

## Transdisciplinarity of Vulvovaginal Candidiasis from a Social-Environmental Education Perspective

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### Abstract

*Vulvovaginal candidiasis stems from the imbalance between the fungus, woman, and environment. This study aimed to describe the genital infection in an ecological vision to identify the risk factors and socio-environmental prophylactic education measures. This descriptive study employed the qualitative and bibliographical methods used in selected scientific articles. The descriptors used were biomedical model, ecological triad, natural history of the disease, systemic model, vaginal ecosystem, and women's disorders. The holistic approach broadens the knowledge of pathogenesis, characterizes risk factors, and identifies the links in the chain of events where prophylactic measures may be applied.*

**Keywords:** *Candida; Transdisciplinarity; Ecological vision*

## 1 Introduction

Environmental transdisciplinarity is a pluralistic and scientific approach to knowledge in order to understand a particular situation of the environment through the analysis of the elements that pass between, through, and beyond the disciplines. The acquisition of increasing amounts of scientific knowledge has induced segmentation in areas, courses, and disciplines. The division of knowledge into compartments propelled the specialization of professionals to meet the needs of the modernization of the society. In this way, a great part of the knowledge was grouped into disciplines to facilitate learning and its social application. However, this fragmented division of knowledge had limitations in the situations of paradoxes, uncertainties, challenges, unpredictability, and instability. Environmental transdisciplinarity emerged as a need to reestablish the integration and contextualization of nature and human beings that were lost with the compartmentalized division (SANTOS, 2008; LUZ, 2009; SOUZA et al., 2015).

René Jubos Dubos, one of the most important microbiologists of the 20th century and a pioneer philosopher in raising human awareness on environmental issues, was the first author to use the term “medical ecology.” He highlighted the dimension of the environment as one of the determinant factors in the health-disease process through his work in 1939, with research on tropical diseases. However, much earlier studies used the term “medical ecology.” Hipócrates (460–377a.C) described in his famous book about air, water, and places the environment as determinant of health and disease. This study aimed to discuss the concept of medical ecology and identify the factors that affect the interaction between the individual and the environment. Medical ecology is also known as environmental medicine, ecomedicine, or ecologic medicine. A disease is a result of the imbalance between the host and the environment. Hence, environmental medicine aims to reintegrate the individual to the environment. The ecosystem, which consists of biotic and abiotic factors, was analyzed. The analysis not only focuses on the disease but also on the individual and their interactions. Medical ecology is not considered a specialty or area of activity, since it consists of a holistic strategy aimed at restoring and maintaining the balance of man's relationship with nature, treating the pathologies that caused the imbalance (LOBO, 2011).

The current conception of understanding the health-disease reinforces that the human being must be studied in his physical, biological, social, cultural, and economic environment. These media represent the causal, predisposing, or determinant factors of the health-disease process and produce infectious and parasitic diseases. In the holistic and multicausal approach, the infectious agent is considered only as one of the causes of the disease (CÂMARA et al., 2012; DIAS-LIMA, 2014). (An example of an infection that should be studied in relation to medical ecology is vulvovaginal candidiasis (CVV), an infection that results from the abnormal growth of opportunistic fungi of the genus *Candida* MURRAY, ROSENTHAL, PFALLER, 2014). The most frequent species is *Candida albicans*, which accounts for more than 90% of the cases. Other isolated species are *C. glabrata*, *C. tropicalis*, *C. krusei*, *C. lusitaniae*, and *C. parapsilosis* (KENNEDY; SOBEL, 2010).

Most of the patients who develop the infection are healthy and immunocompetent and have no known predisposing factors (LEMA, 2017; HÖFS; MOGAVERO; HUBE, 2016). The fundamental point for the elucidation of the CVV pathogenesis is to identify how the fungus ceases to be a commensal microorganism in the vaginal microbiota. It is not known how the factors of the host alter the vaginal microenvironment, reducing the defense mechanisms and accenting the factors of virulence of the fungus (FIDEL, 2007; GONÇALVES et al., 2016; OEVER; NETTEA, 2014; ZAMITH et al., 2013).

In this context, this study aimed to establish the theoretical assumptions about the environmental transdisciplinarity of CVV in the prevention of risk factors associated with infection. For this, the qualitative and

bibliographic methods were applied, by means of scientific articles, using the following descriptors: environmental transdisciplinarity, CVV, prevention, risk factors, medical ecology, and ecological triad.

### 1.1. Medical Ecology

Ecological medicine encompasses the principles of uniqueness and integrality, with a focus on the ecosystem and with the understanding that the focus is not only on the biological aspect of the disease but also on the fact that man is not isolated in that system. The principle of uniqueness emphasizes that each individual is unique in the universe and maintains its biochemical individuality, presenting different reactions to environmental modifications. However, the principle of integrality emphasizes the interconnection of biotic and abiotic factors with the environment, establishing a great network where any simpler action reverberates to varying degrees in all its components. The different modifications of the physiological factors that contribute to the emergence of the diseases maintain a connection between them. Therefore, all beings are integrated and everything that man modifies in the environment generates consequences throughout the ecosystem and its components (DIAS-LIMA, 2014).

In medical schools, students are trained to take care of the disease in the biological gaze and with little preparation for the study at the ecosystem level. The emphasis of treatment is on suppressing the effect or symptom rather than on controlling or eliminating the cause of the disease in a comprehensive ecosystem view. The implementation of ecological discipline with a transdisciplinary focus is of fundamental importance in the training of health professionals. The environment should not be perceived as something that is outside the individual and of secondary relevance to the generation of diseases. Human beings belong to the environment or, more precisely, are a constituent part. They remove everything that is essential for their survival. The current conception of understanding the health-disease process reinforces that the human being must be studied in his physical, biological, social, cultural, and economic environment. These media represent the causal, predisposing, or determinant factors of the health-disease process and produce infectious and parasitic diseases. In the holistic and multicausal approach, the infectious agent is considered only as one of the causes of the disease (CÂMARA et al., 2012; DIAS-LIMA, 2014).

### 1.2 Biomedical Vision of CVV

According to Sobel (2007), the CVV is a monomicrobial disease, but the cause is multifactorial. It is common among women of reproductive age, especially in countries with hot and humid climate. In the United States, more than 10 million gynecological consultations are performed annually. The consultations and treatments, together with loss of productivity, costs 1 billion dollars. Approximately 75% of women presented at least one episode of this infection during their lifetime, of which 40%–50% will experience new outbreaks and 5% will have recurrent disease. Its true incidence remained unknown because it is not a notifiable disease, and the information is based on epidemiological studies with different methods and samples. In a research conducted in the State of Maranhão, Sá et al. (2014) reported a 42.86% prevalence of positive fungal cultures. For Gonçalves et al. (2016), studies published in recent years have reported an incidence ranging from 12.1% to 57% depending on the region and study population.

Among the predisposing factors, the most common were recent use of antibiotics, use of corticosteroids, high carbohydrate diet, use of oral contraceptives, diabetes, pregnancy, hyperestrogenic states, use of tight clothing, absorbent, and immunological deficiencies. It was speculated that inappropriate hygienic habits may favor vaginal contamination, especially anal hygiene performed from the anus to the vagina and the presence of fecal waste in the underwear (ROSA; RUMEL, 2004; LEMA, 2017). CVV has the following clinical characteristics: intense vulvar

pruritus; whitish vaginal discharge in lumps, which adheres to the vaginal walls; dysuria; edema; excoriations; and vulvovaginal erythema (HOLANDA et al., 2006).

Genital infection is not a serious disease, but its morbidity is relevant because it causes emotional disturbances, such as pain, pelvic discomfort, low self-esteem, and anxiety; impairs performance at work; and interferes with affective and sexual relationships (SOBEL, 2007). CVV is a disease described since antiquity and continues to exist with high incidence and many challenges to the clarification of its natural history. Despite the multiple advances made on the environment, etiologic agent, and host, the pathology of CVV remained unclear (MIRÓ, 2017).

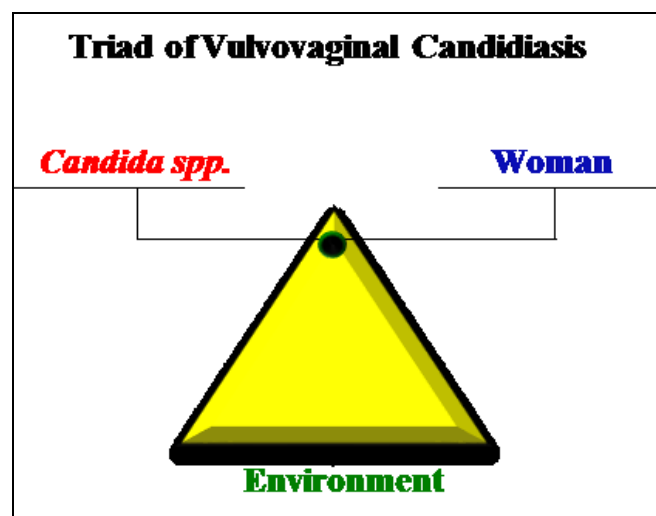
## 2 Explanatory models of the health-disease process

### 2.1. Ecological Triad

In the biomedical model, Pereira (2016) revealed that people were evaluated both in their healthy and sick states, according to the results obtained from clinical and laboratory tests, which evidence the presence or absence of abnormalities. Health is perceived as the “absence of disease” and disease as the absence or alteration of health. The World Health Organization defines health as a complete state of physical, mental, and social well-being, not just the absence of disease. In the study of infectious diseases, the unicausal model, based on a single cause to explain the origin of the disease, was replaced by the ecological model, which is complemented by the natural history of the disease. This model, called the ecological triad or epidemiological triad, was proposed by Leavell e Clark in 1976 and is based on a multicausal view of the disease. The vertices of the triangle are occupied by the agent, host, and environment that represent the etiological or causal factors of the disease.

The causal factors of CVV can be distributed in the ecological triad: the agent *Candida spp.*, the female host, and the environment (Figure 1). The health-disease state depends on the dynamic balance of the components of this interrelationship. The fungus alone is not enough to trigger genital infection because the outbreak of the disease stems from the imbalance involving all the factors of this interaction (LAPREGA, 2011).

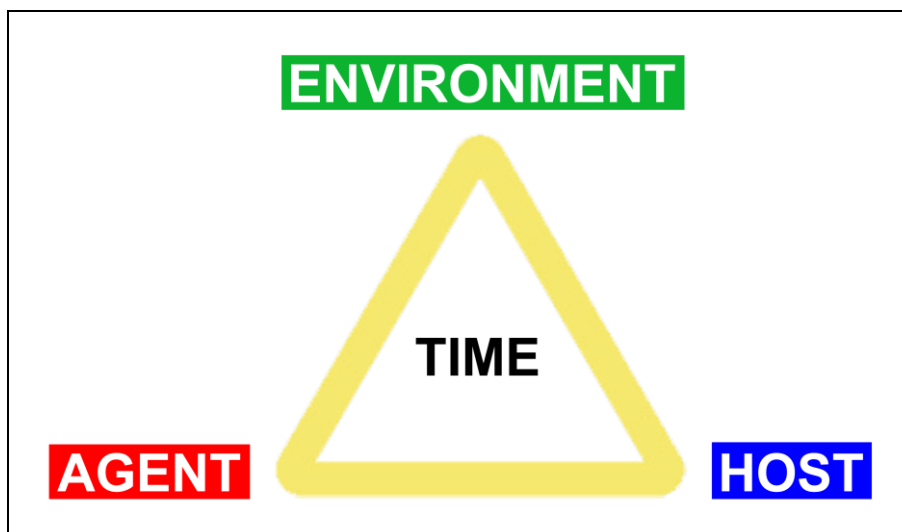
Figure 1 – Ecological triad or disease triangle of vulvovaginal candidiasis



Source: Adapted from CDC, 2012

Francel (2001) reported that time is the fourth element that can be added in this multicausal model to analyze the temporal aspect of each component (Figure 2). A more appropriate model to explain the health-disease process is to convert the triad into a pyramid. Time is an essential dimension and has been added in the ecological triad to emphasize that the onset and intensity of the disease can be influenced by the length of time the three main factors are aligned. The disease will occur depending on the duration of a favorable alignment of these factors involved. The physiological changes in the host that characterize the disease can occur in minutes or hours, whereas the symptomatology of the disease can take days or weeks to appear. Scholthof (2007) pointed out that the use of temporal relations between environment, host, and infectious or abiotic agent improves the understanding of the health-disease process and guides conducts to predict and control the disease.

Figure 2 – Ecological pyramid of disease



Source: Adapted from Francel, 2001

The etiologic agent may be a biotic agent (microorganism) or an abiotic agent (physical, chemical, or mechanical). The host is the living being that shelters and subsists the infectious agent in natural conditions. The environment is the set of instances and processes that maintains interactive relations between the agent and the host (CDC, 2012). According to Rouquayrol (2013), in the epidemiological analysis of the environmental factors of the disease triad, the term environment has a broader scope than is given in the field of environmental sciences and encompasses both the natural habitat and the man-made environment. Environment is represented by factors external to the host and includes the physical environment that provides the conditions for survival, the biological environment that lodges all living beings, and the social environment that surrounds the society that is the seat of social, political, economic, and cultural interactions.

The triangle can be used to search for transdisciplinary environmental and economic solutions to diseases. In this model, the disease is explained by the interrelationships between “agent-host,” “agent-environment,” and “host-environment,” as well as the whole environment, agent, and host. The disease occurs as a result of the imbalance of this interrelationship (PEREIRA, 2016).

Scholthof (2007) described that the environment is a determinant cause of infectious disease in man and vegetables and was undervalued in the history of medicine, particularly in the early and mid-twentieth century, after the

germ theory became a dogma. Although moderation has taken place from this point of view, many researches still focus on the interactions of the host and etiological agent, disregarding the relevance of the participation of the environment in the outcome of the disease. Panackal (2011) described the impact of global climate change on the development of fungal infections in humans through the classic paradigm of the disease triangle. In this model, the presence of a pathogen with its virulence factors, a favorable environment, and a susceptible host with behavioral and immunological changes is necessary for the infectious disease to occur.

The disease triangle can be considered sub-articulated, but it strengthens its usefulness because it allows the complex analysis of relationships and provides flexibility to acquire new and interconnected ideas about the role of the environment in the development of the disease. It is a holistic and empirical tool that highlights the relevance of habitat, climate change, and social policies as contributing factors to health or disease (SCHOLTHOF, 2007).

## 2.2. Natural History of the Disease

The natural history of the disease occurs in two periods that articulate and complement each other: pre-pathogenic and pathogenic. In the pre-pathogenic period, interactions between environmental and social determinants occur until the disease is established in the individual. The factors that cause damage to the living being, producing disease, are called pathogens. Such agents may be physical, chemical, biopathogenic, nutritional, and genetic. No single pathogen is sufficient to trigger the pathological process (PEREIRA, 2016).

The installation of the disease also depends on contributing factors or environmental, biological, socioeconomic, socio-cultural, and psychosocial factors. The force that will act as the pathological stimulus will be bigger according to the structuring of these determinant factors. The association of factors may be synergistic; that is, articulated factors may increase the risk of the disease more than it would make the simple sum of its isolated effects. The situations of minimum and maximum risk will depend on the presence of factors and their interrelationships (ALMEIDA FILHO; ROUQUAYROL, 2017).

In the pathogenic period, the pathological process is active because the biochemical, cytological, and histological changes in the host occur. There are different degrees of impairment, and the clinical manifestations may be mild, moderate, or severe. The disease may be cured, develop sequelae, progress to chronicity, or cause death (PUTTINI; PEREIRA JUNIOR; OLIVEIRA, 2010; ROUQUAYROL; GOLDBAUM; SANTANA, 2013).

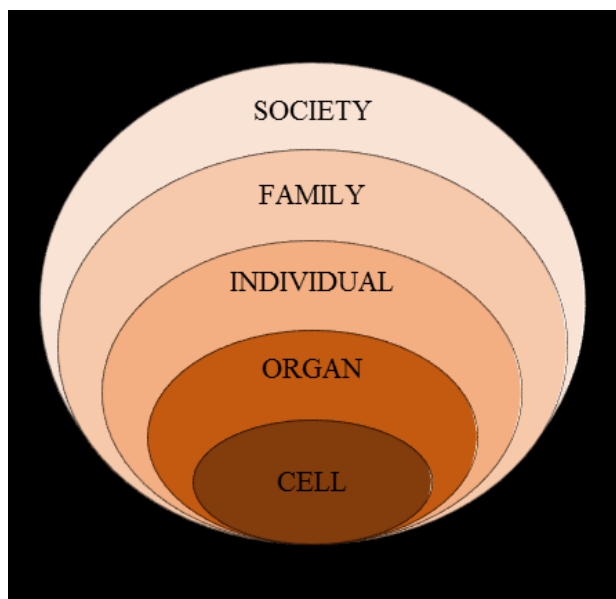
## 2.3. Systemic Model

A health problem situation can be demonstrated as a system or a set of interconnected elements that function as an organized structure. This type of explanatory model of the health-disease process adds a robust ecological substrate based on the causes placed in different levels of organization of health problems. It is structured in circles of progressively larger diameters. The external position involves other components such as the society, which includes the family consisting of individuals, which in turn are composed of organs and tissues organized in functional systems (cardiovascular, respiratory, and others) and formed by cells that are at the lowest level of organization. Depending on the theme, the model structuring process could continue in smaller structures such as molecules and atoms (PEREIRA, 2016).

Each of the circles represents a system and corresponds to the level at which the explanation of the damage to health is sought. The systemic model involves the causal or predisposing factors of biological, social, cultural, economic, and environmental origin. Investigation of the disease may be limited to intracellular enzymatic changes or proceed with a more comprehensive assessment of the individual, involving the family and society (Figure 3). The more

central the search for determinants, the greater will be the reduction of the explanation of the damage to the biological aspects (biomedical or technical view). The further away from the center is the explanation, the greater the approach to social aspects (holistic, collective, political, and social view). Explanations of health impairment can be investigated at any of the levels or on all levels of causation mentioned. A holistic view provides more information than the fractional view of the biomedical model (PUTTINI; PEREIRA JÚNIOR; OLIVEIRA, 2010; PEREIRA, 2016)

Figure 3 – Systemic model of the health-disease process



Source: Adapted from Pereira, 2016

### 3 Ecology, resistance and resilience of the vaginal ecosystem

The vagina should be understood as an ecosystem consisting of the microbiota or set of microorganisms such as bacteria and fungi that have the function of decomposing organic matter and recycling nutrients. Lactobacilli are the predominant microorganisms in the vaginal environment, determine acid pH (3.8 to 4.5), and prevent the growth of bacteria that could cause damage to the vaginal mucosa (OEVER; NETEA, 2014; LEWIS; BERSNSTEIN; ARAL, 2017).

The production of lactic acid and acidifying vaginal pH may protect the vagina against the proliferation of microorganisms and maintain a healthy vaginal ecosystem. Women with low fungal concentrations in the vaginal environment and with no symptoms are considered asymptomatic carriers. The complex interactions between the vaginal microbiota, hormonal status, vaginal pH, microbial metabolism products, and host immune status maintain the stability of the vaginal ecosystem. The frequent variation of genetic polymorphisms between ethnic-racial groups may be related to differences in the composition of the normal vaginal microbiota (LINHARES; GIRALDO; BARACAT, 2010).

Van de Wijgert (2017) reported that vaginal microbiota is needed to maintain a woman's health and protect against infection. The relationships between urogenital complications and host responses involve the microorganisms of the vaginal canal. Green colors signal desirable conditions and red colors indicate undesirable conditions. In both cases, the size of the circle is related to its prevalence. The author highlighted the need for a holistic approach in this analysis.



Inflammatory complications include human immunodeficiency virus, pelvic inflammatory disease, adverse pregnancy outcomes, and maternal (chorioamnionitis) and neonatal infections.

A vaginal ecosystem may exhibit differences in the community of microorganisms. Resistance stems from the ability to resist functional change or its structure in the face of an adverse event, while resilience reflects the ability to recover from an adverse event and return to the initial state of equilibrium. An adverse event stems from an environmental change that affects the population density, thus increasing or decreasing the number of microorganisms and modifying the community function. Communities that suffer from a disorder may or may not return to their previous state (HICKEY et al., 2012).

## 4 Physical and social environment of CVV

### 4.1 Physical environment of CVV

The physical environment is the inanimate world that involves the individual and has a direct or indirect effect on health. Geographic situation, soil, climate, water resources and topography, and chemical and physical agents are the main components of the physical environment (PEREIRA, 2016; ROUQUAYROL; GOLDBAUM; SANTANA, 2013). The interrelationships between climate and human health depend on the intensity and duration of the change of time and susceptibility of the host. These factors may change according to location, individual, and population. The study of climates (natural fact), urban climate (social fact), and health (biological fact) is broad and complex. Environmental knowledge goes beyond the boundaries of environmental sciences and incorporates natural phenomena, social phenomena, ethical values, and political and cultural processes. These processes and phenomena change the relationships between society and nature and establish a broader concept of environment. The vision of environmental health should include the social causes of the disease and abandon the reductionist ecological conceptions (MCMICHAEL; WOODRUFF; HALES, 2006; SETTE; RIBEIRO 2011).

Psychoneuroimmunology examines how human stress, caused by the environment, can depress the immune system. Climatic influences, for example, favor changes in man's behavior by encouraging him to remain in clusters in enclosed areas during the cold season, thus facilitating greater exposure to communicable diseases. Thermal comfort relates to human well-being through temperature, humidity, atmospheric pressure, lighting, and wind. Depression and suicide are related to the short period of sunshine in winter, especially in high latitude countries such as Sweden. However, joy comes when spring comes. An increase in heat or excess of cold changes the health and well-being of individuals in various ways. The combination of high and low temperature rhythms produces a colder sensation of thermal comfort, with a tendency to hypothermia (body temperature below 35°C). Heart rate and respiration may decrease, causing blood vessel contraction to increase (FERREIRA, 2003 *apud* SETTE; RIBEIRO 2011).

Confalonieri and Marinho (2007), based on the fourth report of the Intergovernmental Panel on Climate Change, described the three mechanisms of action of climate change on population health. These mechanisms occur through direct effects of extreme climatic events, effects on the environment altering determinants of human health, and effects of climatic events on social processes, determining socioeconomic, cultural, and demographic ruptures.

Rhythm is a fundamental feature of life. The morphology and function of all living beings present periodic changes so that the organism synchronizes with the geophysical rhythms of the environment. The change from day to night and the seasons of the year can be analyzed through daily or circadian rhythms present in animals and in man. Awakening from sleep, regulation of body temperature, and hormone levels vary within 24 hours, and affective



disorders predominate during autumn and winter. Many infectious diseases caused by viruses, bacteria, and fungi are often seasonal (RIETVELD; BOON; MEULMAN, 1997; DOWELL, 2001).

According to Fares (2013), seasonal patterns of infectious diseases have been recognized since the Hippocratic era. However, the mechanisms of these relations are still poorly understood. In the article, the author reported that climate changes influence human activity, seasonal variability of the human immune system, seasonal variations of vitamin D level, melatonin seasonality, and pathogen virulence. Panackal (2011) pointed out that global climate change through rising temperatures and changing precipitation patterns lead to different patterns of infectious diseases in all space and time. Although the seasonality of viral respiratory diseases, gastrointestinal infections, and vector-borne diseases is more conclusive, geoclimatic influences on fungal diseases remain unclear. At the conclusion of the article, this author pointed out the possibility that fungal infections may be caused by biogeoclimatic factors.

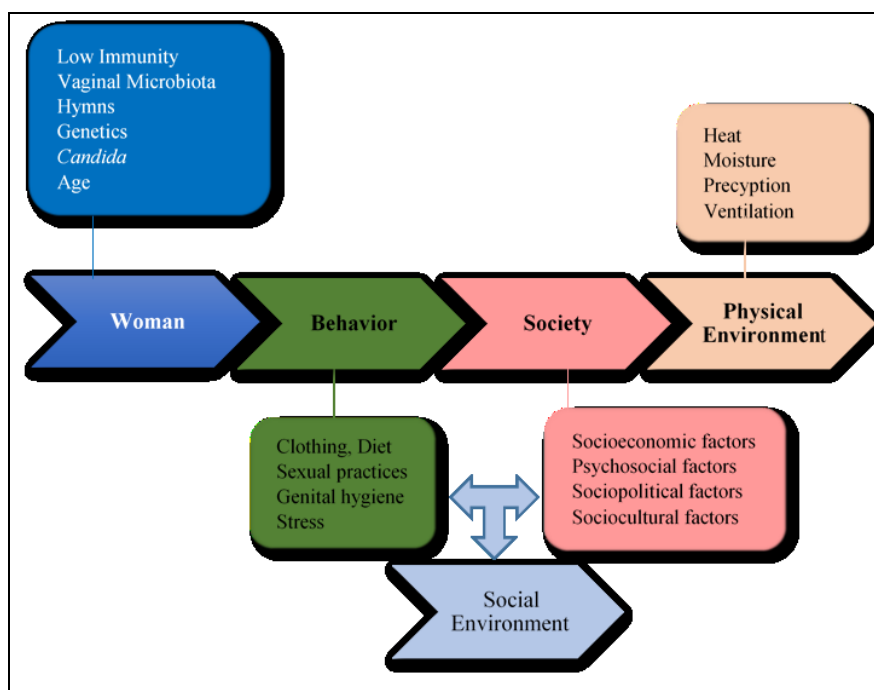
According to Faria (2012), gynecologists and women have the perception that there is an increase in the number of cases of CVV in the summer, due to the more intense heat and greater permanence with wet clothes, causing changes in the vaginal microbiota. However, in the study conducted, there was no increase in the incidence of CVV cases during the summer. In a study on the seasonal frequency of bacterial vaginosis and *Candida* spp., Silva et al. (2017) also found that climate had no influence on the frequency of genital infections. Buthe (2016), in a survey carried out in India, found a greater number of cases (52.49%) of CVV during the rainy season, followed by 35.49% in summer and 11.76% in winter. Takei, Ruiz, and Hicks (2006) described a seasonal variation of *Candida* spp., which was higher in winter (14.9%) and lower in summer (7.9%) and spring (7.5%). These authors emphasized that there were few published studies addressing the seasonal variation of genital infections and their results were contradictory. For them, it was necessary to study sociodemographic and epidemiological factors to better understand the factors related to seasonal variations.

#### 4.2 Social Environment of CVV

The social environment corresponds to the group of factors that cannot be identified as genetic components or physical, chemical, and biological agents (Figure 4). It is the human part of the environment that is formed by the relationships between people and their insertions in society. Social factors can be classified as socioeconomic, psychosocial, sociopolitical, and sociocultural. The social factor is essential in the preservation or recovery of an individual's health. The disease has its origin in social processes, evolves through environmental relations, and reaches the susceptible individual through the direct action of physical, chemical, biological, and psychological agents (PEREIRA, 2016; ROUQUAYROL, 2013).

According to Pereira (2016), social inequality was among the factors associated with the development of disease and determined the extent to which preventive and curative measures are needed. Irving et al. (1998), in the study on psychological factors associated with recurrent candidiasis, did not find significant differences in demographic factors and sexual health problems. However, they reported that women with recurrent CVV have a higher propensity for depression, lower self-esteem, and impairment in their sexual and emotional relationships.

Figure 4 – Physical and social environment of vulvovaginal candidiasis



Source: Modified from Pereira, 2016

## 5 Conclusions

Frequently, candidiasis is analyzed as a relation between etiologic agent, pathophysiological changes and a set of signs and symptoms. In the health-disease process, the interrelated woman and her environment is placed on a secondary plane. The priority is centered on the disease, not the patient, establishing a clear separation between environment and women's health. CVV is a disease with a multifactorial etiology and demands strategies of public policies and educational actions with preventive measures to reduce exposure to various risk factors. To control the fragmentation of the health-disease process in CVV, transdisciplinarity adds reflections and principles studied in medical ecology and emphasizes that women are not isolated from the environment because it is an integral part and interacts with all the associated components.

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