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Literature Review

The Impact of Tuberculosis on People Living With HIV: Scoping Review

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Abstract

Background: Tuberculosis (TB) patients with HIV/AIDS experience higher mortality rates, lower cure rates, and poorer treatment adherence compared to TB patients without HIV. As a result, TB can exacerbate HIV progression and lead to increased mortality. This study aims to investigate and summarize the determinants of TB incidence among people living with HIV/AIDS.

Objective: This study employs a scoping review approach to explore the key factors associated with TB occurrence in HIV/AIDS patients.

Methods: A literature search was conducted across indexed databases, including Scopus, PubMed, Google Scholar, and Crossref. Studies published between 2013 and 2021 were selected based on article titles, study design, population, intervention, and results. Fourteen relevant articles were included. Data were processed by identifying key sentences relevant to the coding framework, highlighting important findings, and organizing a narrative review framework. Qualitative data analysis was performed using NVIVO-12 Plus, with data presentation and report compilation.

Results: The study identifies age, gender, education and knowledge level, nutritional status, use of antiretroviral therapy (ART), and cluster of differentiation 4 (CD4) cell count as the dominant factors influencing TB incidence among people living with HIV/AIDS.

Conclusion: HIV infection weakens the immune system by attacking lymphocytes, leaving individuals with HIV/AIDS highly susceptible to Mycobacterium tuberculosis infection.

Keywords: tuberculosis; HIV; AIDS; ART; CD4

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Background

Tuberculosis is an infectious disease generated by Mycobacterium tuberculosis which generally devours the lungs (pulmonary TB). Still, it could as well attack various organs in the body (extra-pulmonary TB) and is the prominent account of mortality in people with HIV/AIDS (Ahmed et al., 2018). Human immunodeficiency virus (HIV) infection is a drawback in controlling tuberculosis since HIV weakens the immune system, which causes Mycobacterium tuberculosis to develop rapidly, since HIV/AIDS is a risk factor for the incidence of tuberculosis (A. Alemu, Bitew, et al., 2020; Resende et al., 2019). People infected with both HIV and TB have a higher risk of death than those with either HIV or TB alone (Alayu Alemu et al., 2021; Mollel et al., 2020; Tanue et al., 2019). As demonstrated by Alemu et al. (2021), HIV-positive TB patients have a lower treatment success rate. Moreover, Zheng et al. (2020) emphasize that inadequate TB treatment in this population can result in earlier and higher mortality (Alayu Alemu et al., 2021; Zheng et al., 2020).

Based on the WHO Global TB report, about nine million new incidences of tuberculosis occur worldwide. Thirteen percent are related to HIV/AIDS infection, and an estimated 1.49 million TB mortality, including 0.36 million in PLWHA, and 96% of mortality occur in developing nations (Negussie et al., 2018). The highest prevalence of tuberculosis in PLWHA occurs at the age of 36-45 years at 47.62%, while by gender, men are 76.2%, and women are 23.84% (Tahir et al., 2019). Studies show that tuberculosis (TB) is a common problem among people living with HIV (PLWH), with prevalence rates ranging from 3% to 37.4% (A Zeru, 2021; Andrew, 2023; Ganesan et al., 2023; Ugwu et al., 2021). Due to a weakened immune system, HIV disease increases a person's susceptibility to tuberculosis. Meanwhile, tuberculosis disease worsens the diagnosis of HIV disease and can even cause death (Rossetto et al., 2019). Factors such as low CD4 cell counts, underweight status, and advanced HIV clinical stages are linked to an increased likelihood of TB infection in people living with HIV(Ganesan et al., 2023).

Thus, it is necessary to understand the determinants of the incidence of tuberculosis in PLWHA to correct the quality of life of PLWHA against Mycobacterium tuberculosis infection. Nevertheless, considering HIV/AIDS is a type of infectious disease that can be treated by weakening the development of the virus in the human body, it causes the patient to be susceptible to tuberculosis and other infectious diseases. Since the transmission rate is relatively high, the problem of tuberculosis in people living with HIV/AIDS must be treated immediately. It is essential to understand the various perceptions about the risk of tuberculosis in PLWHA. Regardless, there is still a lot of uncertainty about the dominant risk factors for the incidence of tuberculosis in PLWHA, as previous studies reported. It is crucial to conduct and summarize the literature on issues related to the incidence of tuberculosis in PLWHA. The main research question of this review is what are the risk factors for tuberculosis in PLWHA? Accordingly, this study aims to review and summarize the evidence for the determinants of the incidence of tuberculosis in PLWHA to improve the previous studies.

Method

Study design

This study uses a scoping review method to describe, accumulate, summarize and synthesize evidence from previous studies on the determinants of the incidence of tuberculosis among people with HIV/AIDS. This study operates a methodological framework by Xiao & Watson (2017) to perform a scoping review. Several steps were carried out to specify articles, such as formulating problems, developing and validating reviews, searching the relevant literature, extracting data, analyzing, and synthesizing data using NVIVO-12 Plus, and finally completing data reports (Danesh et al., 2022; Dhollande et al., 2021). The main research question of this review is “What are the risk factors for tuberculosis in PLWHA?”

Literature Search Strategy

In this study, we used a search strategy to obtain relevant articles related to the topic of determinants of the incidence of tuberculosis in people with HIV/AIDS. The search strategy was carried out on the Scopus, PubMed, Google Scholar, and Crossref indexed databases with the keywords and MeSH terms synonymous with ("determinant" OR "risk factor" OR "factor affecting" OR "factor associated") AND ("tuberculosis" OR "TB" OR "pulmonary tuberculosis") AND ("HIV/AIDS" OR "HIV" OR "AIDS") AND ("acquired immunodeficiency syndrome") ("prevalence") AND ("PLWHA"). The selection was performed using a PRISMA flow diagram (see **Figure 1**).

Eligibility Criteria

The criteria for inclusion in the research were articles published between 2013 to 2023 with full text and in English with a cross-sectional design, retrospective cohort study, and control. All studies reporting risk factors for recurrent TB in people living with HIV/AIDS were included in this study. By using specific criteria, we were able to focus our review on relevant papers, improving efficiency. Of the 770 journals identified from various databases, 14 met the inclusion criteria.

Identification and Selection

Journal articles not full text, preprinted, not peer-reviewed excluded. Article manuscripts in the proofreading stage were also not included because there might be changes in the results of research reporting.

Data Extraction

Data extraction was carried out in several steps. The first step was to summarize the 14 selected articles starting from the author's name and year of publication, journal volume and title, methods used, results, and database sources. The summaries were constructed in the form of a synthetic matrix table. The second step was to arrange questions related to the topic to make it easier for the author to determine the subtitle of the discussion, i.e., by examining the results of research summaries. The third step was to confer and clarify facts, theories, and opinions about the results and how it was obtained. An explanation of the research results with the relevant theory is presented in the theoretical discussion.

Data Analysis

Relevant study articles related to the issues analyzed were systematically reviewed and analyzed qualitatively using the NVIVO-12 Plus application. The inclusion criteria in this study were designed to reduce the number of papers analyzed while also making the review process more manageable and efficient.

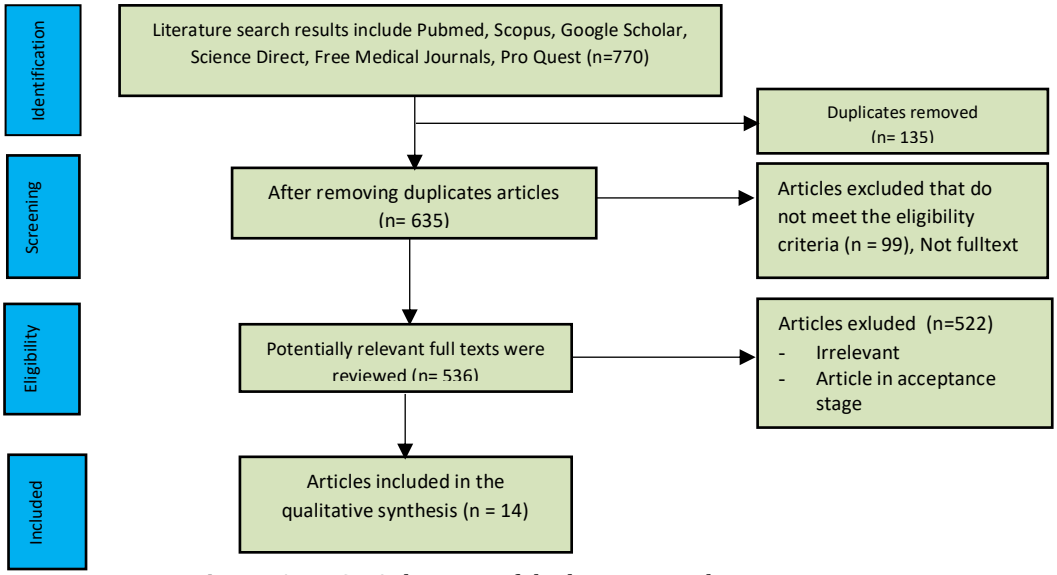

Figure 1 PRISMA diagram of the literature selection

Results

Fourteen articles met the inclusion criteria. Based on publication year, 21.43% of articles were published in 2020. Concerning the research design, 71,47% of the studies used case-control. The sampling techniques varied, as 42.86% of studies used simple random sampling techniques (see Figure 2)

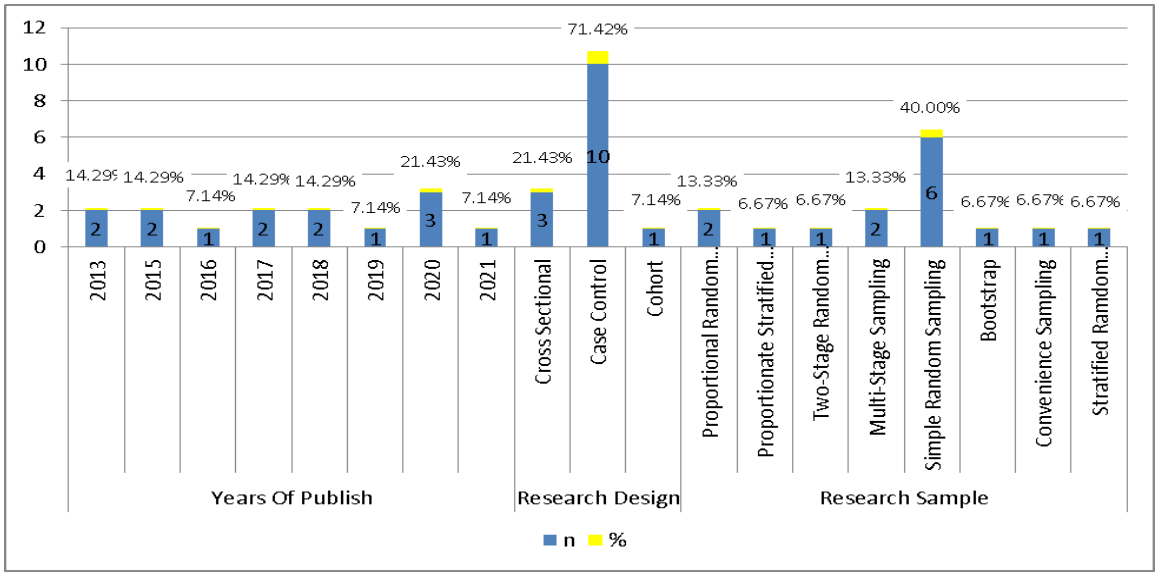

Figure 2 General Characteristics For Study Selection (n=14)

Table 1 exhibits the factors associated with tuberculosis in people living with HIV/AIDS from various reference sources.

Table 1 Results of data extraction

Author	Country	Participant	Study Design	Results	Database
Chen et al. (2015)	China	10,926 TB patients	Cross-sectional	Gender, age, education, married status, monthly income per capital, patient residency, family size, distance from health services, and awareness are all risk factors for TB-HIV co-infection, according to system analysis.	Google scholar
Oljira & Ifa (2017)	Ethiopia	112 who developed active TB, 224 who did not have active TB	Case control	TB in HIV-positive people was significantly associated with lack of formal education, malnutrition (lower BMI <18.5), stage and CD4+ count <200/l	Google scholar
Adugna et al. (2020)	West Ethiopia	127 cases and 255 controls	Case control	Factors linked to tuberculosis in HIV/AIDS patients are age 35 years, consumption of the system, Having CD4 cells <200, Having Hemoglobin <11g/dl, and history of contact with TB patients	Google scholar

Fekadu et al. (2015)	South Ethiopia	499 HIV/AIDS patient	Retrospective cohort study	In multivariate logistic regression, gender, HIV/AIDS clinical stage, and outpatient functional status were independently associated with TB-HIV co-infection with p <0.05	Scopus
Melkamu et al. (2013)	Western Ethiopia	119 TB/HIV co-infected patients and 238 non TB infected HIV-positive patients	Case control	Divorce/widower, education, underweight (BMI <18.5 kg/m2), diabetes history, and HIV/AIDS clinical stage were the factors related with TB/HIV co-infection.	Pubmed
Alemu, Awoke, & Wilder-Smith (2016)	Northwest Ethiopia	150 TB/HIV co-infected patients and 296 non TB infected HIV-positive patients	Case control	Smoking, presence of TB patients in the family, consumption of the system and chewing of khat, are independent determinants of the increased incidence of TB	Crossref
Ahmed et al. (2018)	Ethiopia	451 HIV-infected adults	Retrospective cohort study	History of previous illness, bedridden, underweight (BMI) <18.5 kg/m2), isoniazid therapy (IPT), hemoglobin below 11 g/Dl, and in HIV clinical stages III and IV, respectively significantly cause TB incidence	Scopus
(Alemu et al. (2020)	Ethiopia	566 HIV-positive individuals	Retrospective cohort study	Large family size, lower CD4 cell count, body mass index <18.5, antiretroviral medication, and preventive isoniazid treatment were independent predictors of TB with HIV/AIDS co-infection.	Google scholar
da Silva Escada et al. (2017)	Brazil	310 HIV-1/TB co-infected patients	Retrospective cohort study	factors related to death in HIV coinfected TB patients were: CD4 50, mechanical ventilation; and disseminated tuberculosis	Scopus
Méda et al. (2013)	Burkina Faso	HIV 298, Coinfected 94	Cross sectional	CD4 cell count less than 200/ll, history of sexually transmitted diseases, education, gender, employment, and a history of sickness in the past are all risk factors for tuberculosis in persons living with HIV.	Scopus
Negussie et al. (2018)	southern Ethiopia	People living with HIV/AIDS	Retrospective cohort study	Multivariate analysis showed that clinical stage 3 PLWHA, CD4 levels 200-500 cells/mm3, and those not using INH prophylaxis were significantly associated with TB-HIV co-infection	Scopus
Abdu et al. (2021)	Northeast Ethiopia	565 people (417 controls and 139 patients living with HIV)	Case control	The risk factors for TB in people with HIV consist of patients without a separate kitchen, having opportunistic infections, CD4 count <350 cells/mm3, clinical stage of HIV/AIDS, not using IPT	Scopus

Nhandara et al. (2020)	South Africa	10427 patients ≥18 years of age with HIV infection and co-infected with TB	Cross sectional	Patients with TB/HIV who have been on treatment for a longer period of time are less likely to keep clinic visits.	Scopus
van Halsema et al. (2020)	United Kingdom	58.776 people with 704 tuberculosis events	Cohort Study	The incidence of tuberculosis decreased from 1.3 to 0.6/1000 person-years from pre-2004 to 2011-2017. The incidence remains high among black participants in the last 2.1/1000 person-year period. Of the 283 participants, 191 of whom (67%) were Black Africans, had tuberculosis with a viral load of less than 50 copies/ml	Pubmed

Discussion

All studies in this review assessed determinants of the incidence of tuberculosis in persons with HIV/AIDS. The objective is to reduce the prevalence of tuberculosis in PLWHA, and PLWHA can improve the quality and life expectancy by knowing the risk factors of tuberculosis (see **Table 2**).

Age

Six of 14 journal articles in the literature review reported the age factor in the incidence of tuberculosis in people with HIV/AIDS (Adugna et al., 2020; Chen et al., 2015; da Silva Escada et al., 2017; Nhandara et al., 2020; Oljira & Ifa, 2017; van Halsema et al., 2020). Age is an important factor in the transmission of *Mycobacterium tuberculosis* in people with HIV/AIDS. Increasing physical mobility of PLWHA along with increasing age, high physical activity, and social interaction cause PLWHA at this age to have a high potential for tuberculosis transmission. Based on this age group, the frequency of tuberculosis is highest in young adults. In Indonesia, 75% of tuberculosis patients with HIV/AIDS are in the financially productive age group (15-50 years) (Simamora, 2017). Productive age is when an individual is in the phase of working, both for themselves and for others. People living with HIV at productive age will experience pulmonary TB. As a result, it causes the individuals to be unproductive and become a burden to their families (Zhang et al., 2017).

People with HIV/AIDS infection aged 15-55 years have a 1.5 times greater risk of developing TB pneumonia compared to those aged <15 years and >55 years (Adugna et al., 2020; Oljira & Ifa, 2017; Sultana et al., 2021). Furthermore, Mukuku et al (Mukuku et al., 2019) and da Silva Escada et al (da Silva Escada et al., 2017) stated that age <45 years is the most common age for TB sufferers with HIV/AIDS comorbidities. Studies Visca et al (Visca et al., 2021), Nhandara et al (Nhandara et al., 2020), and van Halsema et al (van Halsema et al., 2020) also reported that there were more tuberculosis patients < 45 years of age than adults > 45 years. The findings of Yew et al(Yew et al., 2018) and Seifert et al (Seifert et al., 2021) reported a relationship between age and the incidence of tuberculosis in people with HIV/AIDS. Sanhueza-Sanzana et al (Sanhueza-Sanzana et al., 2021) affirmed a relationship between age and the incidence of tuberculosis in PLWHA.

Table 2 The related factors with tuberculosis in people with HIV/AIDS

Related Factors	Significant Risk Factors	Main Empirical Sources
Gender, age, education, income, place of residence, number of family members, distance from health institutions, knowledge of HIV/AIDS and tuberculosis	women (aOR 4.122,95%CI (1.18-14.40), aOR age 30-59 years old , 95%CI (1.18-14.40), self-employed (aOR 4.059,95%CI (1.20–13.68),family size >4 (aOR 2.223,95%CI (1.10–6.93)	Chen et al. (2015)
Lack of education, malnutrition, clinical stage of HIV/AIDS, CD4 count, smoking, disease history, age, gender	lack of formal educational (aOR 3.23, 95%CI 1.60, 6.81), under nourished BMI <18.5) (aOR 2.62, 95%CI 1.23, 5.95), CD4+count<200/μL (aOR 2.5 95%CI 1.18, 4.97)	Oljira & Ifa (2017)
Age, alcohol and fortification use, CD4 cell count, clinical-stage, hemoglobin count, disease history, place of residence	Alcohol consumption (aOR=3.34,95%CI (1.68,6.99), CD4 cells <200 (aOR=3.67, 95% CI (1.5, 9.1), Imprisoned in the past 2 years (aOR=4.22, 95%CI (1.56, 11.37), Living with TB patients in the same house (aOR=14.97, 95% CI(1.99, 21.63)	Adugna et al. (2020)
Gender, clinical stage, HIV/AIDS treatment status, marital status, education, nutritional status, disease history, clinical-stage	WHO clinical stage 3 (aOR=5.66; 95%CI:1.79-17.94); WHO clinical stage 4 (aOR=7.89;95%CI:2.01-30.96)	Fekadu et al. (2015)
Gender, clinical stage, HIV/AIDS treatment status, marital status, education, nutritional status, disease history, clinical-stage	divorced/widowed (aOR = 3.02, 95% CI (1.70, 7.88), no education (AOR = 4.32, 95% CI (2.20, 14.15), BMI < 18.5 kg/m2 (aOR = 3.87, 95% CI (2.18, 6.87), history of diabetic mellitus (aOR = 3.63, 95% CI (1.33,9.94), HIV/AIDS clinical staging (aOR = 2.29, 95% CI (1.32, 3.98)	Melkamu et al. (2013)
Smoking, family history of illness, alcohol consumption, chewing khat, antiretroviral therapy, isoniazid preventive therapy, and cotrimoxazole preventive therapy	smoking (aOR 5.47; 95% CI 2.26,13.22), alcohol consumption (aOR 2.49; 95% CI 1.29 to 4.80) and chewing khat (aOR 2.22; 95% CI 1.11 to 4.41)	Alemu et al. (2016)
Nutritional status, isoniazid preventive therapy, hemoglobin count, clinical stage	previous TB disease (aOR 3.65, 95%CI 1.97-6.73),bedridden (aOR 5.45, 95%CI 1.16-25.49), underweight (aOR 2.53, 95% CI 1.27-5.05), haemoglobin below 11 g/dL (aOR 2.31, 95%CI 1.35- 3.93), clinical stages III and IV (aOR 2.84, 95%CI 1.11-7.27; aOR 3.07,95%CI 1.08-8.75)	Ahmed et al. (2018)
Number of family members, CD4 cell count, nutritional status, antiretroviral therapy, and isoniazid preventive therapy	large family size (aOR 1.783, 95% CI 1.113–2.855), lower baseline CD4 (aOR 2.568, 95% CI 1.602–4.116), BMI<18.5 kg/m2 (aOR 1.907, 95% CI 1.530–2.690)	Alemu et al. (2020)
CD4 count, age, education, gender, race, disease history, disseminated tuberculosis	CD4 ≤ 50 cells/mm3 (HR: 3.10; 95% CI: 1.720-5.580; p = 0.00); mechanical ventilation (HR: 2.81; 95% CI: 1.170- 6.760; p = 0.02); and disseminated tuberculosis (HR: 3.70; 95% CI: 1.290 to 10.590, p = 0.01).	da Silva Escada et al. (2017)
Environment, disease history, family size, distance from health institutions, CD4 count, education, gender	Gender (p=0.033), history of pulmonary asthma (p=0.041)	Méda et al. (2013)
Clinical stage, antiretroviral therapy (ART), taking prophylaxis.	WHO clinical stage 3 (aOR = 5.82; 95% CI 1.04–32.30), CD4 level of 200–500 cells/mm3 (aOR = 4.85; 95% CI 1.95–12.05) and < 200 cells/mm3 (aOR = 7.34; 95% CI 2.75–19.58) at	Negussie et al. (2018)

Related Factors	Significant Risk Factors	Main Empirical Sources
	ART initiation, and who didn't take INH prophylaxis (aOR = 12.36; 95% CI 4.47–34.14)	
Opportunistic infections, CD4 cell count, clinical-stage, not using TPT (tuberculosis prevention therapy), patients without separate kitchens, compliance level of people living with HIV/AIDS	Having opportunistic infection (aOR: 3.728, 95% CI: 2.058, 6.753), CD4 count of <350 cells/mm3 (aOR: 3.383, 95% CI: 1.520, 7.528), don't taking IPT (aOR: 3.701, 95% CI: 2.228, 6.147), moderately adherent (aOR: 3.455, 95% CI: 1.885, 6.335)	Abdu et al. (2021)
Age, gender, employment, education, smoking status, baseline CD4 cell count, BMI, alcohol consumption, months on treatment	Co-infection at Baseline (aOR 0.79, 95% CI 0.68-0.91),employment (aOR 0.61, 95% CI 0.55-0,69), months on treatment (aOR 0.98, 95% CI 0.97-0.98)	Nhandara et al. (2020)
Age, gender, ethnicity, CD4 cell count, antiretroviral therapy	Ethnicity, $CD4^+$ cell count, Years since Cart (p-value 0.001)	van Halsema et al. (2020)

Gender

Of the 14 previous journal articles that met the inclusion criteria, seven articles reviewed the gender variable on the incidence of tuberculosis in people with HIV/AIDS (Chen et al., 2015; da Silva Escada et al., 2017; Fekadu et al., 2015; Méda et al., 2013; Nhandara et al., 2020; Oljira & Ifa, 2017; van Halsema et al., 2020). The impact of gender is significant on the incidence of tuberculosis in PLWHA. Biological differences and male and female mindsets towards prevention are the main things. Men with HIV/AIDS infections risk developing tuberculosis more than women. Biological differences between men and women are associated with TB co-infection in people with HIV/AIDS. With more active jobs, men living with HIV are more at risk of contracting *Mycobacterium tuberculosis* which causes tuberculosis (Hermans et al., 2019). Previous studies have concluded that women with HIV infection are more likely to agree with health policy measures to prevent and treat tuberculosis (Nhandara et al., 2020). Moreover, van Halsema et al (van Halsema et al., 2020) found that women with HIV/AIDS were more likely to take preventive measures against tuberculosis.

Studies have reported a significant relationship between gender and the incidence of tuberculosis in people with HIV/AIDS (Nhandara et al., 2020; Oljira & Ifa, 2017). Shah et al (Shah et al., 2021) reported that gender had a significant relationship with the incidence of tuberculosis in PLWHA ($p = 0.036$). Duarte et al (Duarte et al., 2018) also reported the strong link between gender and the prevalence of pulmonary tuberculosis in PLWHA. This study showed men were more likely to suffer from pulmonary TB than women. The study suggested that men's increased risk of TB-HIV co-infection occurred because they tend to engage in diverse activities outside the home. Thus, increasing the possibility of being exposed to *Mycobacterium tuberculosis* (van Halsema et al., 2020).

Nutritional status

Of the 14 previous journal articles that met the inclusion criteria, four articles reviewed the nutrition status variables on the incidence of tuberculosis in people with HIV/AIDS (Ahmed et al., 2018; A. Alemu, Yesuf, et al., 2020; Melkamu et al., 2013; Oljira & Ifa, 2017) Nutrition status has a significant relationship with the incidence of tuberculosis in PLWHA. Poor nutritional status provokes a decline in the immune system, with an impaired immune system plus a diagnosis of HIV causing people living with HIV to be susceptible to mycobacterium tuberculosis. Nutritional status is a state of the body induced by a ratio between nutrient intake from food and the body's nutritional needs. The measurement of nutritional status in adults is performed by BMI (Body Mass Index). These measurements were grouped based on the results of the latest BMI with the classification of <17.00 very thin, 17.10-18.49 thin, 18.50-25.00 normal, 25.10-27.00 fat, and >27.00 obese.(Laar et al., 2018) Generally, an individual without HIV/AIDS needs 57 grams of protein for men and 48 grams for women. However, PLWHA needs more than 50-100% or 85 grams of protein for men and 72 grams for women

(Appiah et al., 2021). Moreover, maintaining nutritional intake in the daily life of PLWHA is a vital strategy to prevent the worsening clinical stage of PLWHA (Feleke et al., 2019).

In contrast to PLWHA with a normal healthy status, PLWHA with nutritional problems BMI < 18.5kg/m2 have a higher risk of developing TB (Niki et al., 2020). As reported by Filteau et al (Filteau et al., 2017), poor nutritional status poses a great danger to the incidence of tuberculosis in people with HIV/AIDS (p=0.029). Nutritional status with BMI < 18.5 is associated with the incidence of tuberculosis in PLWHA. There is an increase in mortality of people living with HIV/AIDS with malnutrition. Therefore, PLWHA needs to maintain and fulfill nutritional intake and physical activity to improve their quality of life and physical health (Gezae et al., 2019).

Cluster of differentiation 4 (CD4)

Of the 14 journal articles in the literature review, seven articles review the CD4 count variable on the incidence of tuberculosis in PLWHA (Abdu et al., 2021; Adugna et al., 2020; A. Alemu, Yesuf, et al., 2020; da Silva Escada et al., 2017; Méda et al., 2013; Oljira & Ifa, 2017; van Halsema et al., 2020). The cluster of differentiation 4 (CD4) has a significant relationship with the incidence of tuberculosis in PLWHA, poor nutritional status the decline in the immune system, and a diagnosis of HIV makes PLWHA susceptible to *Mycobacterium tuberculosis*. The CD4 is a type of lymphocyte that plays an important role in the immune system. CD4 ability as a receptor recognizes binding and fights infections that enter the body (Basingnaa et al., 2019).

A weak immune system, which is described by a low CD4 cell level, will cause people with HIV/AIDS to be more defenseless against attacks of opportunistic infections and worsen the clinical stage (Medeiros et al., 2017). People living with HIV with a CD4 cell count of <200 cells/mm3 are six times more likely to develop opportunistic infections than those with a CD4 cell count of>350 cells/mm^3, given this study suggests that a low CD4 cell level drive people less susceptible to infection opportunistic (Bayabil & Seyoum, 2021; van Halsema et al., 2020). In addition to the use of ARVs, fulfillment of nutritional status can also increase CD4 count. Statistically, PLWHA with good nutritional status has CD4 lymphocyte levels >350 cells/mm^3 compared to PLWHA with poor nutritional status. Therefore, monitoring of nutritional status in PLWHA should be maintained (Riou et al., 2021). However, the increase in CD4 cells is not the same for all PLWHA. There are factors associated with the increase in CD4 cells in HIV patients (Nwabuko, 2018).

Limitation of the study

Due to resource constraints, research published in non-English-language publications was excluded, which may have resulted in selection bias. Furthermore, this study did not evaluate the validation or study quality of the 14 papers that satisfied the inclusion criteria, as several studies did not give adequate information, such as under-reporting, making it impossible to conduct a thorough evaluation.

Conclusion

Human immunodeficiency virus (HIV) infection weakens the immune order by attacking lymphocytes / white blood cells (CD4) and making people with HIV/AIDS very susceptible to infection with Mycobacterium tuberculosis which causes tuberculosis. People living with HIV/AIDS in their productive age, low level of education, poor nutritional status, smoking, not using antiretroviral therapy, and low CD4 cell counts have high-risk contributions for generating tuberculosis.

Conflict of Interest

The authors have no conflicts of interest to declare for this study.

Acknowledgment

We thank the authors of the studies included in this scoping review.

Author Contribution

The authors contributed to this study by searching for papers from various databases, assessing their eligibility, and extracting data. Five out of the nine author teams collected articles by examining eligibility based on title, abstract, inclusion

criteria, article identification, and selection. Then four people retrieved specific study details, such as methodologies, year of publication, study design, and sample size. Furthermore, all author teams collaborated to study and analyze each suitable article, offering critical input and creating the research manuscript.

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