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Sex-related absolute inequalities in tuberculosis incidence in 47 countries in Africa

Aliu Mohammed¹, Richard Gyan Aboagye^{2,3*}, Precious Adade Duodu⁴, Qorinah Estiningtyas Sakilah Adnani⁵, Florence Gyembuzie Wongnaah⁶, Abdul-Aziz Seidu⁷ and Bright Opoku Ahinkorah^{8,9}

Abstract

Background Tuberculosis (TB) remains a major infectious disease of public health concern in Africa; understanding the sex disparities in TB burden is crucial for advancing global health objectives in TB diagnosis and treatment.

Methods This study assessed the sex-related disparities in the incidence of TB in 47 countries in Africa. Data for the study was obtained from the World Health Organization (WHO) repository, which is incorporated into the Health Equity Assessment Toolkit (HEAT). We used the WHO HEAT software version 3.1 and Stata software version 17.0 for the analysis. We estimated the difference between the TB incidence in males and females as a measure of inequality. Inequality was measured using Difference (D), an absolute summary measure of inequality.

Results The study revealed varying degrees of disparities in TB incidence, which skewed towards men in all countries across Africa, encompassing countries with different income levels. Lesotho ($D = -512.07$) recorded the highest difference in TB incidence, which skewed towards men. At the income level, the Central African Republic ($D = -257.77$), Lesotho ($D = -512.07$), and Namibia ($D = -288.12$) recorded the highest absolute disparities in the low-income, lower middle-income, and upper middle-income countries, respectively. Meanwhile, Togo ($D = -19.68$), Comoros ($D = -17.79$), Mauritius ($D = -10.08$), and Seychelles ($D = -19.83$) recorded the least sex-related disparities in TB incidence in low-income, lower middle-income, upper middle-income, and high-income countries, respectively.

Conclusions Interventions aimed at minimising the burden of TB in Africa could be targeted at reducing men's exposure to TB risk factors. Such interventions could reduce the incidence of TB among men in Africa and contribute towards the achievement of the Sustainable Development Goal three target 3.3, which seeks to end the global epidemics of TB by 2030.

Keywords Africa, Inequalities, Sex, Tuberculosis

*Correspondence:

Richard Gyan Aboagye
aboagyegyan94@gmail.com

¹ Department of Health, Physical Education, and Recreation, University of Cape Coast, Cape Coast, Ghana

² Department of Family and Community Health, Fred N. Binka School of Public Health, University of Health and Allied Sciences, Hohoe, Ghana

³ School of Population Health, University of New South Wales, Sydney, NSW 2052, Australia

⁴ Department of Nursing, School of Human and Health Sciences, University of Huddersfield, Queensgate, Huddersfield, England, UK

⁵ Department of Public Health, Faculty of Medicine, Universitas Padjadjaran, Bandung, West Java, Indonesia

⁶ Department of Global Public Health, Karolinska Institutet, Stockholm, Sweden

⁷ Public Health and Tropical Medicine, James Cook University, Townsville, QLD 4811, Australia

⁸ REMS Consultancy Services, Takoradi, Western Region, Ghana

⁹ Faculty of Health and Medical Sciences, The University of Adelaide, Adelaide, Australia



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Background

Tuberculosis (TB), which was declared a global health emergency in 1993, continues to be a global public health concern due to its contribution to morbidity and mortality worldwide [1–3]. TB is a communicable disease caused by the bacillus *Mycobacterium tuberculosis*, and it predominantly affects the lungs [3]. The World Health Organization (WHO) [3] reported 10.8 million TB cases in 2023, consisting of 6.0 million men, 3.6 million women, and 1.3 million children. However, approximately 25% of the world's population is reported to have been infected with TB [4], with many individuals not progressing to active disease [3, 5, 6]. Prior to the coronavirus disease (COVID-19) pandemic, TB was the leading cause of death from a single infectious agent despite being preventable and treatable [3, 7, 8]. Without treatment, about half of the people affected by TB may die [3, 9]. In older persons, delays in diagnosis, ineffective treatment, drug resistance, human immunodeficiency virus (HIV) co-infection, and comorbidities are associated with increased TB-related mortality [10–12].

Although the African Region has generally met the key Millennium Development Goal (MDG) target to halt and begin to reverse TB incidence by the end of 2015, only 35 of the 47 member states met the MDG target [2]. Nonetheless, TB remains a major public health threat in Africa due to unceasing incidence, prevalence, and mortality [2]. Currently, Africa ranks second in the highest TB cases, with approximately 24% of the global incidence [3]. To reduce the global burden of the disease, especially in Africa, the Directly Observed Treatment, Short-course (DOTS) for TB control as well as the expanded framework for DOTS, which integrated response to TB/HIV co-infection and multidrug-resistant TB, was instituted [2]. Additionally, WHO's End TB Strategy and the United Nations' Sustainable Development Goals (SDGs) have also been adopted to help end the pandemic [2, 6, 13]. WHO's End TB Strategy aims to end the global TB pandemic by reducing TB incidence by 90% and mortality by 95% by 2035 [13, 14].

TB case rates are usually higher in men than in women [13, 15, 16]. However, the global burden of TB is higher among females than among males in HIV-positive individuals [8]. Also, females generally have a greater HIV and TB co-infection than males, which may be due to unsafe sex and intimate partner violence, especially in southern sub-Saharan Africa [8]. Case reporting bias [17, 18], differences in the biological composition of men and women [19], and higher TB risk factors like excessive alcohol intake and tobacco use among men [20–22] contribute to the sex differences in TB cases. For example, Watkins and Plant [21] found that cigarette smoking accounts for 33% of the sex-related variations in TB notifications.

Differences in how men and women obtain TB care and how social roles affect contact with infected people with *Mycobacterium tuberculosis* are also contributors [13].

Men and women may respond to TB differently and have various hurdles to accessing TB diagnostic and treatment services [23–25]. Men have less TB health-seeking behaviour due to fear or to circumvent the diagnosis of conditions like TB or HIV [26, 27]. These fears and anxieties are interwoven with societal pressure to forsake symptoms to remain 'strong' as part of masculinity expectations [28–30]. Consequently, they present advanced stages of TB after resolving to seek care. Compared to women, men also have poorer anti-TB treatment adherence [13, 16, 18, 26, 31] and, therefore, experience worse outcomes, including slower conversion of sputum, a higher likelihood of reactivation, and a higher mortality rate [19]. Alternatively, women in low- and middle-income countries (LMICs) may face more obstacles than men in obtaining healthcare services [31, 32]. Women, compared with men, face a substantially longer time to diagnosis [33–37]. This is possibly due to lower attention given to women when they present non-specific TB symptoms [38], evidence of TB diagnostic tools being less sensitive for women [38], and gender norms requiring women to negotiate with husbands to seek TB care [39]. Also, women are frequently expected to care for their husbands or male relatives who have TB and prioritise their access to nutrition, although the reverse typically does not hold true, adding to the complexity of cultural expectations of appropriate gender roles [40]. General barriers that affect access to TB care include financial constraints, unemployment, distance to TB service locations, lack of access to transportation, the stigma associated with TB diagnosis and its link to HIV, and lack of TB-related knowledge and education. Others are gender-specific roles and status in the family, the provider's level of TB suspicion, and lack of adherence to national TB programme guidelines [23, 41–45].

The WHO recommends that effective public health interventions should, whenever possible, consider the social determinants of health, such as sex and gender [46]. Differences in the incidence, prevalence, mortality, and other undesirable health conditions among certain demographic groups constitute health inequalities [47]. It is becoming clearer that vulnerable groups are frequently found in LMICs, including Africa, with high disease burdens, where gender disparities are a significant social determinant of access to proper healthcare and systems of redress [39]. Woodward and Kawachi [48] have highlighted the need to reduce inequalities in health as they are mostly unfair and preventable. By this, a crucial evaluation of sex differences in TB burden is underpinned by the need for equitable access to TB diagnosis and treatment

in global health targets. However, little attention has been paid to the differences in TB burden by sex [8]. Therefore, this study aimed to assess the sex-related differences and inequalities in TB incidence in 47 African countries to inform targeted interventions to combat TB.

Methods

Data source

The study was conducted in 47 countries in Africa. The countries comprised twenty-two low-income, eighteen lower middle-income, six upper middle-income countries, and one high-income country. Data for the study was sourced from the WHO Global Health Observatory Health Equity Monitor [49]. The WHO culminates TB incidence data from sources including the AIDS Indicator Surveys, Demographic and Health Surveys, Malaria Indicator Surveys, Reproductive Health Surveys, and UNICEF Multiple Indicator Cluster Surveys [49]. Additional data sources include those from the TB indicators provided by countries (for TB case notifications) and data from TB prevalence surveys, and TB patient cost surveys available from country reports [49]. Data from all these sources were collated and incorporated into the WHO Health Equity Assessment Toolkit (HEAT) software [50], which was used for this study.

Measures

The outcome measure of interest was the TB incidence per 100,000 population. TB incidence, according to the WHO [49], aids in estimating the burden of TB in a population aside from mortality. The TB incidence data was provided by WHO [49].

Sex was the inequality dimension used in the study. It was defined as the biological sex of the individual. Sex was classified into two sub-groups, namely female and male.

Statistical analysis

We used the WHO HEAT online software version 3.1 [50], Stata version 17.0, and Microsoft Excel to perform all the statistical analyses. The WHO HEAT is an online statistical tool for assessing health disparities within and between countries on a variety of health and social issues, including TB. A detailed description of the WHO HEAT and its usefulness can be found in the literature [50, 51]. We carried out the analysis in three phases. First, we used Stata to present the graphical estimates of the incidence of TB among the 47 countries studied by sex. Next, we segregated the TB incidence for twenty-two low-income, eighteen lower middle-income, six upper middle-income countries, and one high-income country segregated by female and male sub-groups. In the second phase, we presented the difference between the TB incidence in

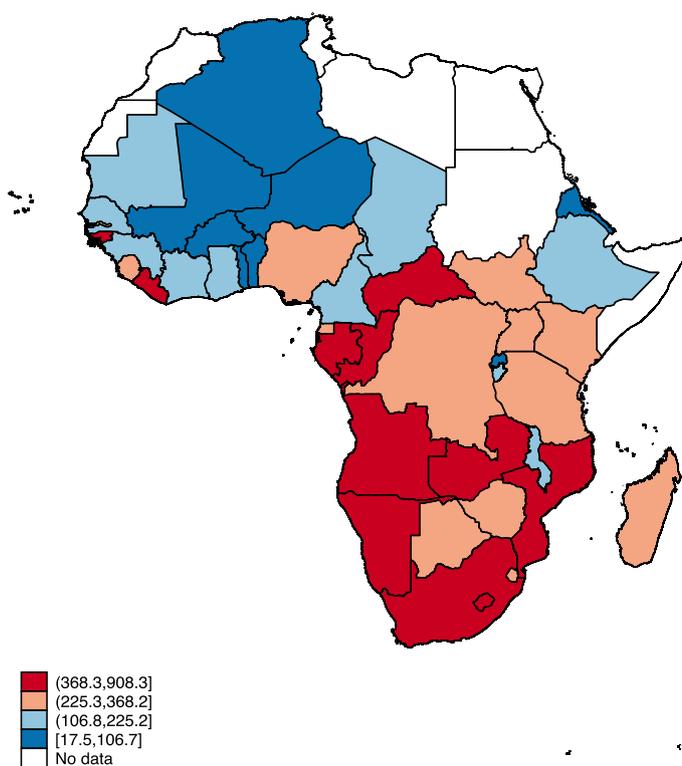


Fig. 1 TB incidence among males in 47 African countries

males and females as a measure of inequality. Our study measured inequality using the difference (D), an absolute summary measure of inequality. The value of D represents a distinction between two population segments, female and male, in our study. D was derived by subtracting the TB incidence in males from that of the females for each country. For inequality to occur, the absolute value of D should be greater than zero. Higher absolute values of D suggest greater inequality in TB incidence, whereas zero values indicate no disparity. Thus, a negative D value indicates that TB incidence is higher among males, whereas a positive D indicates higher incidence among females. A value of zero signifies no difference in incidence rates between the sexes [50, 51].

Results

Figures 1 and 2 show TB incidence among males and females, respectively, across the 47 African countries surveyed. As shown in Fig. 1, countries with high TB incidence among males were predominantly located in the southern and central parts of Africa. They include Lesotho (908), Central Africa Republic (668), South Africa (667), Gabon (636), and Namibia (609) per 100,000 population. We observed a similar trend of TB incidence among the females (Fig. 2). On the other hand, countries

with the least TB incidence among males were Mauritius (18), Seychelles (20), Comoros (43), Togo (46), and Cape Verde (54) per 100,000 population (Fig. 1). Similar pattern of TB incidence was seen among the females (Fig. 2).

Figures 3, 4, 5 and 6 show the sex-related disparities in TB incidence in low-income, lower middle-income, upper middle-income, and high-income African countries, respectively. We observed varied disparities in the incidence of TB between men and women, with higher incidence observed among men across all the 47 countries surveyed. Also, among all the countries surveyed, we found that Lesotho had the highest disparity (512) in the incidence of TB. The incidence for males was 908 while that of the females was 396 (Table 1). At the income level, the Central African Republic (257; males- 668, females -411), Lesotho (512; males -908, females -396), and Namibia (288; male -609, female -321) recorded the highest sex-related disparities in the incidence of TB in low-income, lower middle-income, and upper middle-income countries, respectively. The only high-income country in the survey, Seychelles (20; male -20, female -0), recorded no sex-related disparity in the incidence of TB. Meanwhile, Togo (20; males -46, females -26), Comoros (17, males -43, females -26), and Mauritius (11; males -18, females -7) recorded the lowest sex-related disparities in

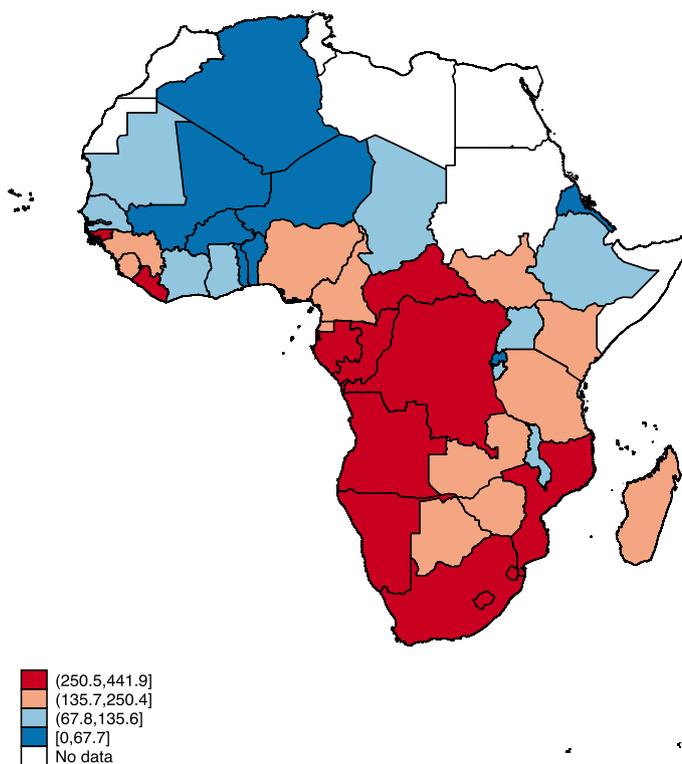


Fig. 2 TB incidence among females in 47 African countries

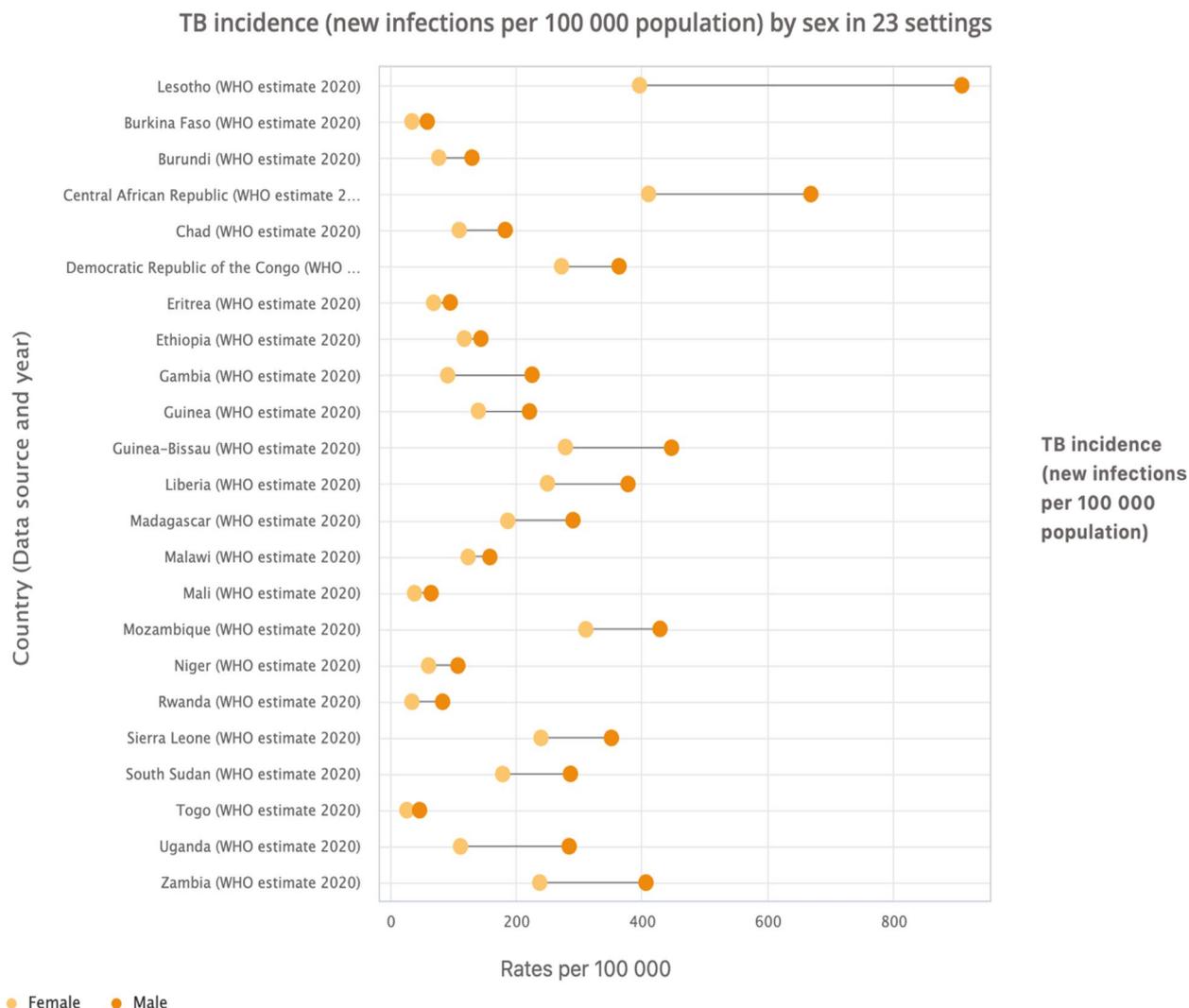


Fig. 3 Sex-related inequalities in TB incidence in Lesotho compared to 22 low-income countries in Africa

the incidence of TB in low-income, lower middle-income, and upper middle-income countries, respectively.

Table 2 shows the sex-related disparities in TB incidence in the 47 countries surveyed by summary measures (D). The relative summary measure (D) revealed varied sex-related disparities in the magnitude of the incidence of TB, which skewed towards men in all the countries surveyed. Lesotho ($D = -512.07$) recorded the highest difference in the incidence of TB, which skewed towards men. At the income level, the Central African Republic ($D = -257.77$), Lesotho ($D = -512.07$), and Namibia ($D = -288.12$) recorded the highest relative disparities in the low-income, lower middle-income, and upper middle-income countries, respectively. Meanwhile, Togo ($D = -19.68$), Comoros ($D = -17.79$), Mauritius ($D = -10.08$), and Seychelles ($D = -19.83$) recorded the least sex-related disparities in the incidence of TB

in low-income, lower middle-income, upper middle-income, and high-income countries, respectively.

Discussion

In this study, we found varied absolute sex-related disparities in the incidence of TB with high burden observed among men in all countries across the African subregions (low-income, lower and upper middle-income, and high-income countries), albeit at varying degrees. Among all the countries surveyed, we observed the highest sex-related disparity in the incidence of TB among men in Lesotho. Other countries with notably higher sex-related disparities in the incidence of TB by relative summary measures include the Central African Republic, South Africa, Namibia, and Gabon. Findings from the present study are consistent with the findings from several previous studies that reported higher incidence

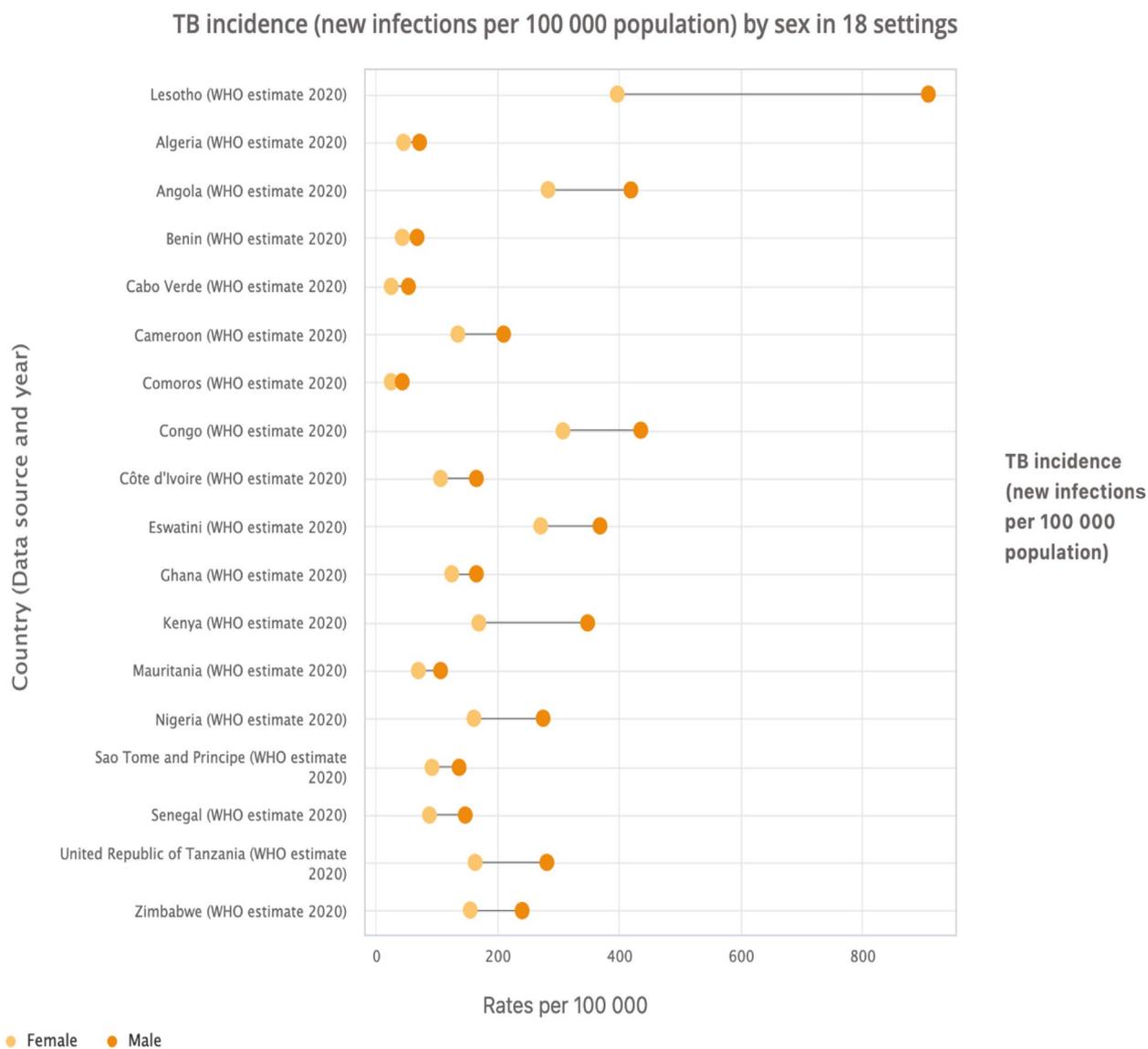


Fig. 4 Sex-related inequalities in TB incidence in Lesotho compared to 17 lower middle-income countries in Africa

of TB among men relative to women in Africa [52–54] and elsewhere [22, 55]. In a recently published global TB data, the WHO reported wide gender-related disparity in the incidence of TB worldwide, with adult men (aged ≥ 15 years) accounting for 55% of the global TB cases while adult women accounted for 33%. Thus, aside from highlighting the persistently high burden of TB among men in Africa, the present study provides the magnitude of the sex-related disparities in the incidence of TB. Having sex-segregated data on the incidence of TB is important in developing targeted interventions to reduce the burden of TB in Africa [56]. Also, considering that sex-related disparities in the incidence of TB have increased

in Africa over the past decades [13], our findings provide an avenue for monitoring progress in reducing the sex-related burden of TB across the countries in Africa.

The differences in TB incidence between men and women have been attributed to several factors, including variations in biological or immunological vulnerability [55, 57], social contact or social mixing patterns [21, 58], occupational exposure to risk factors like mining [54], imprisonment [56], and behavioural risk factors such as smoking and alcohol abuse [53]. For instance, the high rate of alcohol consumption [57] and smoking [21] among men had been widely associated with increased incidence of TB among men relative to women. In a study

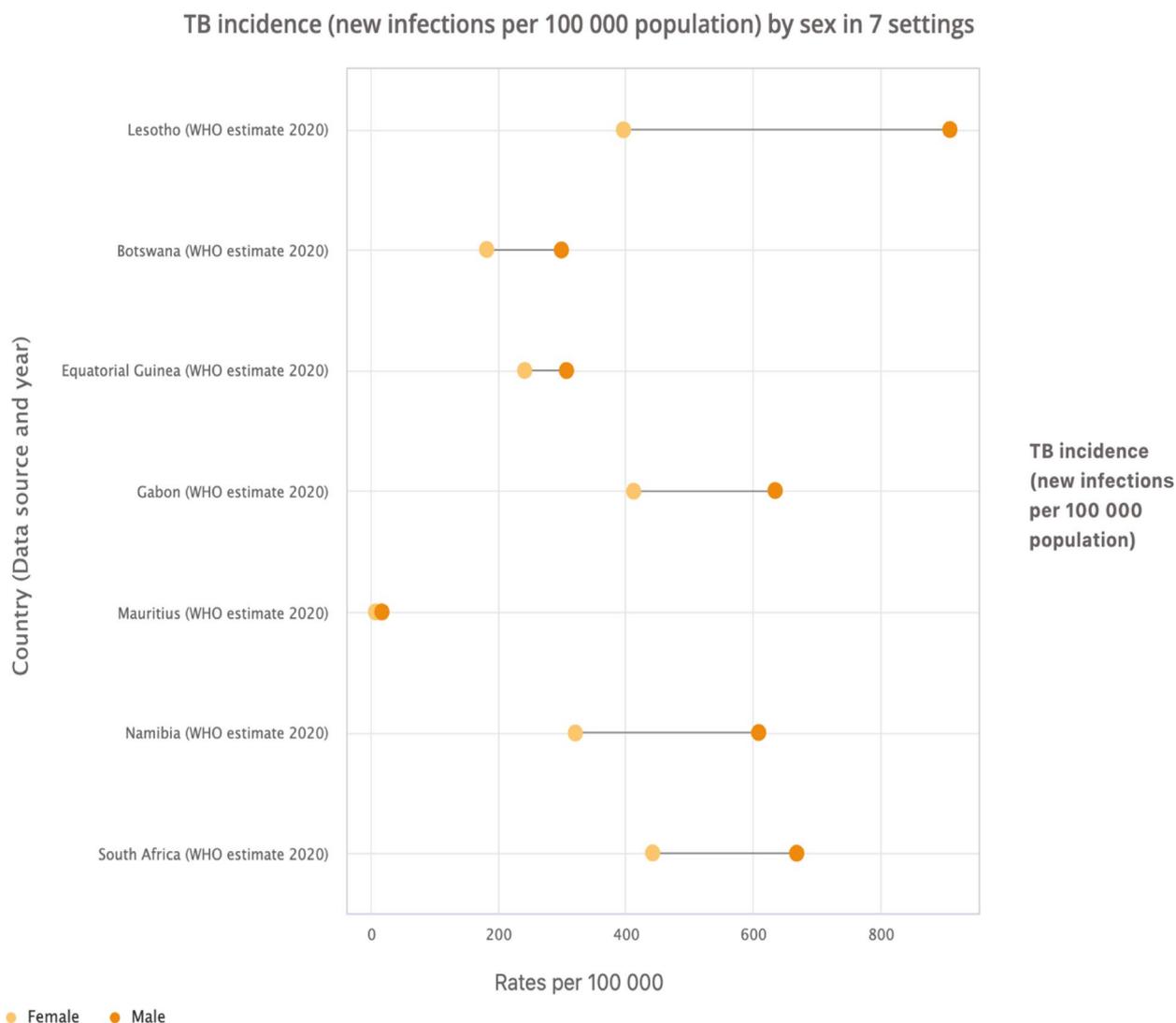


Fig. 5 Sex-related inequalities in TB incidence in Lesotho compared to 6 upper middle-income countries in Africa

of TB patients in India, excluding smokers and alcoholics (who were mainly men) reduced the male-to-female ratio of TB cases from 2:7 to 1:2 [58]. Both alcohol and tobacco smoke have detrimental effects on lung immunity, which predispose abusers to high risk of TB infection [57]. Also, increased men’s exposure to workplace hazards such as silica dust [59] and poor ventilation [54] associated with mining have been implicated in the high incidence of TB among men. In Ghana, being a miner was associated with a threefold increase in risk for TB [60]. Aside from high exposure to TB risk factors, available evidence suggests that men are disadvantaged in accessing or seeking TB care in many low- and middle-income countries, particularly in Africa [13]. Perhaps, providing interventions that

limit men’s exposure to modifiable risk factors for TB, such as smoking and alcohol abuse, and improving access to TB care could contribute towards reducing the burden of the disease in Africa.

Among all the countries surveyed, we observed the highest disparity in the incidence of TB, which skewed towards men in Lesotho. A previous study also reported a wide sex-based disparity in the incidence of TB with higher burden among men in Lesotho [61]. Other countries with notably high incidence of TB among men relative to women were predominantly upper middle-income countries in the southern part of Africa (Botswana, South Africa, and Namibia). Perhaps men in upper middle-income countries in the southern parts of Africa may be

TB incidence (new infections per 100 000 population) by sex in 2 settings

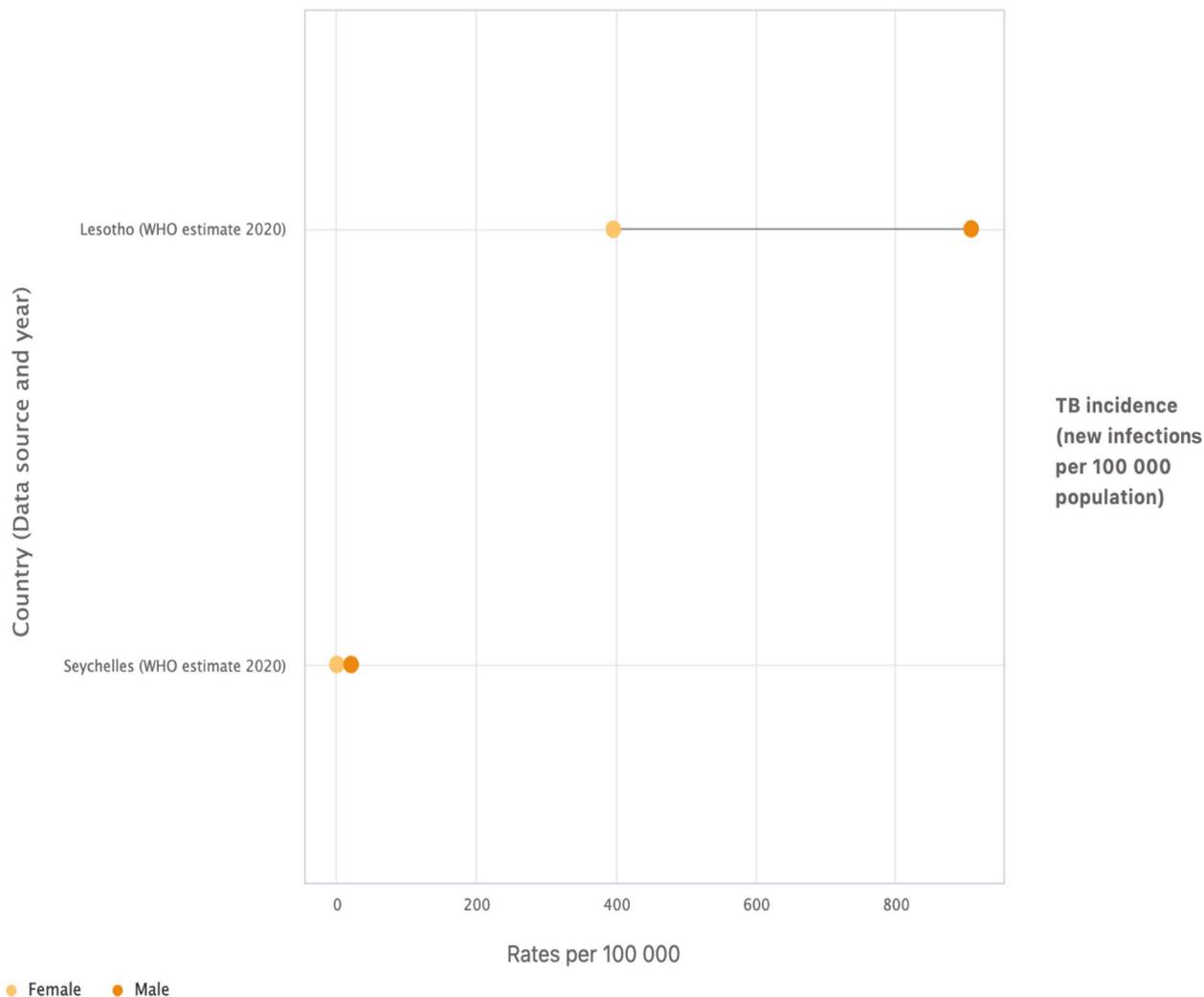


Fig. 6 Sex-related inequalities in TB incidence in Lesotho compared to Seychelles

highly exposed to TB risk factors, which might have contributed to the observed disparity. For example, in South Africa (where a large population of men are involved in mining activities), mine workers are 10 times more likely to develop TB than the general population [62, 63]. Besides, mines in South Africa also employ many migrants from neighbouring countries such as Botswana and Lesotho, which often contribute to high incidence of TB in those countries [63, 64]. Considering that TB has long been considered the disease of the poor [52], there is a need for further studies to ascertain the factors that contribute to the increased burden of TB among men in upper middle-income countries, particularly from the southern parts of Africa.

Strengths and limitations

Since we used nationally representative datasets of the same survey year (2020) from 47 African countries to assess the sex-related differences in the incidence of TB, our findings could serve as baseline data for comparisons and monitoring of progress in reducing the burden of TB in Africa. However, this study has some limitations. First, although previous studies have suggested that individuals in certain age groups have a higher incidence of TB [52, 55, 61], we could not segregate respondents by age, which limits the interpretation of our findings. Second, our analysis only compared the male and female differences in the incidence of TB. Therefore, aside from sex, we could not analyse the

Table 1 Sex-related disparity in TB incidence in 47 African countries

Country	Male	Female	Disparity
Lesotho	908	396	512
Algeria	72	46	26
Angola	418	283	135
Benin	68	43	25
Botswana	298	181	117
Burkina Faso	58	33	25
Burundi	131	77	54
Cape Verde	54	26	28
Cameroon	211	136	75
Central African Republic	668	411	257
Chad	183	109	74
Comoros	43	26	17
Republic of Congo	435	308	127
Côte d'Ivoire	165	107	58
Democratic Republic of the Congo	365	272	93
Equatorial Guinea	308	241	67
Eritrea	96	68	28
Swaziland	368	271	97
Ethiopia	144	118	26
Gabon	636	412	224
Gambia	225	90	135
Ghana	165	124	41
Guinea	220	140	80
Guinea-Bissau	447	279	168
Kenya	348	170	178
Liberia	378	250	128
Madagascar	290	187	103
Malawi	159	124	35
Mali	65	39	26
Mauritania	107	69	38
Mauritius	18	7	11
Mozambique	428	311	117
Namibia	609	321	288
Niger	107	61	46
Nigeria	276	161	115
Rwanda	83	33	50
Sao Tome and Principe	137	91	46
Senegal	147	87	60
Seychelles	20	0	20
Sierra Leone	352	240	112
South Africa	667	442	225
South Sudan	286	179	107
Togo	46	26	20
Uganda	284	112	172
Tanzania	281	164	117
Zambia	406	237	169
Zimbabwe	240	154	86

Table 2 Sex-related inequalities in TB incidence in 47 African countries by summary measure (difference)

Settings	D (estimate)	Setting average
Low-income countries		
Burkina Faso	- 24.94	45.95
Burundi	- 53.73	103.50
Central African Republic	- 257.77	540.00
Chad	- 73.51	143.94
Democratic Republic of the Congo	- 92.56	319.06
Eritrea	- 27.80	81.19
Ethiopia	- 25.94	131.65
Gambia	- 134.97	156.53
Guinea	- 80.23	178.92
Guinea-Bissau	- 168.14	361.23
Liberia	- 127.09	314.46
Madagascar	- 102.18	237.74
Malawi	- 35.24	141.22
Mali	- 26.46	52.18
Mozambique	- 116.77	368.21
Niger	- 46.17	83.18
Rwanda	- 49.83	58.07
Sierra Leone	- 111.39	297.54
South Sudan	- 106.69	231.55
Togo	- 19.68	35.72
Uganda	- 171.76	196.35
Zambia	- 169.41	319.50
Lower middle-income countries		
Lesotho	- 512.07	650.14
Algeria	- 26.59	59.17
Angola	- 135.14	350.21
Benin	- 24.88	55.13
Cabo Verde	- 27.74	39.32
Cameroon	- 75.23	174.48
Comoros	- 17.79	34.90
Congo	- 127.49	379.41
Côte d'Ivoire	- 58.36	135.09
Eswatini	- 97.05	318.84
Ghana	- 41.08	142.87
Kenya	- 178.04	258.75
Mauritania	- 37.94	86.83
Nigeria	- 114.37	219.05
Sao Tome and Principe	- 45.43	117.68
Senegal	- 59.38	117.19
United Republic of Tanzania	- 117.42	222.17
Zimbabwe	- 85.28	192.59
Upper middle-income countries		
Botswana	- 117.04	236.47
Equatorial Guinea	- 66.62	280.37
Gabon	- 223.80	527.09
Mauritius	- 10.08	12.39
Namibia	- 288.12	460.13
South Africa	- 225.47	553.66
High-income country		
Seychelles	- 19.83	10.52

influence of other socio-demographic factors, such as education, income, and marital status in determining the sex-related disparities in the incidence of TB. Also, we could not assess individuals' exposure to TB risk factors such as smoking, alcohol consumption, and mining. Thus, we can only speculate that men have higher exposure to TB risk factors compared to women based on the observed disparities in the incidence of TB. Additionally, the data were sourced from multiple sources with varying data collection methodologies, which could have impacted the data quality and, ultimately, the study's results. Moreso, we could not perform further statistical tests due to the nature of the data.

Conclusion

Findings from this study highlight the magnitude of sex-related disparities in the incidence of TB, with higher burden observed among men across the various countries in Africa. Therefore, interventions aimed at minimising the burden of TB in Africa could be targeted at reducing men's exposure to TB risk factors, especially in countries like Lesotho, Central African Republic, Botswana, South Africa, Namibia, and Gabon. Also, regional-level data may help in planning regional TB control activities, such as monitoring the health of migrant workers and refugees. Perhaps reducing the incidence of TB among men in Africa could contribute towards the realisation of SDG 3.3.2, which seeks to end the global epidemics of TB by 2030.

Abbreviations

COVID-19	Coronavirus disease 19
D	Difference
DOTS	Directly Observed Treatment, Short-course
HEAT	Health Equity Assessment Toolkit
HIV	Human Immunodeficiency Virus
LMICs	Low- and middle-income countries
MDG	Millennium Development Goal
SDG	Sustainable Development Goal
TB	Tuberculosis
WHO	World Health Organization

Acknowledgements

We are grateful to the World Health Organization for making the HEAT software freely accessible for use.

Authors' contributions

BOA and RGA conceived the study. RGA and BOA wrote the methods section and performed the data analysis. RGA, AM, PAD, QESA, FGW, and AS were responsible for the initial draft of the manuscript. All the authors reviewed and approved the final version of the manuscript.

Funding

This study received no funding.

Data availability

The dataset used can be accessed at ([https://www.who.int/data/gho/data/indicators/indicator-details/GHO/incidence-of-tuberculosis-\(per-100-000-population-per-year\)](https://www.who.int/data/gho/data/indicators/indicator-details/GHO/incidence-of-tuberculosis-(per-100-000-population-per-year))).

Declarations

Ethics approval and consent to participate

No ethical clearance was sought for this study due to the public availability of the dataset.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 12 May 2024 Accepted: 24 April 2025

Published: 2 June 2025

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