

Correlates of adherence to tuberculosis treatment among patients in Igembe North, Meru County, Kenya

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ABSTRACT

Tuberculosis (TB) remains a major public health concern globally, with suboptimal treatment adherence contributing to continued transmission, morbidity, and mortality. This study assessed factors associated with adherence to TB treatment among adult patients in Igembe North Sub-County, Meru County, Kenya. The Health Belief Model (HBM) is the foundational theoretical framework used to elucidate the determinants of health-related behaviors and treatment adherence. An analytical cross-sectional study design was employed involving 197 patients aged 18 years and above who were receiving TB treatment across 10 purposively selected health facilities. Participants were selected using proportional allocation and systematic random sampling. Data was collected using an interviewer-administered structured questionnaire, and adherence was measured using the Morisky Medication Adherence Scale (MMAS-8). Data was analyzed using Statistical Package for Social Sciences (SPSS) version 26. Descriptive statistics summarized adherence levels, while chi-square tests assessed associations between independent variables and adherence. Overall, 46% of respondents demonstrated moderate adherence, 37% poor adherence, and 17% good adherence. Marital status was significantly associated with adherence ($\chi^2 = 20.421$, $p = 0.002$), with married individuals more likely to adhere compared to separated individuals. Knowledge of TB transmission was also significantly associated with adherence ($\chi^2 = 40.395$, $p < 0.001$). Health service delivery factors, particularly healthcare provider attitude, showed a strong association with adherence ($\chi^2 = 27.777$, $p < 0.001$). Substance use, including smoking ($\chi^2 = 18.433$, $p < 0.001$) and alcohol consumption ($\chi^2 = 19.811$, $p < 0.001$), was significantly associated with poor adherence. Medicine-related factors, especially perceived impact of side effects, demonstrated a strong association with adherence ($\chi^2 = 66.496$, $p < 0.001$). Adherence to TB treatment in this setting remains suboptimal and is influenced by socio-demographic, patient-related, health system, and treatment-related factors. Interventions should prioritize patient education, strengthening provider–patient interactions, and integrated psychosocial and nutritional support to improve adherence outcomes.

Keywords: Adherence, Health Service Delivery, Medicine Related, Sociodemographic, Tuberculosis

I. INTRODUCTION

Worldwide, tuberculosis continues to be a disease that concerns public health. According to the World Health Organization (WHO), 10.3 million Cases of tuberculosis were predicted to occur worldwide in 2020. Of these, 3.3 million were women and 5.6 million were men. Among the top 10, tuberculosis continues to be one of the main causes of death worldwide. In Africa, the global TB statistics of 2020 showed that the continent contributed 25% of all people who developed TB in the world. South Africa and Nigeria were the two African countries that were among the eight nations that contributed two-thirds of all the global TB cases.

Kenya is among the 30 high-burden nations for TB globally and is among the 14 nations that suffer the triple burden of TB, TB/HIV, and multi-drug resistant (MDR) Tuberculosis (WHO, 2024). In 2020 alone the country reported 72,943 drug-susceptible TB cases which was a 15% reduction compared to the previous year. Treatment coverage was estimated at only 52% for drug-sensitive TB and 60% for drug-resistant TB cases. TB-HIV co-infection among notified cases contributed 25% (NTLDP, 2022). Kenya has enhanced TB diagnosis through the scale-up of new diagnostic tools like GeneXpert equipment across the country. Meru County is categorized by the Kenya National TB program as among the 10 high burden counties for TB that account for two-thirds of all TB cases countrywide. Data from the County Tuberculosis basic information unit reporting system show that Meru County reported 3,815 TB cases in 2021 which was a 6% increase compared to 2020. In 2021, the Kenya National TB program annual report ranked Meru County second out of the 47 counties in TB prevalence. Igembe North Sub-County is ranked 3rd in terms of the prevalence of TB in Meru County. The sub-county notified 576 Tuberculosis cases in 2021 (NTLDP, 2022).

According to the World Health Organization, 85% of people with new and relapsing TB were treated successfully in 2020. Equally, 76% of the people with HIV-associated TB and 57% of people with drug-resistant TB were successfully treated (Chakaya et al., 2021). Meru County had a loss to follow-up rate of 5% during the same period. Among the sub-counties in Meru County, Igembe North sub-county reported the highest loss to follow-up rate at 7%. Since tuberculosis is an infectious disease, patients who disregard their treatment put their families and the general public in danger. Furthermore, there is evidence linking inadequate adherence to elevated disease morbidity and mortality rates (Chakaya et al., 2021).

One of the key variables linked to positive outcome of treatment such as treatment success rate, is optimal adherence to the prescribed therapy. Adherence to TB treatment is associated with numerous and complex interplay of factors including patient sociodemographic characteristics, health service delivery related barriers, and medicine related challenges. Sociodemographic factors such as the gender, age, education level, occupation, knowledge and perception of TB may affect the ability of patients to commit to long-term treatment (Mekonnen & Azagew, 2018). Health service delivery factors such as healthcare provider attitude, availability of medicine, patient-provider relationships and adequacy of follow-up can shape how patients adhere to TB treatment. Additionally, the medicine-related factors such as medication side effects and length of treatment regimen contribute to adherence levels among patients on TB treatment (Toraitich et al., 2022).

Numerous research conducted in several settings have identified numerous characteristics linked to treatment adherence for tuberculosis. They include factors like patient demographics, unique patient variables, elements pertaining to the delivery of healthcare services, and factors pertaining to medicine (Gashu et al., 2021; Kimani et al., 2021; Mbuti et al., 2020). Understanding the factors associated with adherence to TB treatment is crucial for designing effective health interventions to enhance adherence rates and improve TB treatment outcomes.

1.1 Research Objectives

- i. To ascertain the level of adherence to tuberculosis treatment among patients in Igembe North in Meru County, Kenya
- ii. To measure association between socio-demographic factors and adherence to tuberculosis treatment among patients in Igembe North in Meru County, Kenya
- iii. To establish the association between patient-related factors and adherence to tuberculosis treatment among patients in Igembe North in Meru County, Kenya
- iv. To determine association between health service delivery factors and adherence to tuberculosis treatment among patients in Igembe North in Meru County, Kenya.
- v. To establish association between medications related factors and adherence to tuberculosis treatment among patients in Igembe North in Meru County, Kenya.

II. LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 Health Belief Model

The Health Belief Model (HBM) is a foundational theoretical framework used to elucidate the determinants of health-related behaviors and treatment adherence (Sanga et al., 2019). By examining how individual knowledge, attitudes, and perceptions shape health actions, the HBM provides a robust lens for evaluating the efficacy of health interventions and describing behavioral patterns. Central to the HBM are six primary constructs that collectively determine threat perception and behavioral intent: perceived susceptibility to the illness, perceived severity of the condition's consequences, perceived benefits of acting, perceived barriers to action, cues to action, and self-efficacy (Anuar et al., 2020). In the context of Tuberculosis (TB) treatment, these perceptions directly influence an individual's likelihood of adhering to long-term regimens. However, the relationship between these cognitive constructs and health behavior is often moderated by individual differences, including demographic characteristics, socioeconomic status, social pressures, and personality traits.

The application of the HBM in this study facilitates a more granular exploration of how patients' internal perceptions drive TB treatment outcomes. Consistent with previous literature, positive health perceptions are strongly associated with improved medication adherence; specifically, when a treatment regimen is closely aligned with a patient's existing belief system, compliance rates significantly increase (Azeez et al., 2018). Given that treatment adherence is a multidimensional phenomenon, the HBM allows for a detailed analysis of specific variables, ultimately informing the development of more effective, targeted interventions.

2.2 Empirical Review

Empirical evidence indicates that adherence to tuberculosis (TB) treatment is multifactorial, encompassing socio-demographic, patient-related, health system, and medication-related determinants. These factors collectively

influence patients' ability to follow prescribed regimens, with implications for treatment outcomes and public health goals.

2.2.1 Adherence to Tuberculosis Treatment

Adherence refers to the extent to which a patient follows prescribed treatment guidelines. Optimal adherence ($\geq 95\%$) is essential for achieving TB treatment goals, including cure, prevention of drug resistance, and reduction in morbidity and mortality (Masini et al., 2018). Suboptimal adherence is associated with relapse, post-TB complications, and increased mortality. Global strategies such as the End TB Strategy aim to significantly reduce TB incidence and mortality by 2030, underscoring the importance of sustained adherence (WHO, 2023).

Interventions to improve adherence include patient education, counselling, directly observed therapy (DOT), and digital adherence technologies such as video-observed therapy and reminder systems. Despite these efforts, adherence remains suboptimal due to barriers related to patients or the health system (Ali & Prins, 2016). Measurement approaches include pill counts, patient self-reports, and validated tools such as the Morisky Medication Adherence Scale (MMAS-8), although self-reported methods may introduce bias (Waari et al., 2018).

2.2.2 Socio-demographic Factors

Socio-demographic characteristics such as age, gender, occupation, and education have been widely examined, with mixed findings. Some studies report no direct association between age or gender and adherence, while highlighting the influence of socioeconomic status, marital status, and education (Mumbe et al., 2020). Lower educational attainment and vulnerable social status (e.g., widowed or divorced) are consistently linked to non-adherence.

Evidence from sub-Saharan Africa shows variability. In Kenya, adherence has been associated with gender, education, age, and occupation, with females and individuals with higher education demonstrating better adherence (Yusuf et al., 2021). Similarly, age and occupation were significant predictors in other Kenyan settings, with middle-aged patients and farmers showing higher adherence. These findings suggest that contextual socioeconomic factors shape adherence behaviors.

2.2.3 Patient-related Factors

Patient-related determinants include knowledge, perceptions, substance use, social support, and access to care. Poor knowledge and misconceptions about TB are strongly associated with non-adherence. Qualitative evidence highlights the role of stigma, alcohol use, lack of family support, and long travel distances in disrupting treatment (Marahatta et al., 2020). Substance use, particularly alcohol consumption, has been consistently identified as a key risk factor for treatment interruption. Additionally, family and community support systems play a protective role by enhancing motivation and supervision of treatment (Nabunya et al., 2020). Accessibility challenges, including distance to health facilities, further influence adherence. These findings emphasize the importance of patient-centered interventions (Nezenega et al., 2020).

2.2.4 Health Service Delivery Factors

Health system characteristics significantly influence adherence. Positive patient-provider relationships, characterized by effective communication and supportive attitudes, are strong predictors of adherence. Conversely, negative provider attitudes discourage continued engagement in care (Nezenega et al., 2020). Structural barriers such as long waiting times, delayed diagnosis, drug stock-outs, and inadequate health worker capacity have been reported as key determinants of non-adherence (Workie et al., 2021). Evidence from Kenya and other settings indicates that patient satisfaction with healthcare services is associated with improved adherence. These findings highlight the need for strengthened health systems and patient-centered service delivery.

2.2.5 Medication-related Factors

Medication-related factors, including side effects, pill burden, and treatment duration, are critical determinants of adherence. Adverse drug reactions such as nausea and vomiting discourage continued treatment. High pill burden, particularly among TB/HIV co-infected patients, further complicates adherence (Aibana et al., 2020). Treatment phase also influences adherence, with higher interruption rates observed during the continuation phase when symptoms subside. Studies in Kenya and other settings consistently report that prolonged treatment duration and perceived recovery contribute to reduced adherence. Overall, adherence to TB treatment is shaped by a complex interplay of individual, social, health system, and medication-related factors (Pradipta et al., 2020). Addressing these determinants requires integrated, context-specific strategies that strengthen health systems, enhance patient support, and minimize treatment-related barriers (Gebreweld et al., 2018).

III. METHODOLOGY

3.1 Research Design

This study employed an analytical cross-sectional design using a quantitative approach to examine factors associated with adherence to Tuberculosis (TB) treatment. The design enabled the collection of data at a single point in time and facilitated the assessment of relationships between independent and dependent variables. Cross-sectional designs are widely applied in epidemiological studies due to their efficiency, cost-effectiveness, and suitability for measuring prevalence and associations.

3.2 Study Area

The study was conducted in Igembe North Sub-County, located in Meru County, Kenya. Meru County has an estimated population of 1.6 million and is among the high-TB burden counties nationally. Igembe North contributes approximately 14% of TB cases within the county. Igembe North has 46 health facilities (24 public and 22 private), of which 17 provide TB treatment services. Ten high-volume TB treatment facilities were purposively selected based on patient notification trends over the preceding three years.

3.3 Study Population and Sampling

The target population comprised of adult TB patients (≥ 18 years) receiving treatment at the selected facilities. Eligibility required the ability to provide informed consent. Patients with cognitive impairments or those unwilling to participate were excluded. Sample size was calculated using Fisher's formula for populations less than 10,000, assuming a TB prevalence of 46%, 95% confidence level ($Z = 1.96$), and a margin of error of 5%. This yielded an initial sample size of 382. Application of finite population correction ($N = 575$) resulted in a sample of 230 participants. After adjusting for a 10% non-response rate, the final sample size was 253 participants. A multistage sampling approach was applied. Ten facilities were selected due to their high TB caseload, accounting for approximately 90% of patients in the subcounty. Proportionate allocation ensured representation across facilities. Within facilities, systematic random sampling was used with a sampling interval of three ($k = 3$), following a random start. This approach enhanced representativeness and minimized selection bias.

3.4 Data Collection Instruments

Data was collected using an interviewer-administered, pre-tested structured questionnaire comprising both closed and semi-structured items. A pilot study involving 10% of the sample ($n = 23$) was conducted in a neighboring sub-county with similar characteristics. Feedback informed refinement of the tool for clarity, cultural appropriateness, and contextual relevance. Adherence was measured using the 8-item Morisky Medication Adherence Scale (MMAS-8), a validated tool widely applied in adherence research (3). Scores were categorized as high (0), moderate (1–2), or low adherence (≥ 3). Trained research assistants administered the tool to ensure consistency and comprehension.

3.5 Data Analysis

Data was checked for completeness, coded, and analyzed using the Statistical Package for Social Sciences (SPSS) version 26. Descriptive statistics (frequencies and percentages) were used to summarize study variables. Inferential analysis employed the chi-square test to assess associations between adherence and independent variables. Statistical significance was set at $p < 0.05$. Findings were presented using tables and figures.

3.6 Ethical Considerations

Ethical approval was obtained from Mount Kenya University Ethics Review Committee (Ref: MKU/ISERC/3624). A research permit was granted by the National Commission for Science, Technology and Innovation (NACOSTI) (Ref: 129935). Additional permissions were obtained from Meru County health authorities and participating facilities. Written informed consent was obtained from all participants. Participation was voluntary, confidentiality was maintained, and respondents were free to withdraw at any stage without consequence.

IV. FINDINGS & DISCUSSION

4.1 Overview of Study Sample

A total of 253 patients were targeted, of whom 197 participated, yielding a response rate of 78%. This exceeded the minimum acceptable threshold for analytical studies and was considered adequate for statistical analysis.

4.2 Socio-demographic Characteristics of Respondents

The section presents the socio-demographic characteristics of the respondents. This includes gender, age category, level of education, occupation, and marital status. Study results are summarized in Table 1.

Table 1*Socio-Demographic Characteristics of Respondents (N = 197)*

Characteristic	Category	Frequency (n)	Percentage (%)
Sex	Male	143	73
	Female	54	27
Age Group (years)	18–25	64	33
	26–35	69	35
	36–45	29	15
	46–55	16	8
	Above 56 yrs	19	10
	No formal education	43	22
Education Level	Primary	79	40
	Secondary	44	22
	Certificate	14	7
	Diploma	12	6
	Bachelors' Degree	4	2
	Postgraduate	1	1
Marital Status	Married	90	46
	Single	81	41
	Widowed	4	2
	Separated	22	11
Employment Status	Employed	16	8
	Self employed	81	41
	Student	17	9
	Unemployed	83	42

The largest proportion of respondents were aged 26–35 years (69; 35%), followed by those aged 18–25 years (64; 33%). Respondents aged 36–45 years accounted for 29 (15%), with smaller proportions in older age categories. Most respondents had primary-level education as their highest attainment. Approximately 22% had completed secondary education, while a comparable proportion reported no formal education. Overall, 46% of respondents were married, 41% were single, and 11% were separated. The majority of respondents were unemployed (42%), followed by those self-employed (41%). Students constituted 9%, while 8% were formally employed.

4.3 Adherence to Tuberculosis Treatment

The Morisky Medication Adherence Scale (MMAS-8) was used to assess respondents' adherence levels. Of the 197 participants, 34 (17%) demonstrated good adherence, 91 (46%) had moderate adherence, and 72 (37%) exhibited low adherence. Overall, the majority of respondents fell within the moderate adherence category, with a substantial proportion showing low adherence and only a small fraction achieving good adherence.

4.4 Association Between Socio-demographic Characteristics and Adherence

Associations were assessed using Pearson's chi-square test ($\alpha = 0.05$). Results are presented in Table 2.

Table 2*Association between Socio Demographic Characteristics and Adherence to Tuberculosis Treatment*

Variable	Chi-square (χ^2)	p-value
Gender	0.824	0.662
Age category	6.569	0.584
Education level	19.827	0.070
Marital status	20.421	0.002
Occupation	14.024	0.029

No statistically significant association was observed between adherence and gender ($\chi^2 = 0.824$, $p = 0.662$), age category ($\chi^2 = 6.569$, $p = 0.584$), or education level ($\chi^2 = 19.827$, $p = 0.070$).

Statistically significant associations were observed for marital status ($\chi^2 = 20.421$, $p = 0.002$) and occupation ($\chi^2 = 14.024$, $p = 0.029$).

4.5 Patient-related Factors and Adherence

4.5.1: TB Knowledge and Adherence

Associations between knowledge variables and adherence are presented in Table 3.

Table 3*Association Between TB Knowledge and Adherence*

Knowledge Variable	χ^2	p-value
Cause of TB	9.842	0.455
Susceptibility (anyone can get TB)	7.910	0.245
Mode of transmission	40.395	0.0002
Treatment modality	3.571	0.467
Duration of treatment	10.026	0.124

Knowledge of TB transmission was significantly associated with adherence ($\chi^2 = 40.395$, $p = 0.0002$). No statistically significant associations were observed for other knowledge variables.

4.5.2 Perceptions and Adherence

Associations between TB perception and adherence are presented in Table 4.

Table 4*Association Between perception about TB and Adherence*

Variable	χ^2	p-value
TB is embarrassing	7.938	0.019
Doubt about TB diagnosis	42.006	<0.001
TB not curable	1.136	0.567
Discontinuation when feeling better	23.328	<0.001
Clinic attendance not necessary	15.662	0.0004
Need for isolation	0.023	0.0006

Significant associations were observed for perceived stigma, doubt about diagnosis, treatment discontinuation beliefs, clinic attendance perceptions, and isolation beliefs. No significant association was observed for perception of TB curability.

4.5.3 Treatment Support

Table 5*Association Between Treatment Support and Adherence*

Variable	χ^2	p-value
Household size	28.557	0.0001
Disclosure to family	1.878	0.391
Treatment supporter type	36.301	0.0026
Family support	12.048	0.0017
Food availability	20.973	0.0003

Significant associations were observed for household size, type of treatment supporter, family support, and food availability. Disclosure of TB status was not significantly associated with adherence.

4.5.4 Accessibility to TB Services

Table 6*Association Between Accessibility and Adherence*

Variable	χ^2	p-value
Distance to facility	11.023	0.088
Perceived effect of distance	1.550	0.461

No statistically significant associations were observed between adherence and either distance to the facility or perceived impact of distance.

4.5.5 Alcohol and Substance Use

Table 7

Association Between Substance Use and Adherence

Variable	χ^2	p-value
Smoking	18.433	0.0001
Alcohol use	19.811	<0.001
Drug/substance use	8.219	0.016

All substance use variables were significantly associated with adherence.

4.6 Health Service Delivery Factors

4.6.1 Provider-Patient Interaction

Table 8

Association Between Provider Interaction and Adherence

Variable	χ^2	p-value
Provider attitude	27.777	<0.001
Explanation of treatment	4.696	0.096

Provider attitude showed a statistically significant association with adherence, while explanation of treatment did not.

4.6.2 Availability of Anti-TB Medicines

Table 9

Availability of TB Medicines and Adherence

Variable	χ^2	p-value
Availability of TB medicines	6.646	0.036

Availability of TB medicines was significantly associated with adherence.

4.6.3 Health Provider Capacity

Table 10

Health Provider Capacity and Adherence

Variable	χ^2	p-value
Provider availability	6.646	0.036
Satisfaction with explanation	9.040	0.060
Waiting time	2.448	0.294

Health provider availability was significantly associated with adherence, while satisfaction with explanations and waiting time were not.

4.7 Medicine-related Factors

Table 11

Medicine-related Factors and Adherence

Variable	χ^2	p-value
Experience of side effects	10.247	0.036
Extent of side effects	66.496	<0.001
Concomitant medication use	1.528	0.466
Treatment duration	5.032	0.540

Experience of side effects and their extent were significantly associated with adherence. No statistically significant associations were observed for concomitant medication use or treatment duration.

4.8 Discussion

4.8.1 Adherence to Tuberculosis Treatment

The study found that the majority of the respondents, 91 out of 197 (46%) demonstrated moderate Adherence representing nearly half of the total respondents. On the other hand, 37% of the respondents demonstrated poor adherence, and only 17% had good adherence. This suggested that while many patients are following their prescribed regimen to some degree, there is room for improvement in achieving full adherence. Moderate adherence may be attributed to factors like occasional lapses in following recommendations as explained by the health care provider. A significant proportion, (about 37%), were categorized as having poor adherence. This high percentage indicates a considerable challenge in adhering to TB treatment which might undermine the effectiveness of the objectives of the TB control program. Only 34 (17%) of the respondents achieved good adherence. This small proportion suggests that few patients are able to fully adhere to TB treatment. While these individuals represent successful adherence, their relatively low number emphasizes the need for strategies that can help shift more subjects towards this category. The study findings indicated that patients on Tuberculosis treatment in Igembe North Sub County have sub-optimal adherence levels with over 80% of them not achieving good adherence.

The findings concur with the World Health Organization annual report findings which highlighted that achieving good adherence remains a challenge globally, with only about 20% of patients consistently adhering to prescribed TB treatment regimens (WHO, 2024). The 17% good adherence rate in this study is in line with such findings, reflecting the difficulty of sustaining high adherence over long treatment durations. The findings of this study also align with studies conducted in Northeast China (Chen et al., 2020) who reported that only 41.84% of respondents had high adherence to their ant-TB medicine regimen. Study findings also concur with the reality that moderate adherence is a common occurrence among patients on TB treatment (Marahatta et al., 2020).

However, the findings do not compare well with a study conducted in Khartoum state where 86% good adherence was noted (Ali & Prins, 2016). The moderate adherence levels which are predominantly observed in this study do not concur with studies done in South Africa which showed good adherence when programs implement a directly observed treatment programs (Oga-Omenka et al., 2020). This shows that in standard care settings, there still exist challenges related to adherence to TB treatment. While many findings align with those from other resource-constrained settings, disparities with studies in well-supported healthcare environments underline the potential for improvement in adherence among patients on TB treatment.

4.8.2 Socio-demographic factors and Adherence to TB treatment

The study sought to determine the association between socio-demographic factors and the Adherence to Tuberculosis treatment. Gender, age, occupation, education level, and marital status were socio-demographic variables examined. Study findings showed that majority of the study respondents were male (73%). However, while more males than females were represented across all the adherence categories (good, moderate, poor), there was no statistically significant association between gender and Adherence to TB treatment (Chi-square: 0.824, df: 2, P-value: 0.662). Adherence does not significantly differ across age groups. Patients aged 18-25 years show a relatively even distribution across adherence levels (18% good, 41% moderate, and 41% poor). The highest good adherence is found in patients aged 46-55 years (24%), while the worst adherence is seen among the 36-45 age group, where 48% have poor adherence.

The findings compare well with studies conducted in Equatorial Guinea (Fagundez et al., 2016), which showed that non-adherence was associated with lower age groups and marital status played a key role in enabling adherence to TB treatment. A study in India found that married individuals showed better adherence due to spousal support, mirroring the trend observed in this study (Bagchi et al., 2010). A study in Nigeria also reported that separated or divorced individuals exhibited poor adherence due to lack of emotional and social support (Mahmoud M et al., 2022). However, the study findings were contrary to findings from a study in Nepal which reported that employed individuals showed poor adherence due to lack of time to attend to clinic appointments (Marahatta et al., 2020). The study findings, however, provide valuable insights into the sociodemographic factors associated with adherence to TB treatment.

4.8.3 Patient related factors and Adherence to Tuberculosis Treatment

Pertaining to the knowledge and perception of TB, a significant association was found between patients' understanding of how TB is spread and their adherence to treatment ($\chi^2 = 40.3949$, $p = 0.00002$). Respondents who correctly identified coughing and sneezing as the primary modes of TB transmission were more likely to adhere to their medication regimen. Misconceptions, such as believing TB is transmitted through sharing utensils or touching, were associated with lower adherence levels. These findings augur well with other studies such as one conducted in Northwest Ethiopia which demonstrated key elements of poor knowledge and perception about TB disease being significantly connected to the degree of treatment adherence for anti-TB drugs (Gashu et al., 2021).

Household composition was also a strong correlate of adherence. Participants living in households with 2 to 5 members exhibited significantly better adherence than those living alone or with more than five household members ($\chi^2 = 28.5574$, $p = 0.0001$). This suggests that moderate-sized households may offer optimal levels of support without being

overwhelmed by competing needs. Similarly, individuals who received assistance with taking their medication, particularly from spouses or other relatives, were more adherent compared to those without any support ($\chi^2 = 36.3008$, $p = 0.0026$). This aligns with existing literature highlighting the importance of treatment supporters and family involvement in improving adherence outcomes (Ali & Prins, 2016).

Family supportiveness was another significant factor. Respondents who described their families as "always supportive" had higher levels of adherence compared to those reporting only occasional or no support ($\chi^2 = 12.0483$, $p = 0.0017$). This underlines the role of social and emotional support structures in supporting treatment adherence. Food availability within the household emerged as a significant determinant ($\chi^2 = 20.9732$, $p = 0.0003$). Patients reporting consistent access to food had better adherence compared to those in food-insecure households. TB treatment is often associated with gastrointestinal side effects, and adequate nutrition is not only critical for treatment tolerance but may also influence perceptions of drug efficacy. These findings point to the value of integrating nutritional support with TB programs.

4.8.4 Health Services Delivery Factors and Adherence to TB treatment

Study findings showed that the attitude of healthcare providers played a critical role in adherence to TB treatment. Participants who rated their providers as "very friendly" reported higher adherence ($\chi^2 = 27.7774$, $p = 0.000$), emphasizing the importance of patient-provider relationships in fostering treatment compliance. In addition, consistent availability of health workers during clinic visits was significantly associated with adherence ($\chi^2 = 6.646$, $p = 0.036$), suggesting that dependable staffing is a crucial element in supporting patients through their treatment journey. The availability of TB medication during clinic visits also showed a significant association with adherence ($\chi^2 = 6.646$, $p = 0.036$). Stockouts or inconsistent access to medicines may discourage continued treatment, even among motivated patients. However, satisfaction with the explanation provided on adherence at treatment initiation, though related, did not reach statistical significance ($\chi^2 = 4.6956$, $p = 0.0956$).

The findings concur with a study done in Nigeria which found that excellent interaction between the patient and the healthcare worker at the TB clinic was an independent predictor to TB treatment adherence in Nigeria (Mahmoud M et al., 2022). However, findings do not align with a study conducted in Mozambique which found that long waiting times at the health facility contributed to poor TB treatment adherence rates (De Schacht et al., 2019). Pertaining TB medicine availability, findings from the study concur with a study conducted in Kenya which revealed among other key variables that, availability of medicines and related commodities at the health facility had an effect on TB treatment adherence (Kimani et al., 2021).

4.8.5 Medicine-related factors and Adherence to TB treatment

Study findings revealed a majority (71%) of the respondents had experienced medicine side effects during the course of TB treatment. Notably, experiencing side effects was significantly associated with poor adherence outcomes ($\chi^2 = 10.247$, $p = 0.00063$). Patients who experienced adverse drug reactions were more likely to miss doses or discontinue treatment. Further, the perceived extent to which side effects impacted adherence showed a highly significant relationship ($\chi^2 = 66.4961$, $p < 0.001$). Those who perceived no or minimal impact from side effects demonstrated better adherence, while those who reported being affected to a great extent had universally poor adherence. These findings underscore the need for proactive management of side effects, including patient education and access to supportive care.

In contrast, no significant associations were found between adherence and the use of concurrent medications ($\chi^2 = 1.5279$, $p = 0.4658$) or treatment regimen duration ($\chi^2 = 5.0317$, $p = 0.5397$). This suggests that while some patients may be on longer regimens or using other medications, these factors alone may not be primary drivers of adherence behavior in this context. The findings concur with findings by scholars in Ethiopia who found out that drug side effects were associated with non-adherence among patients with TB (Nezenega et al., 2020). In Ukraine, a study on treatment experience and motivators to adherence found similar results with medicine side effects being significant factor that led to negative treatment experience and was associated with non-adherence to treatment (Aibana et al., 2020).

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

Adherence to TB treatment in Igembe North Sub-County was suboptimal, with the majority of patients exhibiting moderate or poor adherence. Adherence was significantly associated with socioeconomic factors (marital and occupational status), patient-related factors (TB knowledge, social support, food security, and substance use), health system factors (provider attitudes and service availability), and medicine-related factors (adverse drug reactions). These results confirm that adherence is a multifactorial phenomenon requiring integrated, cross-cutting interventions. Focusing exclusively on biomedical management is insufficient; broader structural and behavioral determinants must be addressed to improve treatment outcomes and prevent drug resistance.

5.2 Recommendations

The findings of this study indicate that patient knowledge of tuberculosis (TB), healthcare provider attitudes, and the availability of anti-TB medications are significantly associated with adherence to TB treatment. In light of these findings, health practitioners should prioritize structured patient education interventions to improve understanding of TB and its treatment requirements. Additionally, efforts should be made to promote patient-centered care by fostering positive provider attitudes, which may enhance patient engagement and adherence. Ensuring the uninterrupted availability of TB medications remains critical to sustaining adherence. Health practitioners should also implement routine adherence risk assessments to identify patients at increased risk of non-adherence. Targeted interventions, including individualized counseling, adherence support, and timely management of treatment-related adverse effects, should be integrated into routine TB care to mitigate barriers to optimal treatment completion.

At both national and county levels, policymakers should strengthen policies and interventions aimed at reducing TB-related stigma and negative societal perceptions, which remain important barriers to treatment adherence. This may include integrating stigma-reduction strategies into broader public health campaigns and community engagement initiatives. Furthermore, there is a need to develop and operationalize context-specific guidelines that address patient-level and health system barriers to adherence. Such policies should support differentiated care approaches tailored to the needs of patients undergoing TB treatment, with an emphasis on improving continuity of care, patient support systems, and health system responsiveness.

This study examined the association between adherence to TB treatment and four domains: socio-demographic, patient-related, health service delivery, and medication-related factors, within Igembe North Sub-County. Future research should consider employing qualitative or ethnographic approaches to explore the underlying social and cultural determinants of non-adherence, which may not be fully captured through quantitative methods. In addition, given that this study was conducted in a single sub-county, the generalizability of the findings may be limited. Further studies across diverse geographical and health system contexts in Kenya are recommended to validate these findings and assess their consistency across settings. Such research would contribute to a more comprehensive evidence base to inform national TB control strategies.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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