Contents Lists Available at: https://journal2.unusa.ac.id/

Medical Technology and Public Health Journal

Journal Home Page: https://journal2.unusa.ac.id/index.php/MTPHJ

Research Article

Factors associated with non-compliance to tuberculosis treatment among patients in Gauteng Province, South Africa

Serurubele Portia Madumo[1] | *Ms Mmampedi Huma*[1] | Prof Muhammad Hoque[1*]

[1]*Department of Public Health, Sefako Makgatho Health Sciences University, Pretoria, South Africa*

***Corresponding Author*:**
Muhammad Hoque, Department of Public Health, Sefako Makgatho Health Sciences University, Pretoria, South Africa
Email: muhammad.hoque@smu.ac.za

DOI: *10.33086/mtphj.v9i2.5592*

Article History:
Received, May 14th 2024
Revised, March 27th 2025
Accepted, June 4th 2025
Available Online: September 1st 2025

Please cite this article as:
Madumo, S. Portia, et. al., "Factors associated with non-compliance to tuberculosis treatment among patients in Gauteng Province, South Africa". Register: Medical Technology and Public Health Journal, Vol. 9, No. 2, pp. 151-162, 2025

ABSTRACT

Despite the implementation of several tuberculosis (TB) control initiatives, TB continues to be a significant cause of mortality and morbidity in South Africa primarily due to non-compliance with the recommended treatment. The objective of the study was to determine the frequency of non-compliance with treatment and identify the factors linked to non-compliance among tuberculosis patients in the Ekurhuleni South Health Sub-district in South Africa. This study was a quantitative cross-sectional analysis carried out on a sample of 309 patients, utilising an anonymous questionnaire. The data was analysed using Stata version 14. The findings indicated that those who had a sufficient food supply for a period beyond 6 months demonstrated a decreased likelihood of adhering to tuberculosis therapy (odds ratio = -0.12, $p < 0.05$). Additionally, the study revealed that those who had communicated with their family or friends about their tuberculosis treatment were more inclined to comply with the treatment regimen (OR=0.11; $p<0.1$). Individuals who were unmarried had a 22% lower likelihood of adhering to medication (OR=0.22; $p<0.05$). Based on these findings, initiatives designed to enhance adherence to TB treatment in Gauteng Province should implement a comprehensive approach, integrating economic assistance, focused education, and strategies to reduce stigma.

Keywords*: Alcohol consumption, scarcity of food, side effects, knowledge*

INTRODUCTION

Tuberculosis (TB) is annually responsible for the morbidity of approximately 10.4 million people and the mortality of approximately 1,7 million worldwide (WHO, 2021). This impacts negatively on economic growth because almost three- quarters of TB cases are those in the economically productive age group-that is, between 15 and 59 years old (NICD, 2017).

Although the incidence of TB in South Africa has declined from 832 per 100 000 in 2009 to 454 per 100 000 in 2014, South Africa has remained on the list of the 22 countries that are defined

as “high-burden countries" globally since the inception of the term in 1998 (WHO, 2015). This designation categorizes and ranks countries based on the severity of their TB burden, specifically identifying those contributing approximately 80% of global TB cases(WHO, 2015). The definition was later expanded to include multidrug-resistant TB (MDR-TB) and TB/HIV co-infection. Rating countries in this fashion helps in identifying countries with a high burden of disease so that they can be prioritized for international funding and intervention to contain or combat the epidemic (WHO, 2015).

In 2018, South Africa was one of the seven nations that accounted for 64% of the worldwide tuberculosis (TB) mortality and morbidity, according to the World Health Organisation (WHO). Additionally, it was observed that South Africa had the highest estimated occurrence and number of existing cases of tuberculosis among the top twenty-two nations with a high burden of tuberculosis (NICD, 2017). Based on NSP 2012-2016, almost 80% of the population in South Africa is affected by TB bacteria, with the majority having latent TB rather than active. HIV accelerates the progression of latent tuberculosis to active tuberculosis in individuals (WHO, 2018).

TB is curable, and treatment is available free of charge if appropriate anti-TB therapy is initiated immediately after detection (Tesfahuneygn et al, 2015). In addition, a client-centered approach that ensures that TB services are patient-friendly and easy to access has been put in place. This was done in the hope of achieving the global cure rate of 85% by 2011 (National Department of Health, 2009). Despite all this, South Africa has been struggling to reach the WHO targets - that is, the cure rate of 77.2% nationally versus the WHO’s target of 85; and the loss to follow-up rate of 5.6% nationally versus the WHO’s target of 5%. Furthermore, TB remained the leading cause of death in South Africa for three consecutive years. That is, TB accounted for 8.3% of deaths in 2013, 8.3% of deaths in 2014, and 7.2% of deaths in 2015 (Lehohla, 2017).

Non-adherence to TB treatment is a major contributor to TB-related mortality and morbidity. Non-adherence is defined as the patient’s not consuming the prescribed medication as required (Kulkarni et al, 2013). In this study, adherence in the past seven days and in the month (Adane et al, 2013) prior to the study was assessed. This could lead to a high TB loss to follow-up rate. Non-adherent patients are also in danger of worsening ill-health and complications, including relapses and conversion to drug resistance (Finlay et al, 2012; Tesfahuneygn et al, 2015). These drug-resistant TB strains need special treatment that is more toxic and expensive than treating the drug-sensitive TB strain. The XDR-TB treatment cost per patient was found to be $26,392, which is four times greater than the MDR-TB drug cost per patient ($6772), and exceeds the drug-sensitive cost $257 per patient, 103 times (Pooran et al, 2013).

Some of the factors associated with non-adherence to TB treatment are: (i) low socio-economic status; (ii) behavioural factors (Maswanganyi et al, 2014; Ndwandwe et al, 2014) (iii) healthcare facility-related factors (insufficient budget to strengthen the programme, a lack of commitment by the community primarily due to low health literacy, not achieving the required case detection rate, poor case continuity of care, and high levels of treatment non-compliance due to the inadequacy of the health system; incompetent healthcare providers or inadequate supervision of healthcare providers; the indifference of healthcare providers leading to non-compliance to protocols, poor record keeping, and unacceptable attitudes towards patients) (National TB Management Guidelines, 2009); (iv) drug-related factors; and (v) cultural factors (Ndwandwe et al, 2014; Maswanganyi et al, 2014).

Despite the implementation of the free TB programme, which includes the Directly Observed Treatment short-course (DOTS) method, in the South African public health sector to

encourage adherence to the recommended TB treatment, there is still a high prevalence of non-adherence (Kandel et al, 2008). In the Ekurhuleni Health Sub-district, the rate of TB patients who do not continue with their treatment is lower than the national rate of less than 5% as stated in the Tuberculosis Strategic Plan for South Africa from 2007 to 2011. However, according to the District Health Barometer, this rate has been steadily increasing over the years. Specifically, it was 2.8% in 2011, 3.8% in 2012, 4.4% in 2014, and 4.6% in 2015. Research undertaken in developing nations, such as South Africa, demonstrates that failure to comply with tuberculosis (TB) treatment poses a significant risk to the overall well-being of the population (Tesfahuneygn et al, 2015). Identifying and addressing the obstacles related to non-compliance with tuberculosis (TB) treatment in the Ekurhuleni South Health Sub-district, and approaching these obstacles as a unified whole, can enhance adherence to a TB treatment plan (Kulkarni et al, 2013). Hence, the objective of this research is to examine the extent of non-compliance with tuberculosis (TB) therapy and identify the factors that contribute to non-compliance among TB patients in primary healthcare facilities within the Ekurhuleni South Health Sub-district.

MATERIAL AND METHODS

The study utilised a quantitative, cross-sectional approach. This method involves numerical data to examine the relationships between variables by employing statistical analysis to ascertain the magnitude and significance of the relationship. The study was conducted in Ekurhuleni South, which is one of three sub-districts forming Ekurhuleni Metropolitan Municipality (EMM). EMM renders its services to about 3.379,104 million people, who are economic migrants from other provinces and neighbouring African countries. There were 1,627,724 males and 1,550,747 females in the municipal area in 2016 (City of Ekurhuleni Annual Report, 2016/17).

The health sector is managed by two health authorities, which are the local government and the provincial health sector. At the time of the study there were approximately 94 healthcare facilities in the EMM, which are situated within walkable distance of the people they serve, not more than a 5 Km radius, ensuring accessibility to beneficiaries who are still not able to have medical insurance and depend on the government to render healthcare services to them (Ekurhuleni Annual Report, 2016/2017). The facilities offer one-stop comprehensive primary healthcare services with an integrated TB programme. The services provided encompass various areas, such as child health, with a particular focus on infectious diseases, sexually transmitted diseases and HIV/AIDS, reproductive health including ante-natal care, family planning, and maternity services, mental health support, chronic diseases such as high blood pressure, diabetes mellitus, and respiratory illnesses, trauma and injuries, as well as disabilities.

The community healthcare services operate 24 hours, seven days a week, and the primary healthcare facilities operate from 08H00 to 16H00, seven days a week. The facilities are run by managers who are qualified in PHC services. There are doctors and specialists that offer periodic consultations.

A sample was taken from adult patients with medically confirmed pulmonary TB who had been receiving TB therapy for a minimum of one month and had visited a local facility during the study period to refill their prescription. The Raosoft sample size calculator was utilised. With a population of 2,529, a 5% margin of error, and a 95% confidence interval and a response distribution of 50%, the study required a sample size of 334 respondents. A systematic random sampling technique was employed, wherein every second patient who visited the facility for a refill on the appointed date was included in the sample.

Eligibility criteria included those with tuberculosis who were at least 18 years of age but no more than 65 years of age. Participants were required to have had tuberculosis treatment for a minimum duration of one month and express a willingness to take part in the study. The study excluded patients with psychosis and those diagnosed with extra-pulmonary tuberculosis. In addition, the study did not include patients who were severely unwell.

The data collection tool was adapted from a similar study conducted by Chani in Namibia in 2010 and it was administered by trained research assistants. The data collection tool covered demographics, respondent-related factors, health service-related factors, and disease and chemotherapy-related factors (Saczynski et al, 2013).

To perform a pilot study, a small sample of tuberculosis patients who would have been eligible to be a member of the actual group were selected at random and given a questionnaire to fill out. The pilot study was conducted under similar conditions to the main study. It was possible to determine whether the tool was likely to obtain the necessary information with the help of this. Considering the findings of the pilot study, the instrument was modified accordingly. The sample from the pilot study was not included in the sample from the main study.

A standardized questionnaire which exposed all the respondents to the same close-ended questions and gave them the same choice of a set of predetermined answers was administered by the researcher and three trained researcher assistants, immediately after their refill session with the healthcare worker. A session of questionnaire administration lasted for less than 20 minutes. Non-adherence was assessed by determining whether the patient missed a pill in for seven days prior to questionnaire administration and/or in the month prior to questionnaire administration. A quality check was performed on site to ensure the completeness of the questionnaire and any errors found were corrected accordingly. The questionnaires were stored away from the consent forms in a plastic container. The data collection took place from May to November 2018. Although the questionnaire was available in English, isiZulu, and Setswana, most respondents preferred the English questionnaire. The participating clinics were Ramokonopi, Moleleki, Khumalo, Phola Park, Tsietsi, J Dumane, Extension 28, Poly Clinic, Sunrise Park, and Palmridge.

The raw data were entered into Microsoft Excel and coded. After cleaning, the data were exported to Stata 14 for analysis. The mean and frequency distribution were both employed as descriptive statistics. The Chi-square test was used to find correlations and connections between the independent and dependent variables, and the T-test was employed to compare means. The predictor for tuberculosis treatment adherence was also calculated using logistic regression. Statistical significance was set at $p < 0.05$.

The Sefako Makgatho University Research Ethics Committee (SMUREC) provided ethical permission for the project before it began. Permission was also granted by the Gauteng Provincial Department of Health, Ekurhuleni South Sub-district of Health. To ensure voluntary anonymous involvement, respondents were required to complete a permission form after receiving a comprehensive explanation of the study's purpose and agreeing to participate. No coercion was applied or false expectations created to win participation in the study. It was also emphasised that refusal to be part of the study or withdrawal from the study at any time (if the respondents felt uncomfortable) would not compromise the rendering of healthcare services to them in any way.

RESULTS AND DISCUSSION

Table 1 presents the full demographic profile of the respondents. The majority were male (58.2%), and more than two-thirds were single (70%, n = 216). A total of 115 respondents (37.2%)

had completed Grade 12, while fewer than 15% (n = 47) had attained tertiary or college-level education. Regarding employment status, 17 respondents (5.5%) were pensioners, 21 (6.8%) were self-employed, and nine (2.9%) were students. A total of 127 respondents (41.1%) were employed. Additionally, 177 respondents (57.3%) reported having a source of income.

Table 1: Respondents' demographic characteristics (n=309)

Variable	Category	Frequency	Percent
Age group	18-24 yrs	22	7,12
	25-35 yrs	112	36,25
	36-50 yrs	129	41,75
	50 above	46	14,89
Marital status	Divorced	18	5,83
	Married	66	21,36
	Other	8	2,59
	Single	217	70,23
Education status	Grade 12	115	37,22
	Non-school attendant	8	2,59
	Primary	44	14,24
	Secondary	95	30,74
	Tertiary/college	47	15,21
Religion	Christian	225	72,82
	Islamic	5	1,62
	Other	79	25,57
Employment	Employed	127	41,10
	Pensioner	17	5,50
	Scholar	9	2,91
	Self-employed	21	6,80
	Unemployed	135	43,69
Do you have an income	No	132	42,72
	Yes	177	57,28
Income source	Employment	127	41,10
	Grants	29	9,39
	None	132	42,72
	Self-employed	21	6,80
Income level	No income	132	42,72
	Less than R1000	42	13,59
	R1000-R10 000	121	39,16

R10000-R10 000	2	0,65
R11000-R20000	10	3,24
> R20 000	2	0,65

Table 2 summarises the patient-related factors. A total of 191 respondents (61.8%) reported having adequate food for less than six months. Approximately two-thirds (64.1%) indicated that they had not smoked cigarettes in the six months preceding the survey. Half of the respondents (51.5%) reported having consumed alcohol at some point. Regarding social support, 50% of respondents stated that they had someone to remind them to take their treatment. The majority (87.7%) lived with family members, and a similar proportion (87.1%) had disclosed their TB treatment to family and friends. Among those who had not informed their families, the reasons cited were mistrust (32.0%), fear of being isolated (15%), and other unspecified reasons (52.5%).

Table 2. The patient-related factors

Variables		**Frequency**	**Percent**
Food availability (months)	<6 months	191	61.81
	>6 months	118	38.19
Smoked cigarettes in the past 6 months	No	198	64,08
	Yes	111	35,92
Alcohol in the past 6 months	No	150	48,54
	Yes	159	51,46
Have someone to remind - treatment	No	137	44,34
	Yes	172	55,66
Who do you live with?	Alone	30	9,71
	Family	271	87,70
	Friends	4	1,29
	Other	4	1,29
Number of rooms	1-4 Rooms	256	82.82
	5 -10 Rooms	53	17.15
Inform family on TB treatment	No	40	12,94
	Yes	269	87,06
If not, why?	Fear Being isolated	6	15,00
	Trust no-one	13	32,50
	Other	21	52,50
How does taking TB medication make you feel?	Not ashamed	260	84,14
	Feel ashamed	16	5,18
	Not Sure	33	10,68

Health-related factors are summarised in Table 3. The table presents healthcare system-related factors. More than half of the respondents (53%) identified the period between 07h00 and 16h00 as the most suitable clinic operating hours. A quarter of the respondents reported having waited at least one hour for services, while a small proportion experienced waiting times exceeding two hours. The majority of respondents (79.9%; n=279) reported having a good relationship with healthcare workers. However, 144 respondents (46.6%) indicated that they were not supervised by anyone when taking their TB medication, reflecting gaps in the Directly Observed Treatment, Short-course (DOTS) implementation.

Table 3: Healthcare system-related factors

Variables		Frequency	Percent
Best clinic opening and closing time	7am-16pm	164	53,07
	7am-7am	48	15,53
	7am-7pm	97	31,39
Clinic waiting time	Less than an hour	193	62,46
	1 hour	77	24,92
	3-4 hours	10	3,24
	2 hours	29	9,39
Who supervised TB medicine?	family member	102	33,01
	healthcare worker	63	20,39
	Nobody	144	46,60
Relationship with healthcare workers?	Average	58	18,77
	Good	247	79,94
	not sure	4	1,29
Cost to get to the clinic	No cost	269	87,06
	Some cost	40	12,94

A multivariate regression analysis was conducted to identify predictors of non-adherence to tuberculosis (TB) treatment, as shown in Table 4. The results revealed that participants who had an adequate food supply for more than six months were less likely to adhere to TB medication (OR = –0.12; 95% CI: –0.196 to –0.048). Participants who disclosed their TB treatment status to family or friends were more likely to adhere to the treatment regimen (OR = 0.11; $p < 0.1$). Additionally, individuals with only a primary school education were less likely to adhere to medication (OR = 0.02; $p = 0.818$), though this result was not statistically significant. Unmarried participants were 22% less likely to adhere to treatment compared to their married counterparts (OR = –0.22; $p < 0.05$), indicating that marital status positively influences adherence to TB medication.

Table 4: Multivariate regression - predictors of non-adherence to the TB treatment (n=309)

Adherence (takes pills accordingly)	Coef.	t	P>t	95% Conf.	Interval
Months food					
More than 6 months	-0,12	-3,25	0,001	-0,196	-0,048

Informed family					
Yes	0,11	1,86	0,063	-0,006	0,217
Food					
Always Available	0,04	0,71	0,481	-0,072	0,154
Relationship with HCW					
Good	0,10	2,06	0,041	0,004	0,205
Not sure	0,10	0,56	0,578	-0,242	0,433
How soon did you consult when experiencing the symptoms?					
After a month	- 0,07	0,94	0,348	-0,209	0,074
After a week or two	- 0,05	-1,14	0,253	-0,143	0,038
After 2-3 months	0,39	1,19	0,233	-0,251	1,026
Age					
18-24 years	0,11	1,44	0,151	-0,040	0,260
25-35 years	0,01	0,12	0,901	-0,141	0,160
36-50 years	0,10	1,03	0,305	-0,092	0,294
Education Status					
Grade 12	0,05	0,76	0,45	-0,084	0,189
Non-school attendant	0,24	1,8	0,072	-0,022	0,499
Primary	- 0,02	0,23	0,818	-0,192	0,151
Secondary	0,06	0,76	0,45	-0,090	0,202
Tertiary	0,22	2,33	0,021	0,034	0,407
Marital Status					
Married	0,04	0,45	0,652	-0,135	0,215
Other	- 0,22	-1,64	0,103	-0,483	0,044
Single	0,01	0,15	0,882	-0,161	0,188
Income					
Yes	0,26	1,13	0,26	-0,190	0,701
Income source					
Grants	0,05	0,73	0,468	-0,092	0,199
None					
Self-employed	0,00	0,02	0,988	-0,159	0,162
Income level					
Less than R1000	-0,22	0,94	0,346	0,672	0,236
R1000-10 000	-0,19	0,83	0,409	-0,632	0,258
R10000-10 000	-0,23	0,72	0,472	-0,850	0,394
R11000-20000	-0,31	-1,25	0,211	-0,801	0,178
_cons	0,59	3,88	0	0,290	0,887

DISCUSSION

This study aimed to identify predictors of non-adherence to tuberculosis (TB) treatment, based on patient recall over the preceding seven days and one month. The average prevalence of non-adherence found was 17%. While Castelnuovo (2010) used a different methodology—focusing on defaulters—to estimate TB treatment non-adherence in sub-Saharan Africa, the findings of this study fall within the same range (11.3%–29.6%).

Studies conducted in Ethiopia reported varying rates of non-adherence. For instance, Adane et al. (2013) found a non-adherence rate of 10%–13%, Mekonnen and Azagew (2018) reported 21.2%, while Krasniqi et al. (2017) in Kosovo and Woimo et al. (2017) in South Ethiopia reported adherence rates of 14.5% and 24.5%, respectively. Woimo et al. suggested that these differences may arise from a lack of standardized definitions of non-adherence. Adane et al. also emphasized that variations in socio-demographic characteristics and study settings could contribute to discrepancies.

Lack of income emerged as a significant factor associated with non-adherence in this study. This aligns with findings by Mabitsela (2012) in Limpopo, where patients reported being unable to afford transportation to clinics. Similarly, in the present study, transport costs were noted as a barrier to treatment adherence, often linked to income insecurity.

Interestingly, having an adequate food supply for more than six months was associated with lower adherence to TB treatment. This counterintuitive finding is supported by Maswanganyi et al. (2014), who reported that patients often avoid taking TB medication on an empty stomach due to gastrointestinal side effects. Thus, patients with limited food supplies may intentionally delay or skip medication doses.

Substance use, particularly alcohol consumption and smoking, was also associated with non-adherence. These findings corroborate earlier research in developing countries, including South Africa (Tesfahuneygn et al., 2015; Mekonnen et al., 2018). However, contrasting results were found in studies from Sudan and Thailand, where no such associations were observed (Peltzer & Pengpid, 2015; Ali & Prins, 2016).

Disclosure of TB status to family or friends was found to improve adherence, although the relationship was statistically significant only at the 10% level, indicating modest evidence. Non-disclosure, driven by fear of isolation or lack of trust, was more common among female respondents. These findings are consistent with those of El-Muttalut and KhidireElnimeiri (2016), who highlighted that stigma and the fear of marital repercussions often discourage women from disclosing their TB status.

Furthermore, the stigma surrounding TB led some patients to avoid local clinics. Instead, they traveled to distant healthcare facilities and provided incorrect residential information to evade referral to clinics closer to home. This not only complicates patient follow-up but also underscores the deep-rooted stigma and mistrust within the healthcare system.

Study limitations

While our study on predictors for non-adherence to TB treatment in the Gauteng Province of South Africa contributes valuable insights to the field, it is important to acknowledge certain limitations that may impact the interpretation and generalization of our findings. The study relied on a specific sample of TB patients within the Gauteng Province, and the findings may not be entirely representative of the entire TB patient population in South Africa. Variability in socio-economic, cultural, and healthcare access factors across different regions of the country may limit the generalizability of our results. The cross-sectional nature of our study design restricts our ability to establish causation. The data were collected through self-reporting, which introduces the potential for recall bias and social desirability bias. Patients might underreport non-adherence due to social expectations or overstate adherence to align with healthcare norms. The inclusion of objective measures, such as medication adherence monitoring, could enhance the accuracy of the findings. The study did not comprehensively explore the complete medical history of participants, including

comorbidities and previous experiences with TB treatment. These factors could have influenced treatment adherence but were not fully accounted for in our analysis. Addressing these limitations in subsequent studies will contribute to a more robust and nuanced understanding of predictors for non-adherence to TB treatment in diverse settings.

CONCLUSION

The investigation we conducted on determinants of non-compliance with tuberculosis therapy among patients in the Gauteng Province of South Africa has provided valuable insights into the key factors that influence treatment adherence in this area. The results highlight complex and varied aspects of non-compliance, emphasising the necessity of a comprehensive strategy to tackle the difficulties experienced by tuberculosis patients. One key predictor identified in our study is socio-economic status, with individuals facing financial constraints more likely to experience difficulties in adhering to the prescribed TB treatment. Access to healthcare resources, including transportation to healthcare facilities and availability of medications, emerged as significant barriers, particularly for those residing in poor areas. This highlights the importance of addressing social determinants of health and implementing interventions to alleviate economic burdens on TB patients. Stigma associated with TB was identified as another influential predictor of non-adherence. Fear of social isolation and discrimination may lead individuals to conceal their TB status, hindering their commitment to treatment. Addressing the social stigma surrounding TB is crucial for creating an environment that encourages open communication and fosters support for affected individuals.

ACKNOWLEDGEMENT

Authors would like to thank all the participants who voluntarily participated in this study.

CONFLICT OF INTEREST

None declared.

REFERENCES

Adane AA, Alene KA, Koye DN, Zeleke BM. (2013). Non-Adherence to Anti-Tuberculosis Treatment and Determinant Factors among Patients with Tuberculosis in Northwest Ethiopia. Plos One, 8(11).

Ali AO, Prins MH. (2016). Patient knowledge and behavioral factors leading to non-adherence to tuberculosis treatment in Khartoum State, Sudan. Journal of Public Health and Epidemiology, 8(11:)316-625

Burns N, Grove SK. (2011). Understanding nursing research: building an evidence-based practice. 5th edition. Maryland Heights: Elsevier/Saunders.

Castelnuovo B. (2010). A review of compliance to anti tuberculosis treatment and risk factors for defaulting treatment in Sub Saharan African Health Science,10(4):320-4

City of Ekurhuleni Annual Report.2016/2017. Available at: www.ekuhuleni.gov.za/annual-budget-2016-2017

El–Muttalut M, KhidirElnimeiri M. (2016). Factors contributing to non-compliance with treatment among tuberculosis patients-Kassala State- Sudan-2016. International Journal of Public Health and Epidemiology, 6(3):332-338,

Finlay A, Lancaster J, Holtz TH, Weyer K, Miranda A, van der Walt M. (2012). Patient- and provider – level risk factors associated with default from TB treatment, South Africa, 2002: a case-control study. BMC Public Health, 12:56.

Krasniqi S, Jakupi KA, Daci A, Tigani B, Jupolli-Krasniqi N, Pira M, Zhjeqi V, Nezeris B. (2017). Tuberculosis Treatment Adherence of Patients in Kosovo. Tuberculosis Research and Treatment. Tuberculosis Research and Treatment, 2017: 4850324.

Kulkarni P, Akarte S, Mankeshwar R, Bhawalkar J, Banerjee A, Kulkarni A. (2013) Non-adherence of new pulmonary tuberculosis patients to anti-tuberculosis treatment. Annals of Medical & Health Sciences Research, 3(1):67-74

Lehohla PJ. (2017). Mortality and causes of death in South Africa, 2015 Findings from death notifications. StatsSA.

Mabitsela MS. (2012). Compliance with drug treatment among patients with Tuberculosis in the Shiluvane Local Area, Mopani District, Limpopo Province, South Africa. School of Public Health, Faculty of Health Sciences, University of Limpopo, South Africa.

Maswanganyi NV, Lebese RT, Mashau NS, Khoza LB. (2014). Patient-perceived factors contributing to low tuberculosis cure rate at Greater Giyani healthcare facilities. Health SA Gesondheid, 19(1).

Mekonnen HS, Azagew AW. (2018). Non-adherence to anti-tuberculosis treatment, reasons and associated factors among TB patients attending at Gondar town health centres, Northwest Ethiopia. BMC Res Notes, 11-691.

National Department of Health of South Africa. (2009). National TB Management Guidelines.

National Institute of Communicable Diseases. (2017). Microbiological confirmed TB 2004-15. South Africa. http://www.nicd.ac.za/index.php/centres/centre-for-tuberculosis/public-health-surveillance/surveillance-of-microbiologically-confirmed-tb/

Ndwandwe ZSI, Mahomed S, Lutge S, Knight SE. (2014). Factors affecting non-adherence to tuberculosis treatment in uMgungundlovu Health District in 2010. South African Journal of Infectious Diseases, 29(2):56-59

Peltzer K, Pengpid S. (2015). Predictors of Non-adherence to Anti-Tuberculosis Medication in Tuberculosis Patients in Thailand. Journal of Human Ecology, 52(1, 2): 26-3115.

Pooran A, Pieterson E, Davids M, Theron G, Dheda K. (2013). What is the cost of Diagnosis and Management of Drug-resistant TB in South Africa? PLoS ONE, 8(1): e54587.

Saczynski JS, McManus DD, Goldberg RJ. (2013). Commonly utilized data collection approaches in Clinical Research. The Americaj Journal of Medicine, 126(11).

Tesfahuneygn G, Medhin G, Legesse M. (2015). Adherence to Anti-tuberculosis treatment and treatment outcomes among tuberculosis patients in Alamata District, Northeast Ethiopia. Biomed Central, 8:503

WHO. (2015). Use of high burden countries lists for TB by WHO in the post -2015 era. www.who.int/publications/.../high_tb_burdencountrylists2016-2020summary.pdf

WHO/TB. (2018). Comorbidities and Risk factors. www.who>area-of-work>treatment

Woimo TT, Yimer WK, Bati T, Gesesew HA. (2017) The prevalence and factors associated for anti-tuberculosis treatment non-adherence among pulmonary tuberculosis patients in public health care facilities in South Ethiopia: a cross-sectional study. Public Health, 17:269

World Health Organization (WHO) (2021). Global tuberculosis report. Geneva; 2021.