]*. 21ago.2023 [citado 19ene.2024];15(60):01-2. Available from: <https://revistasinvestigacion.lasalle.mx/index.php/recein/article/view/3506>
30. Habak PJ, Griggs, Jr RP. Urinary Tract Infection in Pregnancy. [Updated 2023 Jul 4]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK537047/> (accessed December 2023)