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The burden of serious fungal infections in Sierra Leone: a national estimate

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***Abstract*:** Sierra Leone is a small, resource-limited country that has a low national prevalence of human immunodeficiency virus (HIV) and a very high burden of tuberculosis (TB). Fungal diseases are probably common, but poorly documented. In this article, we reviewed the existing literature on fungal epidemiology in Sierra Leone using national, regional, and international data, identified knowledge gaps, and propose solutions to address the challenges on the prevention and control of fungal diseases in Sierra Leone and similar countries. In advanced HIV disease, we estimate 300 cryptococcal meningitis, 640 *Pneumocystis* pneumonia, and over 4000 esophageal candidiasis cases annually. Chronic lung disease is common, with an estimated 6000 cases of chronic pulmonary aspergillosis, many mistaken for TB, 5000 adults with allergic bronchopulmonary aspergillosis complicating asthma, and probably over 6600 cases of severe asthma with fungal sensitization. Invasive aspergillosis is estimated at 478 cases. None of these diagnoses are made in Sierra Leone at present. Major burdens are recurrent vulvovaginal candidiasis (85,400) and tinea capitis in children (266,450). Improvement in fungal disease diagnosis in Sierra Leone will enable better estimates to be made and reduce morbidity and mortality.

Keywords: advanced HIV disease, burden, fungal diseases, tuberculosis

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Introduction

Despite being a major global health problem, the burden of fungal infections in resource limited countries is largely unknown.[1] Latest estimates of the global burden of fungal infections have demonstrated a huge burden of endemic, superficial, and invasive fungal diseases.[2]

Owing to the high cost and limited diagnostic services for the assessment of people with fungal infections, data on the prevalence rates of fungal infections is scarce in low- and middle-income countries (LMICs). Despite the gaps in the data on fungal infections in Africa and some parts of Asia, about 1.5 million deaths are attributable to fungal infections every year. Of these, invasive candidiasis and cryptococcal diseases are the best studied.[3]

The prevention and control of fungal diseases remains a major challenge, especially in resource-poor countries, despite their likely large burden. In order to improve on this, the World Health Organisation (WHO) has expanded the list of neglected tropical diseases in its portfolio since 2017 to include fungal diseases like mycetoma, chromoblastomycosis, sporotrichosis and other deep mycosis.[4] Global efforts towards this initiative are expected to significantly affect the control and prevention of fungal diseases considering the overarching goal of 90% reduction in the number of people requiring treatment for neglected tropical diseases and a 75% reduction in the neglected tropical diseases-related disability-adjusted life years (DALYs) by 2030.[5] Through research and routine monitoring, followed by data-driven interventions, global efforts to continuously detect and

adequately manage fungal infections and other neglected tropical diseases are critical to achieving these global goals.[5]

The drive to improve on the detection, management, and prevention of fungal diseases requires innovative strategies. The public health experience in the control of neglected tropical diseases (NTDs) can be directed to fungal diseases. Global, regional, and sub-regional collaborative initiatives such as the Expanded Special Project for the Elimination of Neglected Tropical Diseases (ESPEN) can be explored in the effort to control fungal diseases.[6]

Even with different strategies, fungal diseases may still be the main cause of morbidity and mortality in sub-Saharan Africa because they disproportionately affect the poor in tropical and subtropical regions.[7] As the epidemiology of the disease shifts to the double burden of infectious and non-communicable diseases,[8] it is expected that the burden of deep mycosis and other fungal diseases in sub-Saharan Africa will also increase. For example, between 2006 and 2016, the global incidence of cancer in men and women increased by 38%.[9] In response to these emerging health challenges, improvements in medical practice have also been observed, which has also contributed to the increase in the burden of fungal infections.

Sierra Leone is a low-resource country on the West Coast of Africa that has experienced a number of challenges in recent years. These include a decade-long civil war spanning from 1991 to 2002[10] and a devastating Ebola epidemic in 2014/2016[11] with a huge effect on its health service delivery. The 2014/2016 Ebola outbreak disrupted the development of laboratory processes, which may have caused significant diagnostic challenges when mapping Sierra Leone's fungal diseases.[12]

At the moment, the country has limited infrastructure to enable the diagnosis, management, prevention, and control of fungal diseases. Notwithstanding, data from a recent study on cryptococcal diseases in Sierra Leone demonstrated a substantial burden among patients with advanced human immunodeficiency virus (HIV) disease.[13]

In this article, we reviewed the existing literature on fungal epidemiology in Sierra Leone, identified knowledge gaps, and propose solutions to address the challenges on the prevention and control of fungal diseases in Sierra Leone and similar countries.

Materials and methods

Data sources and search strategy

We conducted a review of published articles to evaluate the burden of fungal diseases in Sierra Leone. A literature search was conducted using PubMed, Google Scholar, and the African Journal Online for data on the burden of serious fungal infections, non-communicable diseases, asthma, HIV, cancers, and other immunosuppressive states. All articles with information on the burden of serious fungal infections conducted in Sierra Leone, neighboring countries, or internationally were eligible for inclusion. However, our search for articles in these databases is not systematic, because we included different groups of people that are at risk of various fungal infections. The search was extended to the websites of the National HIV Secretariat (NAS) and the United Nations Agency against HIV/AIDS (UNAIDS) for additional statistics on HIV in Sierra Leone. The website of WHO provided data from the global AIDS and TB reports and other health indices in Sierra Leone.

We extracted information on the population characteristics and profile of Sierra Leone from the websites of the Ministry of Health and Sanitation (MoHS) and other government ministries, departments, and agencies. HIV-related information was obtained by searching the database of NAS, UNAIDS, MoHS, and the global AIDS report from WHO. While the prevalence of HIV was obtained from the demographic health survey of 2019,[14] data on the number of people living with HIV was obtained from the UNAIDS reports of 2018 and the Global AIDS Monitoring Report of 2019.[15,16] Other HIV-related information, including late-stage diagnosis and advanced HIV disease was extracted from articles published on PubMed. We assumed a 7 year decline in immunity in all HIV patients not on antiretroviral therapy, to a CD4 counts $<200/\mu l$. No transplant procedures are currently undertaken in Sierra Leone. Cystic fibrosis has yet to be described in West Africa. All source data is shown in Table 1.

Table 1. Country profile and communicable and non-communicable disease burden in Sierra Leone.

Variable	Result	Source
Population characteristics	Total population: 7,092,113	2015 SL population census[17]
	Population under 15 years: 42%	
	Annual population growth rate: 3.2%	
	Percentage of women aged 15–49 years: 51.0%	
	Total population of women aged 15–49: 1,835, 328	
Economic status	UN Human Development Index: 184 out of 188	SMTDP 2019–2023[18]; DHS 2019[19]
	Poverty level: 57%	
Health status	Total number of functional health facilities: 1512 (67 Hospitals, 153 Clinics, 251 Community Health Centers, 423 Community Health Posts and 618 Maternal and Child Health Posts).	SLMTDP 2019–2023[18]; MICS 2017; DHS 2019[19]
	Maternal mortality rate: 717 per 100,000 live births	
	Infant mortality rate: 75 per 1000 live births	
	Life expectancy at birth in 2017: 52.2 years	
	Prevalence of underweight (weight/age) among children 6–59 months (2SD): 11.7%	
HIV	The national prevalence of HIV among persons aged 15–49 years: 1.7%	DHS 2019[19]; UNAIDS 2019[16]; Lakoh *et al.*[20]; Yendewa *et al.*[21]; Lakoh *et al.*[22]; UNAIDS 2018[15]
	Total number of people living with HIV: 78,667	
	Number of AIDS patients receiving ARVS: 32,468	
	Prevalence of advanced HIV disease: 69.6%	
	Prevalence of late-stage HIV diagnosis: 75.4%	
	HIV prevalence in TB patients: 32.0%	
	AIDS-related deaths: 2700	
TB	National TB incidence rate: 295 per 100,000	Global TB Report 2020[23]
	Total TB cases: 23,000	
	Number of notified TB cases in 2019: 17,144	
	% of TB cases co-infected with HIV: 12.6%	
	Total TB survivors: 19,920	
	Pulmonary TB survivors: 18,526	
Asthma, COPD and cystic fibrosis	Asthma rate in adults: 4.59%	To *et al.*[24]
	Asthma number in adults: 200, 147	Hammond *et al.*
	COPD prevalence GOLD stages II–IV: 3.20%	

(continued)

Table 1. (Continued)

Variable	Result	Source
	COPD admissions to hospital per year: 27,704 (assumes 10.5% admissions per year)	
	Cystic fibrosis: 0	
Malignancies	Number of lung cancer deaths per 100,000 population: 127	Winkler *et al.*[25]; ICD-10 C92.0
	AML population frequency×/100,000: 2.5	
	AML patients per year: 191	
Transplant recipient	Allogenic hematologic stem cell transplant: 0	
	Renal, lung, heart, and liver transplants: 0	

AIDS, autoimmune deficiency syndrome; AML, acute myeloid leukemia; ARVS; antiretroviral treatment; COPD, chronic obstructive pulmonary disease; GOLD, The Global Initiative for Chronic Obstructive Lung Disease; HIV, human immunodeficiency virus; SD, standard deviation; SL, Sierra Leone; TB, tuberculosis; UN, United Nations.

Country profile

According to the 2015 national population census, Sierra Leone had an estimated population of about 7 million, with an average annual population growth rate of 3.2% between 2004 and 2015 of which 42% is below 15 years.[17] See Table 1.

Sierra Leone ranked 184 out of 188 countries in the 2018 United Nations Human Development Index (UNHDI) and it is therefore one of the poorest countries in the world, with a per capita Gross Domestic Product (GDP) of US$499 in 2017. Sierra Leone's poverty level is 57%, and the poverty rate in rural areas (72.4% poverty incidence) is much higher than Sierra Leone's capital, Freetown (18.5%)[18] See Table 1.

The public health system uses the concept of primary health care as the first level of care, which includes peripheral health units, district hospitals for secondary care, and regional/national hospitals for tertiary care. The health system is faced with multiple challenges: poor health infrastructure, inadequate disease prevention, poor surveillance and data systems, weak human resource, and low per capita expenditure on health.[18] See Table 1.

Sierra Leone has the highest infant and maternal mortality rates in the world, although a decrease from 89 deaths per 1000 live births in 2008 to 75 deaths in 2019, and from 1165 per 100,000 live births to 717 deaths, were respectively observed during the same period.[14,19] Preventable non-communicable diseases, malnutrition, pregnancy and neonatal complications account for the majority of infant and maternal mortality.[14] See Table 1.

HIV and TB statistics in Sierra Leone

Among men and women aged 15–49 years, the national HIV prevalence is 1.7%. The prevalence of HIV in women is higher than that of men (2.2% *versus* 1.1%).[14] According to spectrum data, an estimated 78,667 people in Sierra Leone were infected with HIV (PLHIV) in 2019. Among them, 32,468 received antiretroviral drugs.[14] The estimated AIDS-related mortality rate is 33 per 100,000 populations.[14] (Table 1)

Sierra Leone ranks among the top 30 countries with a high burden of TB in the world, accounting for 87% of the global burden of TB patients in 2019. The total TB incidence rate in Sierra Leone is 295 per 100,000 populations.[23,26] In Sierra Leone, 98% of all 17,144 notified cases of TB were tested for HIV in 2019. Of these, 12.6% were co-infected with HIV. The country's recorded success rate of TB treatment was 89% in the same year. Sierra Leone is considered to be approaching a global milestone set in 2020, with a 35% reduction in TB deaths compared to 2015.[23,26] (Table 1)

Statistics of other immunosuppressive and respiratory illness burden in Sierra Leone

Data on the burden of cancers in Sierra Leone is limited. Lung cancer related deaths are estimated at 127 per 100,000.[25] A total 191 patients are affected by acute myeloid leukemia (AML) per year [International Statistical Classification of Diseases and Related Health Problems (ICD-10 C92.0)]. With an asthma prevalence rate of 4.6%,[24] 200, 147 adults in Sierra Leone are affected by asthma. (Table 1)

About 3.2% of the Sierra Leonean population have chronic obstructive pulmonary disease (COPD) in the Global Initiative for Chronic Obstructive Lung Disease (GOLD) stages II–IV. With the assumption that there are 10–15% admissions per year, about 27, 704 COPD-related admissions to hospitals are recorded annually. (Table 1)

Results

Cryptococcal disease and meningitis

Since the current evidence on cryptococcal diseases is limited to the provision of tertiary care, little is known about the nationwide burden of cryptococcal disease in Sierra Leone. There is only one published article that provides primary data on cryptococcal diseases in Sierra Leone. In this study, the prevalence of cryptococcal antigenemia in patients with advanced HIV in a large-scale urban tertiary hospital was 4.7%. The mortality associated with cryptococcosis was 62.5% during the 8-week follow-up.[13] We assume that the nation-wide prevalence of cryptococcal disease in the HIV positive population is 3.2%, and the annual incidence rate is 3.95 per 100,000 populations. Therefore, the total burden of cryptococcosis is 302 cases per year (Table 2). There are no available data on cryptococcal meningitis among patients in Sierra Leone who have other risk factors for cryptococcal diseases.

Pneumocystis *pneumonia (PCP)*

Although PCP is among the most important opportunistic infections in patients with advanced AIDS and a common cause of death in immunosuppression caused by malignant tumors, cytotoxic agents, organ or tissue transplantation, and chronic organ dysfunction among HIV negative people,[35,36] there is limited information on PCP in Sierra Leone.[37] We estimated the burden and annual incidence of PCP at 8.4 per 100,000 HIV populations and 643 HIV patients, respectively. Table 2 There is no data on the HIV negative population with risk factors for PCP.

Chronic pulmonary aspergillosis (CPA)

CPA can mimic pulmonary TB (and be misdiagnosed as TB), may be a co-infection during the course of pulmonary TB treatment, and can occur after the completion of treatment, especially in those with residual cavities.[28] We have modelled the annual CPA incidence based on pulmonary TB survivors, assuming a rate of 22% in those with residual cavities, estimated to be 22%.[28] This yields an estimated 1275 cases; applying a 15% annual mortality, the 5 year period prevalence of CPA after TB is 4,108 cases.[29] The additional earlier and missed cases mistaken for TB, and CPA cases related to other underlying diseases such as pneumothorax, COPD, asthma etc. are estimated to add another 50% of cases, a total prevalence of 6,028 (Table 2).

Allergic fungal respiratory diseases

The global burden of allergic fungal disease is huge. Of the 193 million global adult population with asthma, about 5 million had allergic bronchopulmonary aspergillosis (ABPA).[30,38] The prevalence of ABPA is lower in the WHO African region (419,000) than Europe (1,062,000) and the Americas (1,461,000).[30,38] In Iran, an estimated 340 per 100,000 populations have allergic fungal diseases.[39] Using a 2.5% prevalence rate (from South Africa),[40] we estimate that about 5,000 adults have ABPA (Table 2). Using a conservative figure of 10% having severe asthma (in the Democratic Republic of Congo, the uncontrolled asthma percentage was 56%)[41] and a 33% fungal sensitization rate, about 6,600 adults have severe asthma with fungal sensitization (SAFS) (Table 2). These estimates need corroboration and there could be some double counting between ABPA and SAFS. To address this high burden, there are available safe oral antifungal drugs effective in the control of severe symptoms of asthma.[42]

Invasive aspergillosis (IA) and mucormycosis

IA and mucormycosis are rarely diagnosed in Sierra Leone. We have assumed that 10% of

Table 2. The burden of serious fungal infections in Sierra Leone.

Burden of fungal infection				No underlying disease	HIV/AIDS	Respiratory disease	Cancer + immunocompromised	Critical care + surgery	Assumptions	References
Serious fungal infection	Rate per 100,000	Total	B							
Cryptococcal meningitis	3.95	302	I		302				Country dependent	Lakoh *et al.*[13]
Pneumocystis pneumonia	8.40	643	I		643					
Invasive aspergillosis	6.25	478	I		104		40	334	Rate in non-AML same as in AML patients	Lortholary *et al.*[27] Perkhofer *et al.*[28]
Chronic pulmonary aspergillosis post TB	16.67	1,275	I			1275			From Denning *et al*, Bull WHO 2011	Denning *et al.*[29]
Chronic pulmonary aspergillosis post TB	52.53	4,018	P			4018			From Denning *et al*, Bull WHO 2011	Denning *et al.*[29]
Chronic pulmonary aspergillosis - all	78.79	6,028	P			6,028			From Denning *et al*, Bull WHO 2011	Denning *et al.*[29]
ABPA	65.41	5,004	P			5,004			From Denning *et al*, Med Mycol 2013	Denning *et al.*[30]
SAFS	86.34	6,605	P			6,605				
Candidemia	5.00	383	I				268	115	5/100,000 (mean of 2–11/100,000)	Arendrup *et al.*[31]
Candida peritonitis	0.75	57	I					57		Montravers *et al.*[32]
Oral candidiasis	75.63	5,786	I		5,786				90% of untreated HIV patients, with CD4 < 200	Matee *et al.*[33]
Esophageal candidiasis	55.18	4,221	I		4,221				20% of patients not on ARVs and CD4 < 200, and 0.5% of those on ARVs	Smith *et al.*[31]
Recurrent Candida vaginitis (≥4×/year)	2,233.73	85,440		85,440					6% of adult female. Literature estimate is 5–8%	Foxman *et al.*[33] Denning *et al.*[34]
Mucormycosis	0.20	15	I				15			
Histoplasmosis	0.00	0	I							
Fungal keratitis	13.30	1017	I	1017						
Tinea capitis	3,483.00	266,450	P	266,450						
Total serious fungal infections		376,643 4.92%		352,907	11,056	17,636	323			

ABPA, allergic bronchopulmonary aspergillosis; AIDs, acquired immune deficiency syndrome; AML, acute myeloid leukemia; ARV, antiretrovirals; B, burden; HIV, human immunodeficiency virus; I, annual incidence; P, prevalence; SAFS, severe asthma with fungal sensitization; TB, tuberculosis.

AML is complicated by IA and this represents 50% of all haematological-associated IA. We have also assumed that 2.6% of lung cancers, 1.3% of COPD admissions to hospital, and 4% of AIDS deaths are also complicated by IA. Overall, 478 cases are likely (Table 2), not including other patient groups such those on high dose corticosteroids.[27] A much lower number of mucormycosis cases is assumed, at 2 per million, likely an under-estimate.

Fungal keratitis

Based on data from East Africa, about 50% of microbial keratitis in Africa is fungal in origin. A modeling paper using data from Kenya and Egypt indicates that 13.3/100,000 population develop fungal keratitis annually.[43] Young working age men are the highest risk group, usually with loss of vision or perforation of the eye. This translates into over 1000 eyes affected each year in Sierra Leone (Table 2).

Tinea capitis and other skin conditions

Using a direct estimate based on the population of children below 15 years in Sierra Leone, we estimated the burden of fungal infections using a pooled prevalence of 19% reported in sub-Saharan Africa.[44] A total of 266,450 young persons in Sierra Leone have tinea capitis, giving a prevalence rate of 3,483 per 100,000 populations (Table 2).

Oral and esophageal candidiasis

We estimated the burden of oral candidiasis by assuming that 90% of untreated HIV patients, with CD4 < 200 have oral candidiasis at some time over 2 years. This estimate derives an incidence of 75.6 per 100,000 populations or 5,786 oral *Candida* infections annually in Sierra Leone (Table 2).[45]

The burden of esophageal candidiasis was estimated by assuming that 20% of patients with HIV are not on antiretrovirals (ARVs) and 5% of those on ARVs have CD4 cell count less than 200/μl. The annual incidence of esophageal candidiasis is 55.18 per 100,000 and the total burden of esophageal candidiasis is 4, 225 cases (Table 2).[33]

Other candida infections

We estimated the nationwide annual incidence of candidemia and candida peritonitis in abdominal surgeries and cancer, other immunocompromised states such as diabetes, and on the general wards in Sierra Leone. Based on estimates by Arendrup, we assume the annual incidence of candidemia is 5 per 100, 000,[31] given a total of 382 patients with candidemia reported annually. Of this, 268 occur in patients with cancer and other immunocompromised state and 115 in surgical and critically ill patients (Table 2).

According to the annual incidence rate reported by Montravers, 0.75 cases per 100,000 people,[32] we estimate that a total of 57 cases of abdominal surgery, cancer, and other immunocompromised patients suffer from candidal peritonitis (Table 2).

The presence of four or more episodes of vulvovaginal candidiasis in a woman over a year defines recurrent vulvovaginal candidiasis (RVVC).[46] It is a common infectious disease that is estimated to occur in 5–8% of women between 15–50 years of age.[46]

In contrast to postmenopausal women, many causes of RVVC occur in women between 15 and 50 years of age.[47] Assuming 6% of the 1,424,000 women aged 15–49 years in Sierra Leone have RVVC, the annual prevalence of recurrent *Candida* vaginitis is 2,234 per 100,000 females giving a total burden of 85,440 (Table 2).[47]

Other conditions

We have not been able to estimate the incidence or prevalence of any form of histoplasmosis, including African histoplasmosis, mycetoma, or sporotrichosis in the absence of data. Three cases of chromoblastomycosis were described in a large series of 3,011 patients with various skin diseases in Sierra Leone.[34]

Discussion

We have attempted, for the first time, to estimate the burden of serious fungal infections in Sierra Leone. Overall, 4.92% of the population in Sierra Leone is affected by serious fungal infections. This figure is lower than reported in Nigeria (11%),[48] but slightly higher than reported in Ghana (4%);[49] thus indicating a sub-regional heterogeneity of fungal disease burden despite the similar challenges in the HIV response in West Africa.[16] The emergence of the HIV pandemic in the last three decades in Sierra Leone and other

countries in sub-Saharan Africa and the increase in the burden of non-communicable diseases may have proportionally affected the prevalence of fungal infections in the region.[50] The improvement of medical interventions and the increase in antibiotic consumption are both related to the increase in the GDP of LMICs, as well as the increase in the burden of fungal infections.[2,51]

In this study, nearly 60% of all the serious fungal diseases are tinea capitis infections affecting mostly children with no underlying chronic disorders. This trend is similar to estimates of tinea capitis in sub-Saharan Africa, where one in five children in sub-Saharan Africa have tinea capitis, making it one of the most common childhood diseases in the region.[44]

The estimated burden of fungal infections among people living with HIV in Sierra Leone is huge; the annual fungal burden is 2.9% in this population. This high burden of fungal disease in this population in a low HIV prevalence setting could probably be due to the late-stage presentation of HIV patients to care and the high burden of advanced HIV disease in the country. Alternatively, it could be as a result of the limited access to antiviral therapy, as less than 50% of the total HIV population were receiving antiretroviral therapy in 2019.[15,20,21] In the face of this high burden of fungal diseases, access to potent and safe antifungal drugs is needed to optimize their treatment. Although amphotericin B is an effective anti-fungal agent recommended for the management of cryptococcal meningitis, its use in Sierra Leone is limited by cost and availability. As a result, fluconazole monotherapy is still the only antifungal therapy available in Sierra Leone for the treatment of cryptococcal meningitis.[13] Other antifungal agents like itraconazole, posaconazole, voriconazole, and ecchinocardins are not listed as part of the national essential medicine list and are hardly available in most pharmacies in the country. Changes in the susceptibility to antifungal drugs and the unavailability of routine fungal culture and drug susceptibility testing services have exacerbated the problem of fungal infections.[42]

In order to reduce the effect of fungal infections on HIV-related mortality, national and international guidelines have put forward various recommendations on the screening, treatment and prevention of fungal and other opportunistic infections. The WHO guidelines strongly recommend the use of dual therapy for cryptococcal meningitis and routine screening for cryptococcal disease in all patients living with HIV (PLHIV) with a CD4 cell counts less than 100/µl.[52] Sierra Leone first piloted cryptococcal screening using the cryptococcal antigen assay in all PLHIV with a CD4 of less than 100/µl in 2018.[13] The results of this study highlight that 4.6% of PLHIV with a CD4 less than 100/µl suffer from cryptococcal antigenemia. During the 8-week follow-up, the mortality rate associated with cryptococcal meningitis in this study was 64.2%.[13] The mortality can be reduced to less than 25% by the adoption of the following four measures: delayed onset of ART in meningitis patients, repeated lumbar punctures (especially patients with elevated intracranial pressure), intravenous amphotericin B, and oral flucytosine for 1 week. This would save about 120 deaths a year.

The Consolidated Guidelines on HIV Prevention, Diagnosis, Treatment, and Care in Sierra Leone recommends the prophylactic use of co-trimoxazole to prevent *Pneumocystis* pneumonia and other infections in all PLHIVs, regardless of the number of CD4 cells.[37] Nonetheless, the treatment of PCP in Sierra Leone is syndromic, based mostly on clinical presentation. In a recent report, only 1.7% of hospitalized HIV patients had a syndromic management for a diagnosis of PCP.[20]

Similar to reports in other countries in sub-Saharan Africa,[53] a large number of the Sierra Leonean population has allergic and non allergic respiratory fungal diseases. Even with this high burden, itraconazole and voriconazole (both WHO Essential Medicines) are effective in the control of severe symptoms of asthma in the global market,[27] although most are not available in Sierra Leone. The lack of voriconazole would impact the successful treatment of both chronic and invasive aspergillosis, if these diagnoses could be made.

Chronic lung histoplasmosis can present as nodules, infiltrates, and cavities, and may be misdiagnosed as smear negative TB.[54] Owing to the limited data, we have not been able to estimate the incidence or prevalence of any form of histoplasmosis, including African Histoplasmosis. In some tertiary hospitals in Sierra Leone, where more than 40% of TB cases are smear-negative,[22]

most cases of lung histoplasmosis may be misdiagnosed as smear-negative TB. As a result, the delay in providing the appropriate fungal treatment services to this population.

We estimated a huge burden of mucocutaneous and invasive candidiasis and candidemia in different sub-population groups. This is a concern, because candidiasis is still a main cause of morbidity, and in invasive infections, its mortality rate is as high as 70%.[55] Moreover, the recommended first line antifungal therapy for candidemia, echinocandins, is generally not available in low-income countries like Sierra Leone.[56]

Our study has some limitations worthy of note. Due to limited information on fungal infections in Sierra Leone, we made some assumptions based on data from other countries to estimate the burden of fungal infections. Furthermore, we have not been able to map groups at risk of fungal infections; there was no data on the number of people using immunosuppressive drugs or with autoimmune connective diseases who are major risk groups for serious fungal infections. There is no data on the number of organs or hematopoietic stem cell transplants in Sierra Leone. As a result, the true burden of serious fungal infections in the country may be overestimated or underestimated. Similarly, since there is no complete data, the confidence range we use in the estimation may be very wide.

Despite these limitations, our results of mapping the burden of fungal infections are consistent with findings in neighboring African countries and provide policymakers and clinicians with an understanding of the burden of serious fungal infections needed for clinical and public health practice.

Conclusion

This study estimated for the first time the burden of fungal disease burden in Sierra Leone, where approximately 5% of people suffer from serious fungal infections each year.

In order to improve on the early detection and timely treatment of fungal infections, there is a need to strengthen the capacity of the microbiology laboratories, advocate for the integration of the management, and the prevention of fungal infections to routine health service delivery as part of the package for the universal health coverage, and educate health service providers, patients, and their caregivers and communities about the diagnosis, treatment, and prevention of fungal infections.

Finally, effort should be made to improve the knowledge of fungal infections through research and surveillance of serious fungal infections, especially in high-risk groups, such as immunosuppressed HIV-negative people, patients in intensive care units, and people undergoing major surgery.

Author contributions

DWD and EO conceptualized the study. SL, MNK, and DFJ screened the search results and identified the included studies. DWD, SL, JBK, and SK extracted the data from included studies. SL wrote the first draft of the manuscript. DWD, SL, EO, MNK, DFJ, SK, and JBK reviewed the draft of the manuscript.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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Availability of data

The extracted data that support the findings of this study is available from the corresponding author, upon reasonable request.

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