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Factors Influencing Receipt of an Antibiotic Prescription Among Insured Patients in Tanzania: A Cross-sectional Study

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Key words: Antibiotics prescription, Antibiotics resistance, Antimicrobial Stewardship Programs, Insured patients, Tanzania

Abbreviated running title: Correlates of antibiotics prescription

Key messages

- About half of insured patients attending health facilities in Tanzania, receive an antibiotic prescription.
- Significant predictors of receipt of an antibiotic prescription include being a child, having a diagnosis of upper respiratory tract infection, being attended by prescribers with lower qualifications, and attending a lower-level public health facility.
- Consideration of these factors in revisions or establishment of targeted antibiotic stewardship programs may lead to better antibiotic prescribing practices that are critical for combating antibiotic resistance.

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Strengths and Limitations of this study

- To our knowledge, this is the first study in Tanzania to address predictors of receipt of an antibiotic prescription among insured patients.
- Insured patients being an increasing patient population in recent times and its anticipated risk of polypharmacy, studying antibiotic utilization in this group is important.
- Being a cross-sectional design, our study, doesn't account for seasonal variations in antibiotic use, it lacks robustness in establishing causality, and is less generalizable.
- Using patient claim forms submitted to the insurance fund as our data source ensured no missing data as incomplete forms are not processed for payment and usually returned to the healthcare provider
- Using the Odds Ratio to report associations may have overestimated the magnitude of the association observed. We, therefore interpret our findings with caution.

ABSTRACT

Objectives: Over-prescription of antibiotics may accelerate the development of resistant pathogens. Any effective mitigation requires an understanding of the factors that influence antibiotic prescribing. Yet, there is a paucity of data regarding local factors that predicts antibiotics prescription. We assessed the correlates of receipt of an antibiotic prescription among insured patients

Methods: We conducted a cross-sectional study using a data extraction form to captured data from the claim forms submitted to Ilala NHIF offices for September 2019. Predictors of receipt of an antibiotic prescription were determined by logistic regression analysis.

Results: Of 993 analyzed patients the mean [±SD] age was 36.3 [±23.2] years, 581 [58.5%] were females, and 535 [53.9%] were adults. The prevalence of receipt an antibiotic prescription was 46.4% (95% CI, 42.8-50.0). Strong predictors of receipt of an antibiotic prescription included; a diagnosis of acute tonsillitis 46.1 (95% CI, 5.8-364.4); being attended by a Clinical Officer 6.2 (95% CI, 2.0-19.8); attending a Health Center 3.2 (95% CI,1.5-6.5); URTI of multiple and unspecified site 3.1 (95% CI, 1.5-6.7) and being a child 2.9 (95% CI, 1.6-5.2). Attending a private health facility was protective for receipt of an antibiotic prescription 0.5 (95% CI, 0.3-0.9).

Conclusions: Among insured patients, acute URTI, being attended by a less-qualified prescriber, attending a public lower-level facility and being a child predicts receipt of an antibiotic prescription. Incorporation of these findings in revisions or establishment of targeted antimicrobial stewardship programs may lead to better antibiotic prescribing practices that are critical for combating antibiotic resistance.

INTRODUCTION

Curtailing antibiotics consumption is important to global health. Antibiotics use and misuse may predispose to development of resistant bacteria. [1–4] Furthermore, it is estimated that half of the prescribed antimicrobials are inappropriate. [5] We should strive to preserve antibiotics at all costs by providing a balance between access and excess as both have detrimental consequences. Delayed access may promote mortality from bacterial infections whilst excessive use increases selection pressure thereby favoring the development of resistant strains. [6] Increased antibiotic exposure in healthcare settings is among the key modifiable drivers of antibiotic resistance. [7,8]

Emergence and spread of antibiotic resistant bacteria far outweigh the speed with which newer antibiotics receives market approval. [9] Humana, animals, as well as the surroundings face the catastrophic consequences of antibiotics resistance. [10,11] The consequences of which are associated with higher morbidity, longer duration of hospital stay, higher mortality rates and increased healthcare cost [12,13]. These consequences are more pronounced in Low- and Middle-Income Countries (LMICs) due to burden of infections, limited resources, poor health system, and weak regulatory enforcement to oversee antibiotics quality assurance, prescriptions and dispensing outlets. [5]

In Tanzania, resistance to commonly prescribed antibiotics was demonstrated in up to 60% of β-lactamase bacterial isolates. [14] In another study, 43.3% of staphylococcus aureus nasal isolates which are resistant to methicillin were also resistant to, second generation cephalosporin, cefoxitin. [15] Some studies in children found bacterial pathogens resistant to multiple antibiotics. [16,17] Therefore, the need of curbing antibiotic prescriptions so as to contribute in the fight against antibiotic resistance is warranted.

It has been argued that, the more we procrastinate on taking urgent action to protect the current antibiotics we have, the more difficult and expensive it will be to tackle antibiotic resistance in the future. [18] To combat the problem of increased use of antibiotics and its consequence, a One Health Approach coupled with political will, is necessary in terms of building capacity in areas of Antimicrobial Stewardship Programs (ASPs) and infection control. [19–21] Globally, ASPs in hospitals has shown promise in reducing

irrational antibiotic prescriptions. However, implementation challenges and heterogeneity in structures for antimicrobial stewardship in LMICs, emphasize the need for tailored stewardship programs. [22,23]

We conducted a study to identify factors that influence receipt of an antibiotic prescription among insured patients. ASPs in LMICs are often not comprehensively implemented and this may be partly because of lack of resources and awareness of local important factors that influence antibiotic prescription. [24,25] It is known that factors from health care providers, patients, and the health system may influence the antibiotic prescription rate. Moreover, there is limited data regarding local correlates of antibiotics prescription among insured patients in Tanzania. This poses a key barrier in developing and implementing targeted Antimicrobial Stewardship Programs.

MATERIALS AND METHODS

We did a cross sectional study of antibiotics prescription to patients insured by the National Health Insurance Fund (NHIF) involving claim forms submitted to the Fund by health facilities in Dar es Salaam City Council (formerly Ilala municipal council) in Dar es Salaam. Part of the methodology have previously been published. [26] Briefly, data collection from the claim forms was accomplished using a specially designed form. All forms submitted for claims, in the study period, were included in the study. Each claim form represented a single patient visit. We excluded forms for patients attended by physiotherapists or occupational therapists as they were not prescribers.

Claim forms for 378 patients was our initial sample size and was obtained by assuming 67.7% as prevalence of receiving an antibiotic prescription, [27] a margin of error of 5 % and a 10 % chance of incomplete forms. [28] However, in view of readily available patient claim forms, absence of additional risk to patients and affordability of data collection process, the planned sample size was increased to claim forms for 1100 patients. This was done in order to obtain precise estimates and to have enough data for sub-group analysis with adequate statistical power. Claim forms included in the study were selected randomly [29] from the eligible forms (2A & B) for the month of September 2019 submitted to NHIF headquarters.

The dependent variable was receipt of an antibiotic prescription. It was a No/Yes binary variable. A no/yes question was recorded whether the client received an antibiotic prescription during the health facility visit. The independent variables were sociodemographic, level of health facility, ownership of health facility (public vs private), final ICD-10 diagnosis code, department visited (inpatient vs outpatient), surgical procedure, polypharmacy (optimal number of drugs per encounter ≤ 3), generic name prescribing (optimal 100%), safe injection prescribing (encounter with an injection prescribed, optimal ≤ 10%), Essential Drug List prescribing (optimal 100%), and prescriber qualification such as Clinical Officer (CO)/Dental Therapist (DT), Assistant Medical/Dental Officer (AMO/ADO), Medical/Dental Officer (MO/DO), Specialist, Super-specialist or Consultant). The factors that may influence receipt of an antibiotic prescription were derived from the NHIF claim forms 2A & B.

There were no missing data in our study as our data source was the patient claim forms submitted to the insurance fund for payment claims by health facilities. Health facilities ensure the completeness of the claim forms so as to avoid any delay in the payment process. We used IBM SPSS Statistics Software Version 23 to analyze our data. Descriptive statistics summarized categorical variables whereas numerical data was summarized by using mean and median. Chi-square Test determined the associations between dependent variable (receipt of an antibiotic prescription) and independent variables (factors that influence receipt of an antibiotic prescription) and Fishers Exact Test was used where appropriate. A p-value cut off point of 0.2 was used to enter the covariates in the logistic regression model. To control for confounding, we performed univariable and multivariable logistic regression analysis to predict receipt of an antibiotic prescription.

Patient and Public Involvement

It was not possible to involve patients and the public in the design, conduct, and reporting of the study however dissemination plans of the findings to relevant authorities exists.

RESULTS

Patient characteristics

Sociodemographic characteristics of patients of this study has been published elsewhere. [26] In summary, out of 993 patients who met the analysis criteria, adults comprised the majority 535 (53.9%) and 581(58.5%) patients were of female sex. The average age (± Standard Deviation - SD) was 36.3 (± 23.2) years. Most patients visited the outpatient department 975 (98.2%) and private health care facilities 525 (52.9%). Majority of patients 548 (55.2%) attended facilities at the national level and most received a specialist consultation 437 (44.0%) (Table 1). The complete list of patient characteristics is found in the supplement (Supplement 1). The outcome of interest, receipt of an antibiotic prescription, was found in 46.4% of patients

Diagnoses were reported using ICD-10 diagnostic criteria. Among patients, other disorders of the urinary system (9.3%) was the most common diagnosis followed by essential hypertension (7.4%). The other disorders of urinary system, ICD10-N39 diagnostic code, encompass diagnoses such as: Urinary Tract Infection (UTI), site not specified; persistent proteinuria, unspecified; stress incontinence; other specified urinary incontinence; other specified disorders of urinary system and disorders of urinary system, unspecified. The prevalence of acute and URTI of multiple and unspecified site was 6.5% whereas that of acute tonsillitis was 2.4% (Table 2). A complete list of all diagnoses is found in supplement 1.

Patient characteristics by receipt of an antibiotic prescription

About two-thirds of children (65.4%) received an antibiotic prescription when compared with adults and the elderly (Figure 1). Over three-quarters of patients (77.0%) who attended lower-level health facilities such as dispensaries received an antibiotic prescription compared to those who attended higher-level health facilities such as the referral hospitals (Figure 2). A higher proportion (80.0%) of patients who were attended by prescribers with lower qualification such as assistant medical/dental officers received an antibiotic prescription when compared with other cadres (Figure 3).

Table 1. Socio-demographic and other patient characteristics

Characteristic (N = 993)	n (%)
Age in years	
Mean (SD) = 36.3 (23.2), Median = 37.0	
Children (< 18 years)	264 (26.6)
Adults (18-59 years)	535 (53.9)
Elderly (≥ 60 years)	194 (19.5)
Sex	
Male	412 (41.5)
Female	581 (58.5)
Level of health facility	
Dispensary	102 (10.3)
Health Centre/Stand-alone clinic by Assistant Dental Officer	119 (12.0)
District Hospital/Clinic Level 1 by Medical/Dental Officer	101 (10.2)
Regional Hospital/Clinic Level 2 by specialist)	123 (12.4)
National Referral Hospital/Zonal Hospital/Clinic Level 3 by super-specialist	548 (55.2)
Ownership of health facility	
Public	468 (47.1)
Private	525 (52.9)
Department visited	
Outpatient	975 (98.2)
Inpatient	18 (1.8)
Any Procedure/Surgery done	
No	940 (94.7)
Yes	53 (5.3)
Prescriber Qualification	
Clinical Officer/Dental Therapist	132 (13.3)
Assistant Medical/Dental Officer	18 (1.8)
Medical/Dental Officer	320 (32.2)
Specialist	437 (44.0)
Super-specialist/Consultant	86 (8.7)

More than two-third of patients (70.6%), who visited the inpatient department, received an antibiotic prescription compared to those who visited the outpatient department. A complete list of distribution of study characteristics by receipt of an antibiotic prescription is presented in Supplement 2. Most patients

with a acute tonsillitis (95.8%) and those of other disorders of urinary system (93.7%) were prescribed an antibiotic (Supplement 2).

Table 2: Top ten and other select-diagnosis

Characteristic (N = 993)	n (%)
Diagnosis code	
Other disorders of urinary system such as UTI, unspecified	102 (10.3)
Essential (primary) hypertension	81 (8.2)
Acute and URTI of multiple and unspecified sites	65 (6.5)
Type 2 diabetes mellitus	51 (5.1)
Spondylosis	42 (4.2)
Hypertensive Heart Disease	42 (4.2)
Gastritis and duodenitis	39 (3.9)
Disorders of lipoprotein metabolism and other lipidemias	36 (3.6)
Pain, not elsewhere classified	33 (3.3)
Iron deficiency anemia	31 (3.1)
Dermatophytosis	31 (3.1)
Vasomotor and allergic rhinitis	27 (2.7)
Atopic dermatitis	27 (2.7)
Other sepsis	25 (2.5)
Acute nasopharyngitis (common cold)	24 (2.4)
Acute tonsillitis	24 (2.4)
Conjunctivitis	16 (1.6)
Diseases of pulp and periapical tissues	17 (1.7)
Candidiasis	14 (1.4)
Bacterial infection of unspecified site	11 (1.1)
Pneumonia, unspecified organism	11 (1.1)
Gingivitis and periodontal diseases	8 (0.8)
Other female pelvic inflammatory diseases	8 (0.8)
Amoebiasis	7 (0.7)
Other gastroenteritis and colitis of infectious and unspecified origin	7 (0.7)
Acute pharyngitis	6 (0.6)
Bacterial pneumonia, not elsewhere classified	6 (0.6)
Infections of genitourinary tract in pregnancy	4 (0.4)
Chronic rhinitis, nasopharyngitis and pharyngitis	4 (0.4)
Cutaneous abscess, furuncle and carbuncle	4 (0.4)

Independent predictors of receipt of an antibiotic prescription.

Evidence of an association between the following factors and receipt of an antibiotic prescription were observed (Table 3). The odds of receipt of an antibiotic prescription were highest among patients with acute

tonsillitis in which it was about forty-six times compared to those who have no such a diagnosis**.** This was followed by a diagnosis of other disorders of the urinary system such as UTI, unspecified in which the odds were about twenty-seven times (aOR = 26.8, 95% CI; 10.7-67.3), $p < 0.01$. Moreover, a diagnosis of acute and URTI of multiple and unspecified site was associated with receipt of an antibiotic prescription with the odds of about three times than those who were not (aOR = 3.1, 95% CI; 1.5-6.7), $p < 0.01$.

The probability of receipt of an antibiotic prescription was about three times in children compared with the elderly. Attending a Health Center was associated with about three times likelihood of receipt of an antibiotic prescription compared to those who attended the National Referral Hospital (aOR = 3.2, 95% CI; 1.5-6.5), $p < 0.01$. Furthermore, the odds of receipt of an antibiotic prescription was about six times higher in patients attended by prescribers with low qualification such as Clinical Officer or Dental Therapist compared to those attended by a consultant. There was a decreasing trend in the odds of receiving an antibiotic prescription as the prescriber qualification increase (Table 3). Patients with non-ideal generic prescriptions had a two times likelihood of receipt of an antibiotic prescription compared to patients with ideal generic prescriptions (aOR = 2.1, 95% CI; 1.4-3.2), $p < 0.01$.

Moreover, patients who attended a District Hospital/Level 1 clinic were 2.7 times more likely for receipt of an antibiotic prescription when compared to those who attended the National Referral Hospital whereas attending a privately-owned health-care was associated with 50% less likelihood of receipt of an antibiotic prescription compared to those who visited public facilities.

The probability of receipt of an antibiotic prescription was highest (aOR = 46.1) among patients with acute tonsillitis (Figure 4). Similar odds of receipt of an antibiotic prescription were seen in patients having diagnoses of candidiasis, bacterial infection of unspecified site and pneumonia, unspecified organism. Moreover, attending a private health facility was found to have a protective effect on receipt of an antibiotic prescription. The complete list of variables subjected to univariate and multivariate analysis is found in Supplement 3.

196 **Table 3: Binary Logistic Regression analysis of predictors of receipt of antibiotic prescription**

Characteristic (N = 770)	Univariate Regression		Multivariate Regression	
	cOR* (95% CI)	*P* value	aOR** (95% CI)	*P* value
Age in years				
Elderly (≥ 60 years)	1 [Ref.]		1 [Ref.]	
Children (< 18 years)	6.3 (3.9 - 10.1)	< 0.01	2.9 (1.6 - 5.2)	< 0.01
Adults (18-59 years)	2.8 (1.8 - 4.2)	< 0.01	1.7 (1.0 - 2.8)	0.06
Level of health facility				
Referral Hospital/Clinic L3 by SS	1 [Ref.]		1 [Ref.]	
Dispensary	7.6 (4.6 - 12.8)	< 0.01	1.4 (0.5 - 3.8)	0.56
Health Centre/Stand-alone clinic by ADO	4.0 (2.5 - 6.2)	< 0.01	3.2 (1.5 - 6.5)	< 0.01
District Hospital/Clinic L1 by MO/DO	5.9 (3.5 - 9.7)	< 0.01	2.7 (1.3 - 5.8)	0.01
Regional Hospital/Clinic L2 by Specialist	1.1 (0.7 - 1.7)	0.87	1.1 (0.6 - 2.2)	0.70
Ownership of health facility				
Public	1 [Ref.]		1 [Ref.]	
Private/Non-governmental	1.9 (1.4 - 2.5)	< 0.01	0.5 (0.3 - 0.9)	0.01
Department visited				
Outpatient	1 [Ref.]		1 [Ref.]	
Inpatient	2.8 (1.0 - 8.1)	0.05	2.9 (0.8 - 11.1)	0.12
Any Procedure/Surgery done				
No	1 [Ref.]		1 [Ref.]	
Yes	2.3 (1.0 - 4.9)	0.04	3.9 (1.4 - 10.9)	0.01
Prescriber Qualification				
Super-specialist/Consultant	1 [Ref.]		1 [Ref.]	
Clinical Officer/Dental Therapist	12.4 (6.0 - 25.9)	< 0.01	6.2 (2.0 - 19.8)	< 0.01
Assistant Medical/Dental Officer	13.4 (3.3 - 54.4)	< 0.01	4.3 (0.8 - 24.3)	0.09
Medical/Dental Officer	3.6 (1.9 - 6.7)	< 0.01	2.2 (0.9 - 5.3)	0.07
Specialist	1.5 (0.8 - 2.8)	0.25	1.4 (0.6 - 3.1)	0.45
All medications prescribed using their generic names				
Yes	1 [Ref.]		1 [Ref.]	
No	1.4 (1.1 - 1.9)	0.02	2.1 (1.4 - 3.2)	< 0.01
Was malaria treatment prescribed				
No	1 [Ref.]		1 [Ref.]	
Yes	2.6 (1.0 - 6.8)	0.06	1.3 (0.3 - 4.6)	0.73
Presence of injectable formulation in the prescription				
No	1 [Ref.]		1 [Ref.]	
Yes	2.0 (1.2 - 3.3)	0.01	2.1 (1.0 - 4.2)	0.04

*cOR, Crude Odds Ratio; **aOR, Adjusted Odds Ratio; CI, Confidence Interval, AMO, Assistant Medical Officer;
ADO, Assistant Dental Officer; MO, Medical Officer; SS, Super-specialist; NA, Not Applicable; L1, Level 1; L2, Level 2; L3, Level 3. Ref. Reference group

Table 3: Binary Logistic Regression analysis of predictors of receipt of antibiotic prescription *(continued...)*

	Univariate Regression		Multivariate Regression	
Characteristic (n = 770)	**cOR* (95% CI)**	***P* value**	**aOR** (95% CI)**	***P* value**
Select Diagnostic Codes				
Other disorders of urinary system - N39				
No	1 [Ref.]		1 [Ref.]	
Yes	22.5 (9.7 - 52.2)	< 0.01	26.8 (10.7 - 67.3)	< 0.01
Acute and URTI of multiple and unspecified sites - J06				
No	1 [Ref.]		1 [Ref.]	
Yes	5.1 (2.7 - 9.6)	< 0.01	3.1 (1.5 - 6.7)	< 0.01
Other sepsis - A41				
No	1 [Ref.]		1 [Ref.]	
Yes	5.7 (1.9 - 17.1)	< 0.01	7.1 (2.0 - 25.0)	< 0.01
Acute tonsillitis - J03				
No	1 [Ref.]		1 [Ref.]	
Yes	28.4 (3.8 - 211.2)	< 0.01	46.1 (5.8 - 364.4)	< 0.01
Acute pharyngitis - J02				
No	1 [Ref.]		1 [Ref.]	
Yes	5.9 (0.7 – 50.3)	0.11	12.1 (1.2 – 124.7)	0.04
Candidiasis - B37				
No	1 [Ref.]		1 [Ref.]	
Yes	7.1 (1.6 - 32.2)	0.01	6.0 (1.1 - 32.0)	0.04
Bacterial infection of unspecified site - A49				
No	1 [Ref.]		1 [Ref.]	
Yes	5.3 (1.1 - 24.8)	0.03	6.1 (1.2 - 30.8)	0.03
Pneumonia, unspecified organism - J18				
No	1 [Ref.]		1 [Ref.]	
Yes	4.7 (1.0 - 22.3)	0.05	6.1 (1.1 - 32.7)	0.04
Other female pelvic inflammatory diseases - N73				
No	1 [Ref.]		1 [Ref.]	
Yes	7.0 (0.8 - 58.8)	0.07	16.3 (1.6 - 167.2)	0.02
Other gastroenteritis and colitis of infectious and unspecified origin - A09				
No	1 [Ref.]		1 [Ref.]	
Yes	7.0 (0.8 - 58.8)	0.07	7.7 (0.6 - 99.3)	0.12
Gingivitis and periodontal disease - K05				
No	1 [Ref.]		1 [Ref.]	
Yes	4.7 (0.5 - 42.0)	0.17	5.6 (0.5 - 61.3)	0.16
Conjunctivitis - H10				
No	1 [Ref.]		1 [Ref.]	
Yes	2.4 (0.8 - 6.9)	0.12	6.4 (1.7 - 24.1)	0.01

*cOR, Crude Odds Ratio; **aOR, Adjusted Odds Ratio; CI, Confidence Interval; Ref., Reference.

DISCUSSION

Antibiotics are the most important tool for control of bacterial infections, the commonest human infections that can be life-threatening. In addition, sometimes antibiotics are used to prevent bacterial infections when the risk of infection of an individual is high. As the result, infections that were severe and often fatal before the discovery and development of antibiotics can easily be treated with antibiotics today. However, excessive use and misuse have always threatened the benefits of antibiotics as the two can lead to the emergence and spread of resistance, which is currently the major challenge in the control of bacterial infections. Therefore, for longer effective-life of antibiotics and continued livelihood of the world population, misuse of antibiotics has to be stopped and antibiotic use needs to be kept at optimal levels.

Antimicrobial stewardship is the most promising strategy to stop misuse and excessive use of antibiotics. However, implementation of such programs is challenging and thus, research looking into ways of strengthening antibiotic stewardship programs is critical for ensuring optimal clinical outcomes, minimal unintended consequences of antibiotics use, improved susceptibility rates to targeted antibiotics, optimal resource utilization and hence, control of bacterial infections.

The thrust of our study was to define factors that are strong predictors of an antibiotic prescription so that ASPs may see where to put emphasis. We have identified diagnosis of acute URTI as the strongest predictor of an antibiotic prescription in our study population. This means that the microbiology laboratory aspect of antimicrobial stewardship such as provision of culture and sensitivity results on a regular basis or preparation of annual antibiotic susceptibility pattern needs to be strengthened. There are criteria, WHO or IMCI for prescribing an antibiotic for URTI. However, when clinicians are unwilling to go through the procedures or when procedures are not available, prescription of an antibiotic will be the easy way out and without taking risk for possibility of untreated or delayed treatment of a bacterial infection. Although most URTIs have a viral etiology and have a self-limiting course, antibiotics are commonly prescribed. [30] This observation is in line with other previous published literature that have demonstrated this association. [31–34] The patient and the public should be informed that most of the URTIs are viral in origin and they require

supportive therapy and not antibiotics. This will decrease patient antibiotic expectation. Although some studies shows no evidence, [35] facility-specific guidelines and algorithms, adapted from national standard treatment guideline, should be established with respect to properly diagnosing and treating URTIs. [36–38]

Being attended by less qualified health care worker is another factor which appears to influence prescription of an antibiotic. Less qualified clinicians (non-degree holder) are more likely to issue an antibiotic prescription than the degree holder colleagues. The odds of receipt of an antibiotic prescription were about six times in patients who were attended by lower-level prescribers such as Clinical Officer or Dental Therapists when compared to those seen by higher-level prescribers such as consultants. Clinical Officers and Dental Therapists being less experienced and qualified to prescribe probably explains this observation. Moreover, Clinical Officers and Dental Therapists usually work in primary healthcare facilities in which there is a high volume of patients and fewer resources which increases the likelihood of irrational medication prescriptions including antibiotics. [39] This antibiotic prescribing disparity between prescribers with different qualifications was also demonstrated in previous studies. [40] Another study in Hubei, China found that prescribers with lower qualifications were more likely to prescribe antibiotics. [39] This finding emphasize the need for antibiotic stewardship interventions to target low-level prescribers through clinical education. Opportunities and protected time for clinicians to address knowledge gap through continuing medical education has been found to improve antibiotic utilization. [41–43] Therefore, it is important for hospital policies and administrators to provide clinicians with such opportunities.

Studies have shown that patient's likelihood of receipt of an antibiotic prescription is influenced by the type of health facility they have attended to. A study in Ghana showed that attending a Health Center or a clinic is associated with receipt of an antibiotic prescription (63.7%). [31] Similarly, we have revealed that, there is strong evidence of an association between patient attending a Health Center and receiving an antibiotic prescription when compared to those attending a Referral Hospital. This observation may be attributed to limited resources in terms of medications and diagnostic capabilities resulting in empiric prescribing of antibiotics. Indeed, targeting lower-level health facilities with antimicrobial stewardship

interventions such clinical education, facility-specific guidelines for common infections, and antibiotic oversight through prospective audit and feedback may decrease antibiotic prescriptions. [44,45]

Surprisingly, our study shows that attending a private facility is less likely to have an antibiotic prescribed. The odds of receipt of an antibiotic prescription in a private health facility was 50% less than the odds in a public health facility. This was a surprising finding as private health facilities are driven by profit, so we did expect them to prescribe more medications including antibiotics to patients when compared with public health facilities. We speculate that, insured patients are more likely to attend private health facilities where prescribers better adhere to insurance guidelines than those in public facilities. This was in line with a South African study by Mohlala and colleagues. [46] This is a worrisome finding as, in general, majority of patients are likely to be seen in public lower-level health facilities thus antibiotic prescriptions might be higher than what we have observed. Clinical education, facility-specific guidelines and antibiotic oversight should be established or strengthened in public health facilities.

Our data shows that the probability of receipt of an antibiotic prescription among children are about three times that of the elderly. URTIs and non-bloody diarrhea being prevalent in children and mostly treated with antibiotics despite being viral in origin and contrary to treatment guidelines may explain this finding. [47,48] This observation is comparable to other published results. [31,49–52] Moreover, immune senescence in the elderly causes atypical presentations of infectious disease symptoms such as fever and cough whereas in children they are more pronounced. [53] ASPs should be strengthened in pediatrics so as to decrease antibiotic prescriptions as there is strong evidence supporting that such an approach. [45,54] Despite the challenges of implementing ASPs in pediatrics, clinical education, care-giver education, updated facility-specific guidelines and prospective audit and feedback, are stewardship interventions shown to decrease antibiotics utilization. [44,55,56]

Ideally, all medications in a prescription should be written in their generic names as per WHO/INRUD prescribing indicators. We observed strong evidence of an association between non-ideal generic prescribing and receipt of an antibiotic prescription. This observation may be explained by the fact

that both sub-optimal generic prescribing and over-prescribing antibiotics are indicators of poor prescribing practice. [31] It is essential that ASPs enables prescribers adhere to generic prescribing and other good prescribing practices.

Limitations of this study include inherent weakness of cross-sectional studies as they lack robustness in establishing causality, lack of generalizability of the study findings as our study population was only insured patients, using the odds ratio to report associations may overestimate the magnitude of association, and the overly large sample size used may cause small differences in observations to be statistically significant without any clinical significance. We, therefore interpret our findings with caution.

CONCLUSIONS

Factors influencing antibiotic prescription in Tanzania are similar to factors reported in literature. URTIs, less qualification of the prescriber, attending a public lower-level health facility, and being a child appear to be the most important factors that when targeted through antimicrobial stewardship activities may have an important impact on antibiotic misuse and excessive use.

Ethical approval: Ethical approval from the research and publication committee of MUHAS was sought and was granted (Ref. No. DA.287/298/01A). We requested further permission from the Director of National Health Insurance Fund (NHIF) to proceed with the study using NHIF database after informing him of the purpose of the study and possible benefits to NHIF as well as to the society at large. Utmost confidentiality was maintained as no personal identifiers were collected by our data capture tool.

Author contribution: MAK, PGS, and SFM conceptualized and designed the study, collected, analysed and interpreted the data. MAK drafted the initial manuscript. MAK, PGS and SFM critically revised the manuscript and approved the final version to be submitted.

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Conflict of Interest: None to declare.

Data availability statement: Data set is available upon request from the corresponding author

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Figure 1. Receipt of an antibiotic prescription by age group

Figure 2. Receipt of an antibiotic prescription by the level of health facility

Figure 3. Receipt an antibiotic prescription by prescriber qualification

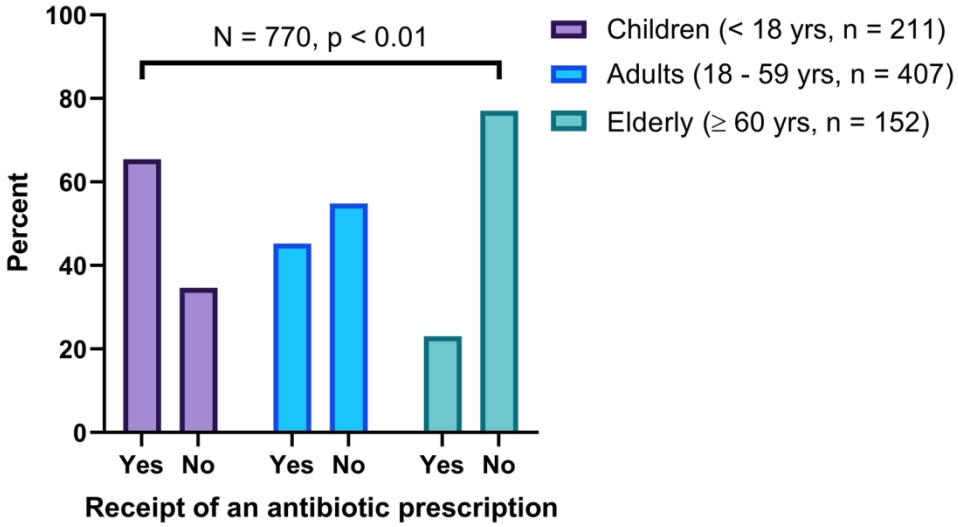

Figure 1. Receipt of an antibiotic prescription by age group

152x88mm (300 x 300 DPI)

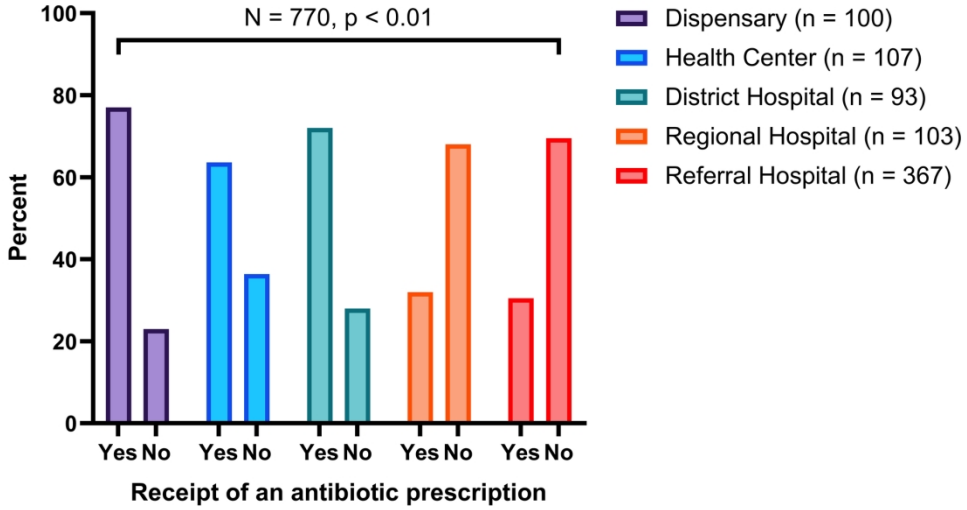

Figure 2. Receipt of an antibiotic prescription by the level of health facility

173x96mm (300 x 300 DPI)

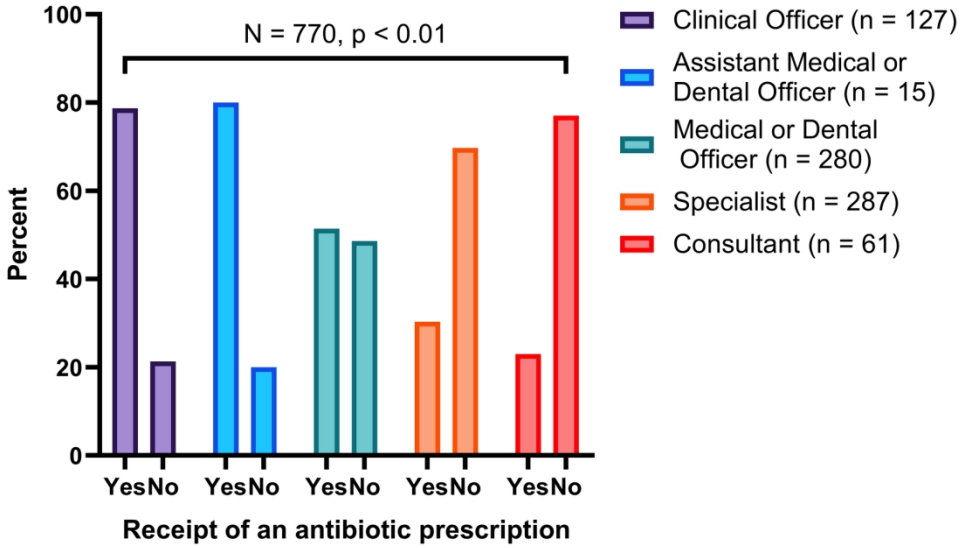

Figure 3. Receipt an antibiotic prescription by prescriber qualification

160x96mm (300 x 300 DPI)

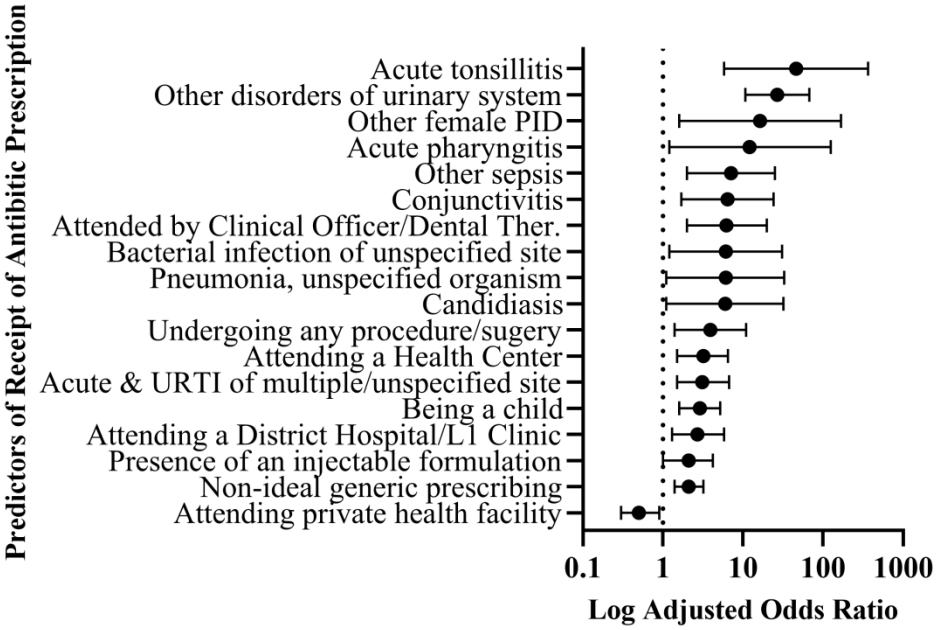

Figure 4: A forest plot of log-adjusted odds ratios for receipt of an antibiotic prescription

218x143mm (300 x 300 DPI)

1

Supplement 1: Frequency distribution of all study variables

Characteristic	n (%)
Age in years (N = 993)	
Mean (SD) = 36.3 (23.2), Median = 37.0	
Children (< 18 years)	264 (26.6)
Adults (18-59 years)	535 (53.9)
Elderly (≥ 60 years)	194 (19.5)
Sex (N = 993)	
Male	412 (41.5)
Female	581 (58.5)
Level of health facility (N = 993)	
Dispensary	102 (10.3)
Health Centre/Stand-alone clinic by Assistant Dental Officer	119 (12.0)
District Hospital/Clinic Level1 by Medical/Dental Officer	101 (10.2)
Regional Hospital/Clinic Level 2 by specialist)	123 (12.4)
Referral/National/Zonal Hospital/Clinic Level 3 by super specialist	548 (55.2)
Ownership of health facility (N = 993)	
Public	468 (47.1)
Private/Nongovernmental	525 (52.9)
Department visited (N = 993)	
Outpatient	975 (98.2)
Inpatient	18 (1.8)
Diagnosis code (N = 993)	
Other disorders of urinary system	102 (10.3)
Essential (primary) hypertension	81 (8.2)
Acute and URTI of multiple and unspecified sites	65 (6.5)
Type 2 diabetes mellitus	51 (5.1)
Spondylosis	42 (4.2)
Hypertensive Heart Disease	42 (4.2)
Gastritis and duodenitis	39 (3.9)
Disorders of lipoprotein metabolism and other lipidemias	36 (3.6)
Pain, not elsewhere classified	33 (3.3)
Iron deficiency anaemia	31 (3.1)
Dermatophytosis	31 (3.1)
Vasomotor and allergic rhinitis	27 (2.7)
Atopic dermatitis	27 (2.7)
Other sepsis	25 (2.5)

Key; RefH, Referral Hospital, L1C, Level 1 Clinic; L2C, Level 2 Clinic

Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N = 993)	**n (%)**
Iron deficiency anaemia	31 (3.1)
Dermatophytosis	31 (3.1)
Vasomotor and allergic rhinitis	27 (2.7)
Atopic dermatitis	27 (2.7)
Other sepsis	25 (2.5)
Acute nasopharyngitis (common cold)	24 (2.4)
Acute tonsillitis	24 (2.4)
Asthma	23 (2.3)
Malaria, unspecified	23 (2.3)
PUD, site unspecified	22 (2.2)
Chronic kidney disease	18 (1.8)
Complications of analgesics, antipyretics and anti-inflammatory drugs	18 (1.8)
Plasmodium falciparum	16 (1.6)
Conjunctivitis	16 (1.6)
Diseases of pulp and periapical tissues	17 (1.7)
Cough	16 (1.6)
Hookworm disease	14 (1.4)
Candidiasis	14 (1.4)
Other vitamin deficiency	14 (1.4)
Chronic diseases of tonsils and adenoids	14 (1.4)
Other joint disorders, not elsewhere classified	14 (1.4)
Gonarthrosis (arthrosis of knee)	13 (1.3)
Supervision of normal pregnancy	13 (1.3)
Dental caries	13 (1.3)
Bacterial infection of unspecified site	11 (1.1)
Deficiency of other nutrient elements	11 (1.1)
Pneumonia, unspecified organism	11 (1.1)
Other deforming dorsopathies	11 (1.1)
Epilepsy	10 (1.0)
Cystitis	10 (1.0)
Chronic viral hepatitis	10 (1.0)
Acute bronchitis	10 (1.0)
Hyperplasia of prostate	10 (1.0)
Deficiency of other B group vitamins	9 (0.9)

Supplement 1: Frequency distribution of all study variables (Continued)	
Characteristic (N = 993)	**n (%)**
Disorders of refraction and accommodation	9 (0.9)
Other arthritis	8 (0.8)
Headache	9 (0.9)
Ascariasis	8 (0.8)
Other disorders of fluid, electrolyte and acid-base balance	8 (0.8)
Gingivitis and periodontal diseases	8 (0.8)
Gastro-oesophageal reflux disease	8 (0.8)
Gout	8 (0.8)
Other female pelvic inflammatory diseases	8 (0.8)
Other disorders of bladder	7 (0.7)
Amoebiasis	7 (0.7)
Other gastroenteritis and colitis of infectious and unspecified origin	7 (0.7)
Other anemias	7 (0.7)
Other hypothyroidism	7 (0.7)
Cardiomyopathy	7 (0.7)
Other functional intestinal disorders	7 (0.7)
Allergic contact dermatitis	7 (0.7)
Dorsalgia	6 (0.6)
Nerve root and plexus compressions in diseases classified elsewhere	6 (0.6)
Malaise and fatigue	6 (0.6)
Other helminthiasis	6 (0.6)
Other superficial mycoses	6 (0.6)
Type 1 diabetes mellitus	6 (0.6)
Other polyneuropathies	6 (0.6)
Heart failure	6 (0.6)
Acute pharyngitis	6 (0.6)
Bacterial pneumonia, not elsewhere classified	6 (0.6)
Unspecified acute lower respiratory infection	6 (0.6)
Other diseases of upper respiratory tract	6 (0.6)
Cellulitis	6 (0.6)
Other disorders of external ear	6 (0.6)
Unspecified intestinal parasitism	5 (0.5)
Malignant neoplasm of the breast	5 (0.5)
Leiomyoma of the uterus	5 (0.5)
Inflammatory polyneuropathy	5 (0.5)

Supplement 1: Frequency distribution of all study variables (continued)

Characteristic (N = 993)	n (%)
Glaucoma	5 (0.5)
Secondary hypertension	5 (0.5)
Other diseases of hard tissues of teeth	5 (0.5)
Irritable bowel syndrome	5 (0.5)
Arthrosis of first carpometacarpal joint	5 (0.5)
Other disorders of muscle	5 (0.5)
Excessive vomiting in pregnancy	5 (0.5)
Nausea and vomiting	5 (0.5)
Infections of genitourinary tract in pregnancy	4 (0.4)
Varicella (chickenpox)	4 (0.4)
Malignant neoplasm of the prostate	4 (0.4)
Sickle cell disorders	4 (0.4)
Coagulation defect, unspecified	4 (0.4)
Cervical disc disorders	4 (0.4)
Other retinal disorders	4 (0.4)
Otitis externa	4 (0.4)
Disorders of vestibular function	4 (0.4)
Chronic ischemic heart disease	4 (0.4)
Chronic rhinitis, nasopharyngitis and pharyngitis	4 (0.4)
Dental facial anomalies (including malocclusion)	4 (0.4)
Cutaneous abscess, furuncle and carbuncle	4 (0.4)
Other soft tissues disorders, not elsewhere classified	4 (0.4)
Single delivery by caesarean section	4 (0.4)
Congenital malformation of cardiac septa	4 (0.4)
Abdominal and pelvic pain	4 (0.4)
Open wound of the forearm	4 (0.4)
Fever of other and unknown origin	4 (0.4)
Fracture of lower leg, including ankle	4 (0.4)
Dislocation, sprain and strain of joints and ligaments of knee	4 (0.4)
Other intervertebral disc disorders	3 (0.3)
Coxarthrosis (arthrosis of hip)	3 (0.3)
Polyarthrosis	3 (0.3)
Acne	3 (0.3)
Urticaria	3 (0.3)
Other parasitologically confirmed malaria	3 (0.3)

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Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N = 993)	**n (%)**
Trichomoniasis	3 (0.3)
Other bacterial Intestinal Infections	3 (0.3)
Herpes Simplex Infection	3 (0.3)
HIV disease resulting in infectious and parasitic diseases	3 (0.3)
Maligant neoplasm of colon	3 (0.3)
Malignant neoplasm of cervix uteri	3 (0.3)
Haemangioma and lymphangioma, any site	3 (0.3)
Thyrotoxicosis	3 (0.3)
Vitamin D deficiency	3 (0.3)
Disorders of mineral metabolism	3 (0.3)
Hereditary and idiopathic neuropathy	3 (0.3)
Senile cataract	3 (0.3)
Duodenal ulcer	3 (0.3)
Impetigo	3 (0.3)
Other dermatitis	3 (0.3)
Internal derangement of knee	3 (0.3)
Osteomyelitis	3 (0.3)
Acute renal failure	3 (0.3)
Other general symptoms and signs	3 (0.3)
Other abnormal findings of blood chemistry	3 (0.3)
Presence of prosthetic heart valve	3 (0.3)
Fracture of femur	2 (0.2)
Other dorsopathies, not elsewhere classified	2 (0.2)
Other spondylopathies	2 (0.2)
Psoriasis	2 (0.2)
Seborrheic dermatitis	2 (0.2)
Diphyllobothriasis and sparganosis	2 (0.2)
Scabies	2 (0.2)
Streptococcal sepsis	2 (0.2)
Miliary tuberculosis	2 (0.2)
Typhoid and paratyphoid fevers	2 (0.2)
Unspecified HIV disease	2 (0.2)
Viral infection of unspecified site	2 (0.2)
Myasis	2 (0.2)

Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N = 993)	**n (%)**
Streptococcus and staphylococcus as the cause of diseases classified elsewhere	2 (0.2)
Other specified infectious agents as the cause of diseases classified elsewhere	2 (0.2)
Malignant neoplasm of esophagus	2 (0.2)
Malignant neoplasm of penis	2 (0.2)
Malignant neoplasm of thyroid gland	2 (0.2)
Benign lipomatous neoplasm	2 (0.2)
Benign neoplasm of thyroid gland	2 (0.2)
Vitamin B12 deficiency anemia	2 (0.2)
Other nutritional anemias	2 (0.2)
Purpura and other haemorrhagic conditions	2 (0.2)
Other disorders of white blood cells	2 (0.2)
Other specified diabetes mellitus	2 (0.2)
Unspecified diabetes mellitus	2 (0.2)
Hyperprolactinemia	2 (0.2)
Disorders of purine and pyrimidine metabolism	2 (0.2)
Schizophrenia	2 (0.2)
Migraine	2 (0.2)
Other headache syndromes	2 (0.2)
Disorders of autonomic nervous system	2 (0.2)
Other inflammation of the eyelid	2 (0.2)
Other disorders of conjunctiva	2 (0.2)
Nonsuppurative otitis media	2 (0.2)
Suppurative and unspecified otitis media	2 (0.2)
Other rheumatic heart disease	2 (0.2)
Pulmonary embolism	2 (0.2)
Acute and subacute infective endocarditis	2 (0.2)
Cerebral infarction	2 (0.2)
Stroke, not specified as hemorrhage or infarction	2 (0.2)
Other venous embolism and thrombosis	2 (0.2)
Hemorrhoids	2 (0.2)
Hypotension	2 (0.2)
Acute sinusitis	2 (0.2)
Pneumonia due to *H. influenza*	2 (0.2)
Acute bronchiolitis	2 (0.2)

Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N = 993)	**n (%)**
Chronic sinusitis	2 (0.2)
Nasal polyp	2 (0.2)
Respiratory disorders in diseases classified elsewhere	2 (0.2)
Gastric ulcer	2 (0.2)
Inguinal hernia	2 (0.2)
Umbilical hernia	2 (0.2)
Other diseases of the liver	2 (0.2)
Pruritus	2 (0.2)
Nephrotic syndrome	2 (0.2)
Calculus of kidney and ureter	2 (0.2)
Other disorders of kidney and ureter in diseases classified elsewhere	2 (0.2)
Urethral stricture	2 (0.2)
Excessive, frequent and irregular menstruation	2 (0.2)
Abnormal uterine and vaginal bleeding, unspecified	2 (0.2)
Female infertility	2 (0.2)
Threatened abortion	2 (0.2)
Perineal laceration during delivery	2 (0.2)
Single spontaneous delivery	2 (0.2)
Anaemia complicating pregnancy, childbirth and the purperium	2 (0.2)
Congenital malformation of the great arteries	2 (0.2)
Abnormalities of heart beat	2 (0.2)
Other symptoms and signs involving the digestive system and abdomen	2 (0.2)
Abnormal involuntary movements	2 (0.2)
Dislocation, sprain and strain of joints and ligaments of lumbar spine and pelvis	2 (0.2)
Fracture of shoulder and upper arm	2 (0.2)
Fracture of lower end of radius	2 (0.2)
Dislocation of wrist	2 (0.2)
Open wound of lower leg	2 (0.2)
Poisoning by local antifungal, anti-infective and anti-inflammatory drugs, not elsewhere classified	2 (0.2)
Allergy, unspecified	2 (0.2)
Supervision of high-risk pregnancy, unspecified	2 (0.2)
Health supervision and care of other healthy infant and child	2 (0.2)
Spastic quadriplegic cerebral palsy	1 (0.1)
Dengue fever (classical dengue)	1 (0.1)

Supplement 1: Frequency distribution of all study variables (continued)

Characteristic (N = 993)	n (%)
Open wound of abdomen, lower back and pelvis	1 (0.1)
Sensorineural hearing loss, bilateral	1 (0.1)
Antenatal screening	1 (0.1)
Pregnancy confirmed	1 (0.1)
Contact with and exposure to communicable diseases	1 (0.1)
Routine general health check-up of defined subpopulation	1 (0.1)
Other medical procedures as the cause of abnormal reaction of the patient, or of later complication, without mention of misadventure at the time of the procedure	1 (0.1)
Hanging, strangulation and suffocation, undetermined intent	1 (0.1)
Intentional self-harm by jumping from a high place	1 (0.1)
Exposure to discharge of firework	1 (0.1)
Poisoning by antihyperlipidaemic and antiarteriosclerotic drugs	1 (0.1)
Poisoning by hormones and their synthetic substitutes and antagonists, not elsewhere classified	1 (0.1)
Poisoning by antiviral drug	1 (0.1)
Poisoning by antifungals and antibiotics, systemically used	1 (0.1)
Corrosions classified according to extent of body surface involved	1 (0.1)
Burns classified according to extent of body surface involved	1 (0.1)
Burn of first degree of wrist and hand	1 (0.1)
Injury of unspecified muscle and tendon of lower limb, level unspecified	1 (0.1)
Fracture of other toe	1 (0.1)
Open wound of other parts of foot	1 (0.1)
Superficial injury of hip and thigh, unspecified	1 (0.1)
Other and unspecified injuries of wrist and hand	1 (0.1)
Sprain and strain of wrist	1 (0.1)
Superficial injury of wrist and hand	1 (0.1)
Injury of muscle(s) and tendon(s) of the rotator cuff	1 (0.1)
Superficial injury of shoulder and upper arm	1 (0.1)
Fracture of lumbar spine and pelvis	1 (0.1)
Intracranial injury	1 (0.1)
Fracture of skull and facial bones	1 (0.1)
Open wound of the head	1 (0.1)
Intracranial space-occupying lesion	1 (0.1)
Symptoms and signs concerning fluid intake	1 (0.1)
Dizziness and giddiness	1 (0.1)

Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N = 993)	**n (%)**
Unspecified urinary incontinence	1 (0.1)
Painful micturition, unspecified	1 (0.1)
Abnormalities of gait and mobility	1 (0.1)
Rash and other nonspecific skin eruption	1 (0.1)
Other specified symptoms and signs involving the circulatory and respiratory systems	1 (0.1)
Hemorrhage from respiratory passages	1 (0.1)
Gangrene, not elsewhere classified	1 (0.1)
Congenital posterior urethral valves	1 (0.1)
Polycystic kidney, unspecified	1 (0.1)
Congenital pulmonary valve stenosis	1 (0.1)
Congenital hydrocephalus	1 (0.1)
Hypoxic ischemic encephalopathy of newborn	1 (0.1)
Maternal care for breach presentation	1 (0.1)
Other specified pregnancy-related conditions	1 (0.1)
Pre-eclampsia	1 (0.1)
Pre-existing hypertension, complicating pregnancy, childbirth and the puerperium	1 (0.1)
Blighted ovum and nonhydatiform mole	1 (0.1)
Habitual aborter	1 (0.1)
Complete or unspecified abortion without complication	1 (0.1)
Secondary dysmenorrhea	1 (0.1)
Other inflammatory disorders of vagina	1 (0.1)
Endometriosis	1 (0.1)
Female pelvic inflammatory disorders in diseases classified elsewhere	1 (0.1)
Inflammatory disorders of the breast	1 (0.1)
Impotence of organic origin	1 (0.1)
Redundant prepuce, phimosis and paraphimosis	1 (0.1)
Orchitis and epididymitis	1 (0.1)
Hydrocele and spermatocele	1 (0.1)
Inflammatory diseases of the prostate	1 (0.1)
Urethral disorders in diseases classified elsewhere	1 (0.1)
Urethral caruncle	1 (0.1)
Urethritis and urethral syndrome	1 (0.1)
Unspecified renal colic	1 (0.1)
Unspecified kidney failure	1 (0.1)

Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N =993)	**n (%)**
Obstructive and reflux uropathy	1 (0.1)
Hydronephrosis with ureteral stricture, not elsewhere classified	1 (0.1)
Chronic nephritic syndrome	1 (0.1)
Periprosthetic fracture around internal prosthetic joint	1 (0.1)
Other disorders of bone density and structure	1 (0.1)
Short Achilles tendon (acquired)	1 (0.1)
Spontaneous rupture of synovium and tendon	1 (0.1)
Discitis, unspecified	1 (0.1)
Other acquired deformities of limbs	1 (0.1)
Acquired deformities of fingers and toes	1 (0.1)
Arthrosis, unspecified	1 (0.1)
Other specific arthropathies	1 (0.1)
Seropositive rheumatoid arthritis	1 (0.1)
Ulcer of lower limb, not elsewhere classified	1 (0.1)
Lichen planus	1 (0.1)
Unspecified contact dermatitis due to other chemical products	1 (0.1)
Other local infection of skin and subcutaneous tissue	1 (0.1)
Pilonidal cyst without abscess	1 (0.1)
Cholelithiasis	1 (0.1)
Alcoholic hepatic failure	1 (0.1)
Malignant neoplasm of rectum	1 (0.1)
Malignant neoplasm of stomach	1 (0.1)
Malignant neoplasm of liver and intrahepatic bile ducts	1 (0.1)
Malignant neoplasm of other and ill-defined sites in the respiratory system and intrathoracic organs	1 (0.1)
HIV disease resulting in other specified diseases	1 (0.1)
Foodborne staphylococcal intoxication	1 (0.1)
Rotaviral enteritis	1 (0.1)
Other and unspecified syphilis	1 (0.1)
Chlamydial infection of lower genitourinary tract	1 (0.1)
Anogenital herpesviral infection, unspecified	1 (0.1)
Anogenital (venereal) warts	1 (0.1)
Unspecified sexually transmitted disease	1 (0.1)
Enteroviral exanthematous fever	1 (0.1)
Other mosquito-borne viral fevers	1 (0.1)

Supplement 1: Frequency distribution of all study variables (continued)

Characteristic (N = 993)	n (%)
Measles without complications	1 (0.1)
Other viral infections characterized by skin and mucous membrane lesions, not elsewhere classified	1 (0.1)
Unspecified viral hepatitis without hepatic coma	1 (0.1)
Subcutabeous phaeomycotic abscess and cyst	1 (0.1)
Other cestode infections	1 (0.1)
Onchocerciasis	1 (0.1)
Strongyloidiasis	1 (0.1)
Trichiuriasis	1 (0.1)
Enterobiasis	1 (0.1)
Sequelae of tuberculosis	1 (0.1)
Malignant neoplasm of the palate	1 (0.1)
Malignant neoplasm of the tonsil, unspecified	1 (0.1)
Malignant neoplasm of piriform sinus	1 (0.1)
Maignant neoplasm of hypopharynx, unspecified	1 (0.1)
Malignant neoplasm of the bone and articular cartilage, unspecified	1 (0.1)
Kaposi sarcoma	1 (0.1)
Malignant neoplasm of peripheral nerves of lower limb, including hip	1 (0.1)
Malignant neoplasm of ovary	1 (0.1)
Malignant neoplasm of the testis	1 (0.1)
Malignant neoplasm of the kidney, except renal pelvis	1 (0.1)
Malignant (primary) neoplasm, unspecified	1 (0.1)
Hodgkin lymphoma	1 (0.1)
Non-follicular lymphoma	1 (0.1)
Mediastinal (thymic) large B-cell lymphoma	1 (0.1)
Other specified types T/NK-cell lymphoma	1 (0.1)
Chronic lymphocytic leukemia of B-cell type	1 (0.1)
Benign neoplasm of mouth and pharynx	1 (0.1)
Benign neoplasm of parotid gland	1 (0.1)
Other benign neoplasms of connective and other soft tissue	1 (0.1)
Benign neoplasm of the breast	1 (0.1)
Benign neoplasm of the prostate	1 (0.1)
Benign neoplasm of the brain and other parts of the central nervous system	1 (0.1)
Benign neoplasm of other and unspecified endocrine glands	1 (0.1)
Folate deficiency anemia	1 (0.1)

Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N = 993)	**n (%)**
Iodine-deficiency-related (endemic) goiter, unspecified	1 (0.1)
Polycystic ovarian syndrome	1 (0.1)
Vitamin A deficiency, unspecified	1 (0.1)
Niacin deficiency (pellagra)	1 (0.1)
Ascorbic acid deficiency	1 (0.1)
Dietary calcium deficiency	1 (0.1)
Lipid storage disorder, unspecified	1 (0.1)
Mental and behavioral disorders due to use of alcohol	1 (0.1)
Schizotypal disorder	1 (0.1)
Mild depressive episode	1 (0.1)
Recurrent depressive disorder	1 (0.1)
Unspecified mental retardation	1 (0.1)
Secondary parkinsonism, unspecified	1 (0.1)
Essential tremor	1 (0.1)
Other demyelinating diseases of central nervous system	1 (0.1)
Nerve root and plexus disorder, unspecified	1 (0.1)
Diabetic polyneuropathy	1 (0.1)
Other specified disorders of brain in diseases classified elsewhere	1 (0.1)
Other disorders of nervous system in diseases classified elsewhere	1 (0.1)
Disorders of lacrimal system	1 (0.1)
Disorders of orbit	1 (0.1)
Chorioretinal inflammation	1 (0.1)
Diabetic retinopathy	1 (0.1)
Disorders of globe	1 (0.1)
Optic atrophy	1 (0.1)
Otitis externa in mycoses	1 (0.1)
Hearing loss, unspecified	1 (0.1)
Hypertensive heart and renal disease	1 (0.1)
Angina pectoris	1 (0.1)
Other nonrheumatic mitral valve disorders	1 (0.1)
Endocarditis, valve unspecified	1 (0.1)
Other conduction disorders	1 (0.1)
Other cardiac arrhythmias	1 (0.1)
Other cerebrovascular diseases	1 (0.1)
Abdominal aortic aneurysm, ruptured	1 (0.1)

Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N = 993)	**n (%)**
Phlebitis and thrombophlebitis of femoral vein	1 (0.1)
Post procedural disorders of circulatory system, not elsewhere classified	1 (0.1)
Influenza due to identified seasonal influenza virus	1 (0.1)
Influenza, virus not identified	1 (0.1)
Pneumonia due to other specified infectious organisms	1 (0.1)
Peritonsillar abscess	1 (0.1)
Unspecified chronic bronchitis	1 (0.1)
Status asthmaticus	1 (0.1)
Hypersensitivity pneumonitis due to organic dust	1 (0.1)
Pneumonitis due to solids and liquids	1 (0.1)
Adult respiratory distress syndrome	1 (0.1)
Other disorders of tooth development	1 (0.1)
Impacted teeth	1 (0.1)
Disorders of teeth and supporting structures, unspecified	1 (0.1)
Other cysts of jaw	1 (0.1)
Other diseases of jaws	1 (0.1)
Other diseases of lip and oral mucosa	1 (0.1)
Esophagitis	1 (0.1)
Functional dyspepsia	1 (0.1)
Acute appendicitis	1 (0.1)
Incisional hernia without obstruction or gangrene	1 (0.1)
Other abdominal hernia	1 (0.1)
Ulcerative (chronic) pancolitis	1 (0.1)
Other specified noninfective gastroenteritis and colitis	1 (0.1)
Anal fissure, unspecified	1 (0.1)
Anorectal fistula	1 (0.1)
Chronic hepatitis, not elsewhere classified	1 (0.1)
Any Procedure/Surgery done (N = 993)	
No	940 (94.7)
Yes	53 (5.3)
Type of Procedure/Surgery (N = 53)	
Minor	25 (47.2)
Major	7 (13.2)
Specialized	21 (39.6)

Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic	**n (%)**
Length of stay in days (n = 17)	
Mean (SD) = 6.1 (5.7), Median = 3	
1	3 (17.6)
2	4 (23.5)
3	2 (11.8)
5	1 (5.9)
6	1 (5.9)
7	1 (5.9)
8	1 (5.9)
14	2 (11.8)
15	1 (5.9)
18	1 (5.9)
Prescriber Qualification (N = 993)	
Clinical Officer/Dental Therapist	132 (13.3)
Assistant Medical/Dental Officer	18 (1.8)
Medical/Dental Officer	320 (32.2)
Specialist	437 (44.0)
Super-specialist/Consultant	86 (8.7)
Prescriber Qualification Grouped (N = 993)	
Low level (Clinical Officers or Assistant Medical/Dental Officers)	150 (15.1)
Mid-level (Doctor of Medicine/Doctor of Dental Surgery)	320 (32.2)
High level (Specialists/Consultants)	523 (52.7)
Any Medication Prescribed (N = 993)	
No	223 (22.5)
Yes	770 (77.5)
Number of Medications in the prescription (N = 770)	
Mean (SD) = 3.0 (1.7), Median = 3.0	
1	117 (15.2)
2	209 (27.1)
3	212 (27.5)
4	118 (15.3)
5	55 (7.1)
6	39 (5.1)
7	11 (1.4)
8	6 (0.8)
10	2 (0.3)

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Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N = 770)	**n (%)**
13	1 (0.1)
Polypharmacy of > 3 Medications	
No	538 (69.9)
Yes	232 (30.1)
Polypharmacy of ≥ 5 Medications	
No	657 (85.3)
Yes	113 (14.7)
Receipt of an antibiotic prescription (N = 770)	
No	413 (53.6)
Yes	357 (46.4)
Receipt of more than one antibiotic prescription (N = 357)	
No	286 (80.1)
Yes	70 (19.6)
Antibiotics prescribed according to TZ STG2017 recommendation with respect to HFL (N = 357)	
No	28 (7.8)
Yes	329 (92.2)

Supplement 2: Study characteristics by receipt of antibiotic prescription

Characteristic (N = 770)	Antibiotic prescription, n (%) No	Yes	*P* value
Age in years			
Children (< 18 years)	73 (34.6)	138 (65.4)	< 0.01
Adults (18-59 years)	223 (54.8)	184 (45.2)	
Elderly (≥ 60 years)	117 (77.0)	35 (23.0)	
Sex			
Male	165 (52.2)	151 (47.8)	0.51
Female	248 (54.6)	206 (45.4)	
Level of health facility			
Dispensary	23 (23.0)	77 (77.0)	< 0.01
Health Centre/Stand-alone clinic by ADO	39 (36.4)	68 (63.6)	
District Hospital/Clinic L1 by MO/DO	26 (28.0)	67 (72.0)	
Regional Hospital/Clinic L2 by specialist	70 (68.0)	33 (32.0)	
Referral/National/Zonal Hospital/Clinic L3 by SS	255 (69.5)	112 (30.5)	
Ownership of health facility			
Public	195 (62.7)	116 (37.3)	< 0.01
Private/Non-governmental	218 (47.5)	241 (52.5)	
Department visited			
Outpatient	408 (54.2)	345 (45.8)	0.04
Inpatient	5 (29.4)	12 (70.6)	
Select Diagnosis			
Other disorders of urinary system			
No	407 (60.3)	268 (39.7)	< 0.01
Yes	6 (6.3)	89 (93.7)	
Acute and URTI of multiple and unspecified sites			
No	400 (56.7)	306 (43.3)	< 0.01
Yes	13 (20.3)	51 (79.7)	
Other sepsis			
No	409 (54.8)	338 (45.2)	< 0.01*
Yes	4 (17.4)	19 (82.6)	
Acute tonsillitis			
No	412 (55.2)	334 (44.8)	< 0.01*
Yes	1 (4.2)	23 (95.8)	

p-values are from Pearson Chi-Square Test or Fisher's Exact Test (*); SS, Super Specialist

Supplement 2: Study characteristics by receipt of antibiotic prescription (Continued)			
	Antibiotic prescription, n (%)		
Characteristic (N = 770)	**No**	**Yes**	***P* value**
Diseases of pulp and periapical tissues			
No	413 (54.3)	347 (45.7)	< 0.01*
Yes	0 (0.0)	10 (100.0)	
Candidiasis			
No	411 (54.4)	345 (45.6)	0.01
Yes	2 (14.3)	12 (85.7)	
Bacterial infection of unspecified site			
No	411 (54.2)	348 (45.8)	0.03*
Yes	2 (18.2)	9 (81.8)	
Pneumonia, unspecified organism			
No	411 (54.1)	349 (45.9)	0.05*
Yes	2 (20.0)	8 (80.0)	
Cystitis			
No	413 (54.3)	348 (45.7)	< 0.01*
Yes	0 (0.0)	9 (100.0)	
Other female pelvic inflammatory diseases			
No	412 (54.0)	351 (46.0)	0.05*
Yes	1 (14.3)	6 (85.7)	
Other disorders of bladder			
No	413 (54.1)	350 (45.9)	< 0.01*
Yes	0 (0.0)	7 (100.0)	
Amoebiasis			
No	413 (54.1)	350 (45.9)	< 0.01*
Yes	0 (0.0)	7 (100.0)	
Cellulitis			
No	413 (53.9)	353 (46.1)	0.05*
Yes	0 (0.0)	4 (100.0)	
Infections of genitourinary tract in pregnancy			
No	413 (53.9)	353 (46.1)	0.05*
Yes	0 (0.0)	4 (100.0)	
Chronic rhinitis, nasopharyngitis and pharyngitis			
No	413 (53.9)	353 (46.1)	0.05*
Yes	0 (0.0)	4 (100.0)	

p-values are from Pearson Chi-Square Test or Fisher's Exact Test (*)

Supplement 2: Study characteristics by receipt of antibiotic prescription (Continued)			
	Antibiotic prescription, n (%)		
Characteristic (N = 770)	**No**	**Yes**	***P* value**
Cutaneous abscess, furuncle and carbuncle			
No	413 (53.9)	353 (46.1)	0.05*
Yes	0 (0.0)	4 (100.0)	
Other gastroenteritis and colitis of infectious and unspecified origin			
No	412 (54.0)	351 (46.0)	0.05*
Yes	1 (14.3)	6 (85.7)	
Acute nasopharyngitis (common cold)			
No	404 (54.1)	343 (45.9)	0.16
Yes	9 (39.1)	14 (60.9)	
Conjunctivitis			
No	408 (54.0)	347 (46.0)	0.11
Yes	5 (33.3)	10 (66.7)	
Cough			
No	408 (54.1)	346 (45.9)	0.07
Yes	5 (31.3)	11 (68.8)	
Gingivitis and periodontal diseases			
No	412 (53.9)	353 (46.1)	0.19*
Yes	1 (20.0)	4 (80.0)	
Acute pharyngitis			
No	412 (53.9)	352 (46.1)	0.10*
Yes	1 (16.7)	5 (83.3)	
Bacterial pneumonia, not elsewhere classified			
No	412 (53.9)	352 (46.1)	0.10*
Yes	1 (16.7)	5 (83.3)	
Unspecified acute lower respiratory infection			
No	412 (53.9)	353 (46.1)	0.19*
Yes	1 (20.0)	4 (80.0)	
Other diseases of upper respiratory tract			
No	412 (53.9)	352 (46.1)	0.10*
Yes	1 (16.7)	5 (83.3)	

p-values are from Pearson Chi-Square Test or Fisher's Exact Test (*)

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Supplement 2: Study characteristics by receipt of antibiotic prescription (Continued)

Characteristic (N = 770)	Antibiotic prescription, n (%) No	Yes	*P* value
Otitis externa			
No	413 (53.8)	354 (46.2)	0.10*
Yes	0 (0.0)	3 (100.0)	
Single delivery by caesarean section			
No	413 (53.8)	354 (46.2)	0.10*
Yes	0 (0.0)	3 (100.0)	
Abdominal and pelvic pain			
No	413 (53.8)	355 (46.2)	0.22*
Yes	0 (0.0)	2 (100.0)	
Impetigo			
No	413 (53.8)	354 (46.2)	0.10*
Yes	0 (0.0)	3 (100.0)	
Osteomyelitis			
No	413 (53.8)	355 (46.2)	0.22*
Yes	0 (0.0)	2 (100.0)	
Non-suppurative otitis media			
No	413 (53.8)	355 (46.2)	0.22*
Yes	0 (0.0)	2 (100.0)	
Suppurative and unspecified otitis media			
No	413 (53.8)	355 (46.2)	0.22*
Yes	0 (0.0)	2 (100.0)	
Acute sinusitis			
No	413 (53.8)	355 (46.2)	0.22*
Yes	0 (0.0)	2 (100.0)	
Respiratory disorders in diseases classified elsewhere			
No	413 (53.8)	355 (46.2)	0.22*
Yes	0 (0.0)	2 (100.0)	
Dislocation of wrist			
No	413 (53.8)	355 (46.2)	0.22*
Yes	0 (0.0)	2 (100.0)	
Any Procedure/Surgery done			
No	403 (54.4)	338 (45.6)	**0.04**
Yes	10 (34.5)	19 (65.5)	

p-values are from Pearson Chi-Square Test or Fisher's Exact Test (*)

Supplement 2: Study characteristics by receipt of antibiotic prescription (Continued)

Characteristic	Antibiotic prescription, n (%) No	Yes	*P* value
Type of Procedure/Surgery (N = 29)			
Minor	4 (40.0)	6 (60.0)	0.71*
Major	0 (0.0)	7 (100.0)	
Specialized	6 (50.0)	6 (50.0)	
Prescriber Qualification (N = 770)			
Clinical Officer/ Dental Therapist	27 (21.3)	100 (78.7)	**< 0.01***
Assistant Medical Officer/Assistant Dental Officer	3 (20.0)	12 (80.0)	
Medical Officer/Dental Officer	136 (48.6)	144 (51.4)	
Specialist	200 (69.7)	87 (30.3)	
Super-specialist/Consultant	47 (77.0)	14 (23.0)	
Prescriber Qualification Grouped (N = 770)			
Low level (Clinical Officer/DT/AMO/ADO)	30 (21.1)	112 (78.9)	**< 0.01**
Mid-level (Medical/Dental Officer	136 (48.9)	144 (51.4)	
High level (Specialists/Consultants)	247 (71.0)	101 (29.0)	
Polypharmacy of ≥ 5 Medications (N = 770)			
No	346 (52.6)	312 (47.4)	0.16
Yes	67 (59.8)	45 (40.2)	
Availability of all medications prescribed in 2017 TZ NEMLIT (N = 770)			
No	220 (72.6)	83 (27.4)	**< 0.01**
Yes	193 (41.3)	274 (58.7)	
All medications prescribed using their generic names (N = 770)			
No	171 (48.9)	179 (51.1)	**0.02**
Yes	242 (57.6)	178 (42.4)	
Was malaria treatment prescribed (N = 770)			
No	407 (54.2)	344 (45.8)	0.05
Yes	6 (31.6)	13 (68.4)	
Presence of injectable formulation in the prescription (N = 770)			
No	388 (55.0)	317 (45.0)	**0.01**
Yes	25 (38.5)	40 (61.5)	

p-values are from Pearson Chi-Square Test or Fisher's Exact Test (*); DT, Dental Therapist; AMO, Assistant Medical Officer; ADO, Assistant Dental Officer

1

Supplement 3: Binary Logistic Regression analysis of predictors of receipt of antibiotic prescription

Variable (N = 770)	Univariate Regression cOR* (95% CI)	*P* value	Multivariate Regression aOR** (95% CI)	*P* value
Age in years				
Elderly (≥ 60 years)	1 [Ref.]		1 [Ref.]	
Children (< 18 years)	6.3 (3.9-10.1)	< 0.01	2.9 (1.6-5.2)	< 0.01
Adults (18-59 years)	2.8 (1.8-4.2)	< 0.01	1.7 (1.0-2.8)	0.06
Level of health facility				
Referral Hospital/Clinic L4 by SS	1 [Ref.]		1 [Ref.]	
Dispensary	7.6 (4.6-12.8)	< 0.01	1.4 (0.5-3.8)	0.56
Health Centre/Stand-alone clinic by ADO	4.0 (2.5-6.2)	< 0.01	3.2 (1.5-6.5)	< 0.01
District Hospital/Clinic L1 by MO/DO	5.9 (3.5-9.7)	< 0.01	2.7 (1.3-5.8)	0.01
Regional Hospital/Clinic L2 by Specialist	1.1 (0.7-1.7)	0.87	1.1 (0.6-2.2)	0.70
Ownership of health facility				
Public	1 [Ref.]		1 [Ref.]	
Private/Non-governmental	1.9 (1.4-2.5)	< 0.01	0.5 (0.3-0.9)	0.01
Department visited				
Outpatient	1 [Ref.]		1 [Ref.]	
Inpatient	2.8 (1.0-8.1)	0.05	2.9 (0.8-11.1)	0.12
Any Procedure/Surgery done				
No	1 [Ref.]		1 [Reference]	
Yes	2.3 (1.0-4.9)	0.04	3.9 (1.4-10.9)	0.01
Prescriber Qualification				
Super-specialist/Consultant	1 [Ref.]		1 [Ref.]	
Clinical Officer/Dental Therapist	12.4 (6.0-25.9)	< 0.01	6.2 (2.0-19.8)	< 0.01
Assistant Medical/Dental Officer	13.4 (3.3-54.4)	< 0.01	4.3 (0.8-24.3)	0.09
Medical/Dental Officer	3.6 (1.9-6.7)	< 0.01	2.2 (0.9-5.3)	0.07
Specialist	1.5 (0.8-2.8)	0.25	1.4 (0.6-3.1)	0.45
All medications prescribed using their generic names				
Yes	1 [Ref.]		1 [Ref.]	
No	1.4 (1.1 - 1.9)	0.02	2.1 (1.4 - 3.2)	< 0.01
Was malaria treatment prescribed				
No	1 [Ref.]		1 [Ref.]	
Yes	2.6 (1.0-6.8)	0.06	1.3 (0.3-4.6)	0.73
Presence of injectable formulation in the prescription				
No	1 [Ref.]		1 [Ref.]	
Yes	2.0 (1.2-3.3)	0.01	2.1 (1.0-4.2)	0.04

*cOR, Crude Odds Ratio; **aOR, Adjusted Odds Ratio; CI, Confidence Interval, AMO, Assistant Medical Officer; ADO, Assistant Dental Officer; MO, Medical Officer; SS, Super-specialist

Supplement 3: Binary Logistic Regression analysis of predictors of receipt of antibiotic prescription (Continued)

Variable (N = 770)	Univariate Regression cOR* (95% CI)	*P* value	Multivariate Regression aOR** (95% CI)	*P* value
Select Diagnostic Codes				
Other disorders of urinary system - N39				
No	1 [Ref.]		1 [Ref.]	
Yes	22.5 (9.7-52.2)	< 0.01	26.8 (10.7-67.3)	**< 0.01**
Acute and URTI of multiple and unspecified sites - J06				
No	1 [Ref.]		1 [Ref.]	
Yes	5.1 (2.7-9.6)	< 0.01	3.1 (1.5-6.7)	**< 0.01**
Other sepsis - A41				
No	1 [Ref.]		1 [Reference]	
Yes	5.7 (1.9-17.1)	< 0.01	7.1 (2.0-25.0)	**< 0.01**
Acute tonsillitis - J03				
No	1 [Ref.]		1 [Ref.]	
Yes	28.4 (3.8-211.2)	< 0.01	46.1 (5.8-364.4)	< 0.01
Candidiasis - B37				
No	1 [Ref.]		1 [Ref.]	
Yes	7.1 (1.6-32.2)	0.01	6.0 (1.1-32.0)	0.04
Bacterial infection of unspecified site - A49				
No	1 [Ref.]		1 [Ref.]	
Yes	5.3 (1.1-24.8)	0.03	6.1 (1.2-30.8)	0.03
Pneumonia, unspecified organism - J18				
No	1 [Ref.]		1 [Ref.]	
Yes	4.7 (1.0-22.3)	0.05	6.1 (1.1-32.7)	0.04
Other female pelvic inflammatory diseases - N73				
No	1 [Ref.]		1 [Ref.]	
Yes	7.0 (0.8-58.8)	0.07	16.3 (1.6-167.2)	0.02
Other gastroenteritis and colitis of infectious and unspecified origin - A09				
No	1 [Ref.]		1 [Ref.]	
Yes	7.0 (0.8-58.8)	0.07	7.7 (0.6-99.3)	0.12
Gingivitis and periodontal disease - K05				
No	1 [Ref.]		1 [Ref.]	
Yes	4.7 (0.5-42.0)	0.17	5.6 (0.5-61.3)	0.16
Cough - R05				
No	1 [Ref.]		1 [Ref.]	
Yes	2.6 (0.9-7.5)	0.08	0.8 (0.2-3.4)	0.79

*cOR, Crude Odds Ratio; **aOR, Adjusted Odds Ratio; CI, Confidence Interval

3

Supplement 3: Binary Logistic Regression analysis of predictors of receipt of antibiotic prescription (Continued)

Variable (N = 770)	Univariate Regression cOR* (95% CI)	*P* value	Multivariate Regression aOR** (95% CI)	*P* value
Conjunctivitis - H10				
No	1 [Ref.]		1 [Ref.]	
Yes	2.4 (0.8-6.9)	0.12	6.4 (1.7-24.1)	0.01
Amoebiasis - A06				
No	1 [Ref.]		1 [Ref.]	
Yes	1906260340	1.00	Not entered	NA
Otitis Externa – H60				
No	1 [Ref.]		1 [Ref.]	
Yes	1884720675	1.00	Not entered	NA
Acute nasopharyngitis (common cold) - J00				
No	1 [Ref.]		1 [Ref.]	
Yes	1.8 (0.8-4.3)	0.16	0.7 (0.2-2.1)	0.49
Acute pharyngitis – J02				
No	1 [Ref.]		1 [Ref.]	
Yes	5.9 (0.7-50.3)	0.11	12.1 (1.2-124.7)	0.04
Bacterial pneumonia not elsewhere classified - J15				
No	1 [Ref.]		1 [Ref.]	
Yes	5.9 (0.7-50.3)	0.11	5.8 (0.4-90.2)	0.21
Unspecified acute lower respiratory infection - J22				
No	1 [Ref.]		1 [Ref.]	
Yes	4.7 (0.5-42.0)	0.17	2.9 (0.2-39.7)	0.43
Chronic rhinitis, nasopharyngitis and pharyngitis - J31				
No	1 [Ref.]		1 [Ref.]	
Yes	1890059827	0.99	Not entered	NA
Other diseases of upper respiratory tract - J39				
No	1 [Ref.]		1 [Ref.]	
Yes	5.9 (0.7-50.3)	0.11	4.9 (0.5-51.7)	0.19
Disease of the pulp and periapical tissues - K04				
No	1 [Ref.]		1 [Ref.]	
Yes	1922740977	0.99	Not entered	NA
Impetigo - L01				
No	1 [Ref.]		1 [Ref.]	
Yes	1884720675	0.99	Not entered	NA

*cOR, Crude Odds Ratio; **aOR, Adjusted Odds Ratio; CI, Confidence Interval

Supplement 3: Binary Logistic Regression analysis of predictors of receipt of antibiotic prescription (Continued)

Variable (N = 770)	Univariate Regression cOR* (95% CI)	*P* value	Multivariate Regression aOR** (95% CI)	*P* value
Cutaneous abscess, furuncle and carbuncle - L02				
No	1 [Ref.]		1 [Ref.]	
Yes	1890059827	0.99	Not entered	NA
Cellulitis - L03				
No	1 [Ref.]		1 [Ref.]	
Yes	1890059827	0.99	Not entered	NA
Cystitis - N30				
No	1 [Ref.]		1 [Ref.]	
Yes	1917215861	0.99	Not entered	NA
Other disorders of bladder - N32				
No	1 [Ref.]		1 [Ref.]	
Yes	1906260340	0.99	Not entered	NA
Infections of genitourinary tract in pregnancy - O23				
No	1 [Ref.]		1 [Ref.]	
Yes	1890059827	0.99	Not entered	NA
Single delivery by caesarean section - O82				
No	1 [Ref.]		1 [Ref.]	
Yes	1884720675	0.99	Not entered	NA

*cOR, Crude Odds Ratio; **aOR, Adjusted Odds Ratio; CI, Confidence Interval

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4, 5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	5
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9, 10, 11
		(*b*) Report category boundaries when continuous variables were categorized	7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12,13,14,15
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	2

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Factors Influencing Receipt of an Antibiotic Prescription Among Insured Patients in Tanzania: A Cross-sectional Study

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Key words: Antibiotic prescription, Factors influencing, Antimicrobial Stewardship Programs, Insured patients, Tanzania

Abbreviated running title: Correlates of antibiotic prescription

Word count: 3770

Strengths and Limitations of this study

- To our knowledge, this is the first study in Tanzania to address predictors of receipt of an antibiotic prescription among insured patients.
- Insured patients being an increasing patient population in recent times and its anticipated risk of polypharmacy, studying antibiotic utilization in this group is important.
- Being a cross-sectional design, our study, does not account for seasonal variations in antibiotic use, it lacks robustness in establishing causality, and is less generalizable.
- Our data does not account for rejected claim forms, thereby making the results less generalizable.
- We did not adjust for specific confounders, all variables with $p < 0.2$ were entered in the multivariable regression to model the receipt of an antibiotic prescription. We, therefore interpret our findings with caution.

ABSTRACT

Objectives: There is limited data on factors influencing antibiotic prescription among insured patients. We assessed for correlates of an antibiotic prescription among insured patients.

Design: A cross-sectional study

Setting: The study was conducted at the National Health Insurance Fund offices, Dar es Salaam, Tanzania

Data source: We captured data from the claim forms**,** containing inpatient and outpatient treatment information for insured patients, for the month of September 2019.

Outcome variable: Receipt of an antibiotic prescription

Exposure variables: Age, sex, diagnosis, prescriber qualification, and health facility level, ownership, and department were exposure variables. Predictors of receipt of an antibiotic prescription were determined by Poisson regression analysis.

Results: Of 993 analyzed patients the mean [±SD] age was 36.3 [±23.2] years, 581 [58.5%] were females, and 535 [53.9%] were adults. The prevalence of antibiotic prescription was 46.4% (95% CI, 42.8 - 50.0). Strong predictors of an antibiotic prescription were; being a child 1.7 (95% CI, 1.3 - 2.2), acute upper respiratory tract infection (URTI) of multiple and unspecified site 1.6 (95% CI, 1.3 - 1.4), chronic rhinitis, nasopharyngitis, and pharyngitis 4.0 (95% CI, 2.4 - 6.4); being attended by a clinical officer 1.9 (95% CI, 1.2 - 3.0); attending a health center 1.5 (95% CI, 1.1 - 2.0); attending a public facility 1.2 (95% CI, 1.0 - 1.4), and visiting an inpatient department 2.0 (95% CI, 2.0 (1.2 – 3.4).

Conclusions: Among insured patients, being a child, acute URTI, being attended by a clinical officer or dental therapist, being attended by assistant medical/dental officer, attending a health center or a district hospital, attending a public health facility and visiting an inpatient department predicted an antibiotic prescription. Incorporation of these findings in revisions or establishment of targeted antimicrobial stewardship programs may lead to better antibiotic prescribing practices that are critical for combating antibiotic resistance.

INTRODUCTION

Curtailing antibiotics consumption is important to global health. Antibiotics use and misuse may predispose to development of resistant bacteria. [1–4] Furthermore, it is estimated that half of the prescribed antimicrobials are inappropriate. [5] We should strive to preserve antibiotics at all costs by providing a balance between access and excess as both have detrimental consequences. Delayed access may promote mortality from bacterial infections whilst excessive use increases selection pressure thereby favoring the development of resistant strains. [6] Increased antibiotic exposure in healthcare settings is among the key modifiable drivers of antibiotic resistance. [7,8]

Emergence and spread of antibiotic resistant bacteria far outweigh the speed with which newer antibiotics receives market approval. [9] Humans, animals, as well as the surroundings face the catastrophic consequences of antibiotics resistance. [10,11] The consequences of which are associated with higher morbidity, longer duration of hospital stay, higher mortality rates and increased healthcare cost [12,13]. These consequences are more pronounced in Low- and Middle-Income Countries (LMICs) due to burden of infections, limited resources, poor health system, and weak regulatory enforcement to oversee antibiotics quality assurance, prescriptions and dispensing outlets. [5]

In Tanzania, resistance to commonly prescribed antibiotics was demonstrated in up to 60% of β-lactamase bacterial isolates from inpatients and outpatients attending a tertiary healthcare facility. [14] In another study, 43.3% of staphylococcus aureus nasal isolates, from inpatients, which are resistant to

methicillin were also resistant to, second generation cephalosporin, cefoxitin. [15] Some studies in children found bacterial pathogens resistant to multiple antibiotics. [16,17] Therefore, the need of curbing antibiotic prescriptions so as to contribute in the fight against antibiotic resistance is warranted.

It has been argued that, the more we procrastinate on taking urgent action to protect the current antibiotics we have, the more difficult and expensive it will be to tackle antibiotic resistance in the future. [18] To combat the problem of increased use of antibiotics and its consequence, building capacity in areas of Antimicrobial Stewardship Programs (ASPs) and infection control is important. [19–21] Globally, ASPs in hospitals has shown promise in reducing irrational antibiotic prescriptions. However, implementation challenges and heterogeneity in structures for antimicrobial stewardship in LMICs, emphasize the need for tailored stewardship programs. [22,23]

It is known that factors from health care providers, patients, and the health system may influence the antibiotic prescription rate. Moreover, there is limited data regarding local factors influencing receipt of an antibiotic prescription among insured patients in Tanzania. This poses a key barrier in developing and implementing targeted antimicrobial stewardship programs. We conducted a study to identify factors that influence receipt of an antibiotic prescription among insured patients. Antimicrobial stewardship programs in LMICs are often not comprehensively implemented and this may be partly because of lack of resources and awareness of local important factors that influence antibiotic prescription. [24,25]

MATERIALS AND METHODS

We did a cross sectional study of antibiotics prescription to patients insured by the National Health Insurance Fund (NHIF) involving claim forms submitted to the fund by health facilities in Dar es Salaam City Council (formerly Ilala municipal council) in Dar es Salaam. We chose insured patients because of having a high antibiotic prescription prevalence. [26] Moreover, there is limited data on factors influencing receipt of an antibiotic prescription among this group. Part of the methodology have previously been published. [27] Briefly, data collection from the claim forms was accomplished using a specially designed

form. All forms submitted for claims, containing inpatient and outpatient patient information, in the period of one month of September 2019, were included in the study. Each claim form submitted to the insurance fund represented a request for payment or reimbursement for a single patient visit after receiving a service by a provider. A decade average of reimbursement rate is about 98.0%. [28] Prescribers and designated healthcare workers at the respective health facility could access the claim forms and prepare them before submitting to the insurance fund. We accessed only the claim forms processed by the fund for paying the health care facilities for the services they have offered in the respective month of September. We could not access rejected claim forms, so they were not part of our sampling frame. We excluded forms for patients attended by physiotherapists or occupational therapists as they were not prescribers.

Claim forms for 378 patients was our initial sample size and was obtained by assuming 67.7% as prevalence of receiving an antibiotic prescription, [29] a margin of error of 5 % and a 10 % chance of incomplete forms. [30] However, in view of readily available patient claim forms, absence of additional risk to patients and affordability of data collection process, the planned sample size was increased to claim forms for 1100 patients. This was done in order to obtain precise estimates and to have enough data for sub-group analysis with adequate statistical power. Claim forms included in the study were selected randomly [31] from the eligible forms (2A & B) for the month of September 2019 submitted to NHIF headquarters.

The dependent variable was receipt of an antibiotic prescription. It was a no/yes dichotomous variable. A no/yes question was recorded whether the client received an antibiotic prescription during the health facility visit. Patient, prescriber, and health facility factors were selected on theoretical basis of similar studies. The independent variables were sociodemographic [(sex (male, female), age (child < 18 years, adult (18 years and above but < 60 years), elderly (≥ 60 years)], level of health facility (dispensary, health center, district hospital, regional referral hospital, national referral hospital), ownership of health facility (public vs private), final International Classification of Diseases, Tenth Revision (ICD-10) diagnosis code, department visited (inpatient vs outpatient), surgical procedure, polypharmacy (optimal number of drugs per encounter ≤ 3), generic name prescribing (optimal 100%), safe injection prescribing

(encounter with an injection prescribed, optimal ≤ 10%), Essential Drug List prescribing (optimal 100%), and prescriber qualification such as clinical officer or dental therapist, assistant medical/dental officer, medical/dental officer, specialist, consultant. The patient, prescriber, and health facility factors that may influence receipt of an antibiotic prescription were derived from the NHIF claim forms 2A & B and were selected on theoretical basis of similar studies.

There were no missing data in our study as our data source was the patient claim forms submitted to the insurance fund for payment claims by health facilities. Health facilities ensure the completeness of the claim forms so as to avoid any delay in the payment process. We used IBM SPSS Statistics Software Version 23 to analyze our data. Descriptive statistics summarized categorical variables whereas numerical data was summarized by using mean and median. Chi-square test determined the associations between dependent variable (receipt of an antibiotic prescription) and independent variables (factors that influence receipt of an antibiotic prescription) and Fishers Exact test was used when cell count is less than five. To identify predictors of receipt of an antibiotic prescription, we performed a poison regression with robust variance analysis. To control for confounding. first univariable analysis was done and then factors with a p-value cut off point < 0.2 were entered into the multivariable model. We did not adjust for specific confounders.

Patient and Public Involvement

It was not possible to involve patients and the public in the design, conduct, and reporting of the study however, dissemination plans of the findings to relevant authorities exists.

RESULTS

Patient characteristics

Sociodemographic characteristics of patients of this study has been published elsewhere. [27] In summary, out of 993 patients who met the analysis criteria, most were adults (n = 535, 54%) and of female sex (n = 581, 59%). The average age (± Standard Deviation - SD) was 36.3 (± 23.2) years. Most patients visited the

outpatient department (n = 975, 98%) and private health care facilities (n = 525, 53%). Majority of patients (n = 548, 55.2%) attended a national referral hospital facility and most (n = 437, 44.0%) received a specialist consultation (Table 1). The complete list of patient characteristics is found in the supplement (Supplement 1). The outcome of interest, receipt of an antibiotic prescription, was found in (n = 357, 46.4%) of patients.

Table 1. Socio-demographic and other patient characteristics

Characteristic (N = 993)	n (%)
Age in years	
Mean (SD) = 36.3 (23.2), Median = 37.0	
Children (< 18 years)	264 (26.6)
Adults (18-59 years)	535 (53.9)
Elderly (≥ 60 years)	194 (19.5)
Sex	
Male	412 (41.5)
Female	581 (58.5)
Level of health facility	
Dispensary	102 (10.3)
Health Centre	119 (12.0)
District Hospital	101 (10.2)
Regional Referral Hospital	123 (12.4)
National Referral Hospital	548 (55.2)
Ownership of health facility	
Public	468 (47.1)
Private	525 (52.9)
Department visited	
Outpatient	975 (98.2)
Inpatient	18 (1.8)
Any Procedure/Surgery done	
No	940 (94.7)
Yes	53 (5.3)
Prescriber Qualification	
Clinical Officer/Dental Therapist	132 (13.3)
Assistant Medical/Dental Officer	18 (1.8)
Medical/Dental Officer	320 (32.2)
Specialist	437 (44.0)
Consultant	86 (8.7)

Diagnoses were reported using ICD-10 diagnostic criteria. Among patients, other disorders of the urinary system (n = 102, 10.3%) was the most common. The other disorders of urinary system, ICD10-N39 diagnostic code, encompass diagnoses such as: Urinary Tract Infection (UTI), site not specified; persistent proteinuria, unspecified; stress incontinence; other specified urinary incontinence; other specified disorders of urinary system and disorders of urinary system, unspecified. The prevalence of acute and URTI of multiple and unspecified site was (n = 65, 6.5%) whereas that of acute tonsillitis was (n =24, 2.4%). A complete list of prevalence of diagnoses among the study participants is found in supplement 1.

Patient characteristics by receipt of an antibiotic prescription

About two-thirds of children (65.4%) received an antibiotic prescription when compared with adults (45.2%) and the elderly (23.0%) (Figure 1). Over three-quarters of patients (77.0%) who attended lower-level health facilities such as dispensaries received an antibiotic prescription compared to those who attended health facilities at the level of a national referral hospital (30.5%) (Figure 2). A higher proportion (80.0%) of patients who were attended by either assistant medical or dental officers received an antibiotic prescription when compared with medical or dental officers (51.4%), specialists (30.3%), and consultant (23.0%) (Figure 3).

More than two-third of patients (70.6%), who visited the inpatient department, received an antibiotic prescription compared to those who visited the outpatient department (45.8%). Most patients with acute tonsillitis (95.8%) and those of other disorders of urinary system (93.7%) were prescribed an antibiotic. A complete list of distribution of study characteristics by receipt of an antibiotic prescription is presented in Supplement 2.

Factors associated with receipt of an antibiotic prescription

Evidence of an association between the following factors and receipt of an antibiotic prescription were observed. The prevalence of receipt of an antibiotic prescription were highest among patients with chronic rhinitis, nasopharyngitis, and pharyngitis and was about four times compared to those who have no such a diagnosis**.** This was followed by a diagnosis of other disorders of the bladder in which the prevalence of

receipt of an antibiotic prescription was about 3.5 times compared to those without such a diagnosis (aPR = 3.5, 95% CI; 2.5-4.8), $p < 0.001$. Moreover, having a diagnosis of acute and URTI of multiple and unspecified site was associated with receipt of an antibiotic prescription at a prevalence of about 1.6 times than those who were not (aPR = 1.6, 95% CI; 1.3-1.4), $p < 0.001$.

The prevalence of receipt of an antibiotic prescription was about 1.7 times in children compared to that with the elderly. Attending a Health Center was associated with about 1.5 times the prevalence of receipt of an antibiotic prescription compared to those who attended the national referral hospital (aPR = 1.5, 95% CI; 1.1 - 2.0), $p < 0.009$. Similarly, attending a district hospital predicted receipt of an antibiotic prescription (aPR = 1.5, 95% CI; 1.1 - 1.9), $p < 0.004$ when compared to those who attended the national referral hospital. Furthermore, the prevalence of receipt of an antibiotic prescription was about 1.9 times higher in patients attended by a clinical officer or a dental therapist compared to those attended by a consultant. In addition, being attended by an assistant medical or dental officer was associated with an antibiotic prevalence of about two times that those being attended by a consultant (Table 2). Patients with non-ideal generic prescriptions had an antibiotic prescription prevalence of 1.3 times that of patients with ideal generic prescriptions (aPR = 1.3, 95% CI; 1.1 - 1.5), $p < 0.002$.

Moreover, patients who attended a public hospital had an antibiotic prescription prevalence of about 1.2 times compared to those who attended a private hospital whereas attending an inpatient department predicted receipt of an antibiotic prescription compared to attending an outpatient department (aPR = 2.0, 95% CI; 1.2 - 3.4), $p < 0.01$. Similar prevalence of receipt of an antibiotic prescription were seen in patients having diagnoses of candidiasis, and acute and URTI of multiple and unspecified site. The complete list of variables subjected to univariate and multivariate analysis is found in Supplement 3.

206 **Table 2: Poisson regression analysis of factors influencing receipt of an antibiotic prescription**

Characteristic (N = 770)	Univariate Regression		Multivariate Regression	
	cPR* (95% CI)	P value	aPR** (95% CI)	P value
Age in years				
Children (< 18 years)	2.8 (2.1 – 3.9)	< 0.001	1.7 (1.3 – 2.2)	< 0.001
Adults (18-59 years)	2.0 (1.4 - 2.7)	< 0.001	1.5 (1.1 - 1.9)	0.004
Elderly (≥ 60 years)	1 [Ref.]		1 [Ref.]	
Any medical procedure/surgery done				
Yes	1.4 (1.1 – 1.9)	0.01	1.3 (0.8 – 2.0)	0.34
No	1 [Ref.]		1 [Ref.]	
Chronic rhinitis, nasopharyngitis and pharyngitis - J31				
Yes	2.2 (2.0 – 2.3)	< 0.001	4.0 (2.4 – 6.4)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Other disorders of bladder - N32				
Yes	2.2 (2.0 – 2.3)	< 0.001	3.5 (2.5 – 4.8)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Disease of the pulp and periapical tissues - K04				
Yes	2.2 (2.0 – 2.4)	< 0.001	3.4 (2.3 – 4.8)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Infections of genitourinary tract in pregnancy - O23				
Yes	2.2 (2.0 – 2.3)	< 0.001	2.9 (2.1 – 4.0)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Cutaneous abscess, furuncle and carbuncle - L02				
Yes	2.2 (2.0 – 2.3)	< 0.001	3.0 (1.9 – 4.9)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Acute pharyngitis – J02				
Yes	1.8 (1.3 – 2.6)	0.002	2.7 (1.1 – 6.3)	0.03
No	1 [Ref.]		1 [Ref.]	
Acute tonsillitis - J03				
Yes	2.1 (1.9 – 2.4)	< 0.001	2.3 (1.8 – 3.0)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Acute and URTI of multiple and unspecified sites - J06				
Yes	1.8 (1.6-2.1)	< 0.001	1.6 (1.3 – 1.9)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Candidiasis - B37				
Yes	1.9 (1.5 – 2.4)	< 0.001	1.6 (1.2 – 2.1)	0.002
No	1 [Ref.]		1 [Ref.]	

*cPR, Crude Prevalence Ratio; **aPR, Adjusted Prevalence Ratio; CI, Confidence Interval, Ref. Reference category

Table 2: Poisson Regression analysis of factors influencing receipt of an antibiotic prescription *(continued...)*

Characteristic (n = 770)	Univariate Regression		Multivariate Regression	
	cPR* (95% CI)	P value	aPR** (95% CI)	P value
Prescriber Qualification				
Clinical Officer/Dental Therapist	3.4 (2.1-5.5)	< 0.001	1.9 (1.2-3.0)	0.005
Assistant Medical/Dental Officer	3.5 (2.1-5.9)	< 0.001	2.0 (1.1-3.4)	0.02
Medical/Dental Officer	2.2 (1.4-3.6)	0.001	1.6 (1.1-2.5)	0.03
Specialist	1.3 (0.8-2.1)	0.27	1.3 (0.8-1.9)	0.25
Consultant	1 [Ref.]		1 [Ref.]	
All medications prescribed using their generic names				
No	1.2 (1.0-1.4)	0.02	1.3 (1.1-1.5)	0.002
Yes	1 [Ref.]		1 [Ref.]	
Presence of injectable formulation in the prescription				
Yes	1.4 (1.1-1.7)	0.003	1.4 (1.1-1.8)	0.004
No	1 [Ref.]		1 [Ref.]	
Level of health facility				
Dispensary	2.5 (2.1-3.0)	< 0.001	1.3 (0.9-1.8)	0.14
Health Centre	2.1 (1.7-2.6)	< 0.001	1.5 (1.1-2.0)	0.009
District Hospital	2.4 (1.9-2.9)	< 0.001	1.5 (1.1-1.9)	0.004
Regional Referral Hospital	1.1 (0.8-1.4)	0.77	1.0 (0.7-1.4)	0.97
National Referral Hospital	1 [Ref.]		1 [Ref.]	
Ownership of health facility				
Public	0.7 (0.6-0.8)	< 0.001	1.2 (1.0-1.4)	0.03
Private	1 [Ref.]		1 [Ref.]	
Department visited				
Inpatient	1.5 (1.1-2.1)	0.007	2.0 (1.2-3.4)	0.01
Outpatient	1 [Ref.]		1 [Ref.]	

*cPR, Crude Prevalence Ratio; **aOR, Adjusted Prevalence Ratio; CI, Confidence Interval; Ref., Reference category.

DISCUSSION

We conducted a cross-sectional study among insured patients to determine factors influencing receipt of an antibiotic prescription. We assessed factors related to patient, prescriber, and the health facility. Factors, related to patient, with strong evidence of association with receipt of an antibiotic prescription included being a child and having a diagnosis of URTI. Prescriber-related factors influencing receipt of antibiotic prescription were being attended by a clinical officer or dental therapist and assistant medical/dental officer. Furthermore, absence of ideal generic prescribing and presence of injectable formulation in the prescription, both independently predicted receipt of an antibiotic prescription. Factors related to the health facility that

were associated with receipt of an antibiotic prescription included attending either a health center or a district hospital, attending a public health facility, and visiting an inpatient department.

Antimicrobial stewardship is the most promising strategy to stop misuse and excessive use of antibiotics. However, implementation of such programs is challenging and thus, research looking into ways of strengthening antibiotic stewardship programs is critical for ensuring optimal clinical outcomes, minimal unintended consequences of antibiotics use, improved susceptibility rates to targeted antibiotics, optimal resource utilization and hence, control of bacterial infections. The thrust of our study was to define factors that are strong predictors of an antibiotic prescription so that ASPs may see where to put emphasis.

We have identified diagnosis of URTI, both acute and chronic, as the strong predictors of an antibiotic prescription in our study population. This means that the microbiology laboratory aspect of antimicrobial stewardship such as provision of culture and sensitivity results on a regular basis or preparation of annual antibiotic susceptibility pattern needs to be established and strengthened. There are criteria, WHO or IMCI for prescribing an antibiotic for URTI. However, when clinicians are unwilling to go through the procedures or when procedures are not available, prescription of an antibiotic will be the easy way out and without taking risk for possibility of untreated or delayed treatment of a bacterial infection. Although most URTIs have a viral etiology and have a self-limiting course, antibiotics are commonly prescribed. [32] This observation is in line with other previous published literature that have demonstrated this association. [33–36] The patient and the public should be informed that most of the acute URTIs are viral in origin and they require supportive therapy and not antibiotics. This will decrease patient antibiotic expectation. Although some studies shows no evidence, [37] facility-specific guidelines and algorithms, adapted from national standard treatment guideline, should be established with respect to properly diagnosing and treating URTIs. [38–40]

Our data shows that the prevalence of receipt of an antibiotic prescription was high among children and with a decreasing trend towards the elderly. URTIs and non-bloody diarrhea being prevalent in children and mostly treated with antibiotics despite being viral in origin and contrary to treatment guidelines may

explain this finding. [41,42] This observation is comparable to other published results. [26,33,43–45] Moreover, immune senescence in the elderly causes atypical presentations of infectious disease symptoms such as fever and cough whereas in children they are more pronounced. [46] ASPs should be strengthened in pediatrics so as to decrease antibiotic prescriptions as there is strong evidence supporting that such an approach. [47,48] Despite the challenges of implementing ASPs in pediatrics, clinical education, care-giver education, updated facility-specific guidelines and prospective audit and feedback, are stewardship interventions shown to decrease antibiotics utilization. [49–51]

Being attended by a clinical officer or dental therapist is another factor which appears to influence prescription of an antibiotic. The prevalence of receipt of an antibiotic prescription was about 1.7 times in patients who were attended by either a clinical officer or dental therapists when compared to those seen by consultants. Similarly, the prevalence of antibiotic prescription in patients attended by an assistant medical/dental officer was twice to that of patients seen by a consultant. Clinical officers, dental therapists, and assistant medical/dental officer being less experienced and less trained to prescribe probably explains this observation. Moreover, clinical officers, dental therapists, assistant medical/dental officers, usually work in primary healthcare facilities in which there is a high volume of patients and fewer resources which increases the likelihood of irrational medication prescriptions including antibiotics. [52] This antibiotic prescribing disparity between prescribers with different qualifications was also demonstrated in previous studies. [53] Another study in Hubei, China, similarly, found that prescribers with higher qualifications were less likely to prescribe antibiotics. [52] This finding emphasizes the need for antibiotic stewardship interventions to target clinical officers, dental therapists, assistant medical/dental officers through clinical education. Opportunities and protected time for clinicians to address knowledge gap through continuing medical education has been found to improve antibiotic utilization. [54–56] Therefore, it is important for hospital policies and administrators to provide clinicians with such opportunities.

Ideally, all medications in a prescription should be written in their generic names as per WHO/INRUD prescribing indicators. We observed strong evidence of an association between non-ideal

generic prescribing and receipt of an antibiotic prescription. This observation may be explained by the fact that both sub-optimal generic prescribing and over-prescribing antibiotics are indicators of poor prescribing practice. [33] In addition, presence of an injectable formulation in the prescription was associated with receipt of an antibiotic. The presence of an injectable formulation in the prescription may be indicative of the severity of the illness or infection and this may explain why the prevalence of receiving an antibiotic prescription is higher. It is essential that ASPs enables prescribers adhere to generic prescribing and other good prescribing practices.

Studies have shown that patient's likelihood of receipt of an antibiotic prescription is influenced by the type of health facility they have attended to. A study in Ghana showed that attending a Health Center or a clinic is associated with receipt of an antibiotic prescription. [33] Similarly, we have revealed that, there is strong evidence of an association between patient attending a health center and receiving an antibiotic prescription when compared to those attending a national referral hospital. This observation may be attributed to limited resources in terms of medications and diagnostic capabilities resulting in empiric prescribing of antibiotics. Indeed, targeting lower-level health facilities with antimicrobial stewardship interventions such clinical education, facility-specific guidelines for common infections, and antibiotic oversight through prospective audit and feedback may decrease antibiotic prescriptions. [48,50]

Surprisingly, our study showed that attending a public health facility was associated with a higher prevalence of receipt of an antibiotic prescription. This was a surprising finding as private health facilities are driven by profit, so we did expect them to prescribe more medications including antibiotics to patients when compared with public health facilities. We speculate that, insured patients are more likely to attend private health facilities where prescribers better adhere to insurance guidelines than those in public facilities. This was in line with a South African study by Mohlala and colleagues. [57] Similarly, an Australian study also showed a higher prevalence of antibiotic prescriptions for treatment and not for prophylaxis in public hospitals when compared with private hospitals. [58] This is a worrisome finding as, in general, majority of patients are likely to be seen in public health facilities thus antibiotic prescriptions

might be higher than what we have observed. Clinical education, facility-specific guidelines and antibiotic oversight should be established or strengthened in public health facilities.

Attending the inpatient department was also associated with a prevalence of receipt of an antibiotic prescription twice to that of patients who visited the outpatient department. This high antibiotic prevalence could be explained by the fact that inpatients tend to have a more severe illness when compared with those treated at the outpatient department. A similar observation of high antibiotic prescriptions among inpatients was found in a study by Bediako-Bowan et al. in Ghana. [59] Facility specific guidelines for inpatient management should be established or strengthened to minimize antibiotic prescriptions.

To our knowledge, this is the first study in Tanzania to address predictors of receipt of an antibiotic prescription among insured patients. Insured patients being an increasing patient population in recent times and its anticipated risk of polypharmacy, studying antibiotic utilization in this group is important. Our data does not account for rejected claim forms, thereby making the results less generalizable. Using patient claim forms submitted to the insurance fund as our data source ensured no missing data as incomplete forms are not processed for payment and usually returned to the healthcare provider. However, limitations of this study include inherent weakness of cross-sectional studies as they lack robustness in establishing causality, lack of generalizability of the study findings as our study population was only insured patients, and inability to account for seasonal variations in antibiotic use. Moreover, the overly large sample size used may cause small differences in observations to be statistically significant without any clinical significance. Furthermore, we did not adjust for specific confounders, all variables with $p < 0.2$ were entered in the multivariable regression to model the main effect. We, therefore interpret our findings with caution.

CONCLUSIONS

Factors influencing antibiotic prescription in Tanzania are similar to factors reported in literature. Being a child, having a diagnosis of URTIs, being attended by a clinical officer, dental therapist and assistant medical/dental officer, and attending a health center or district hospital, and attending a public health

facility, appear to be the most important factors that when targeted through antimicrobial stewardship activities may have an important impact on antibiotic misuse and excessive use.

Ethical approval: Ethical approval from the research and publication committee of MUHAS was sought and was granted (Ref. No. DA.287/298/01A). We requested further permission from the Director of National Health Insurance Fund (NHIF) to proceed with the study using NHIF database after informing him of the purpose of the study and possible benefits to NHIF as well as to the society at large. Utmost confidentiality was maintained as no personal identifiers were collected by our data capture tool.

Author contribution: MAK, PGS, and SFM conceptualized and designed the study, collected, analyzed and interpreted the data. MAK drafted the initial manuscript. MAK, PGS, and SFM critically revised the manuscript and approved the final version to be submitted.

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Figure 1. Receipt of an antibiotic prescription by age group

Figure 2. Receipt of an antibiotic prescription by the level of health facility

Figure 3. Receipt an antibiotic prescription by prescriber qualification

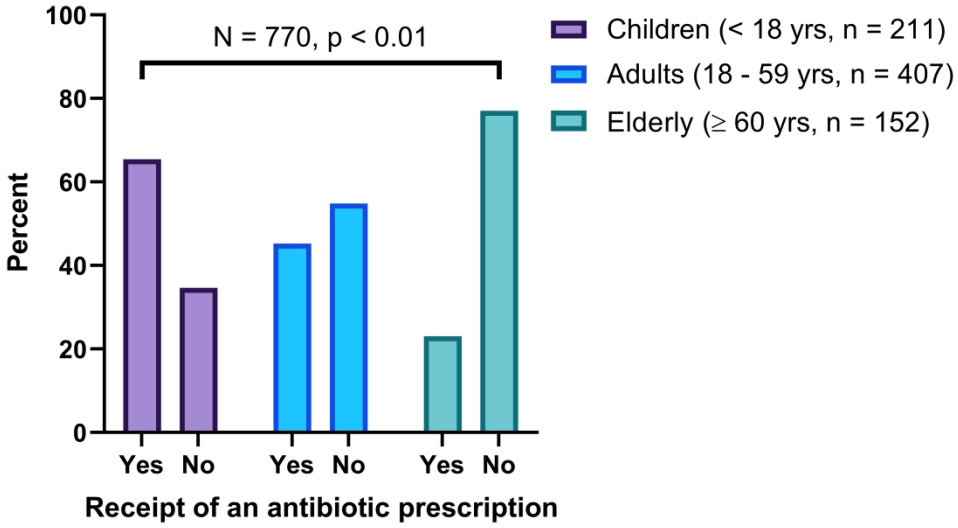

Figure 1. Receipt of an antibiotic prescription by age group

152x88mm (600 x 600 DPI)

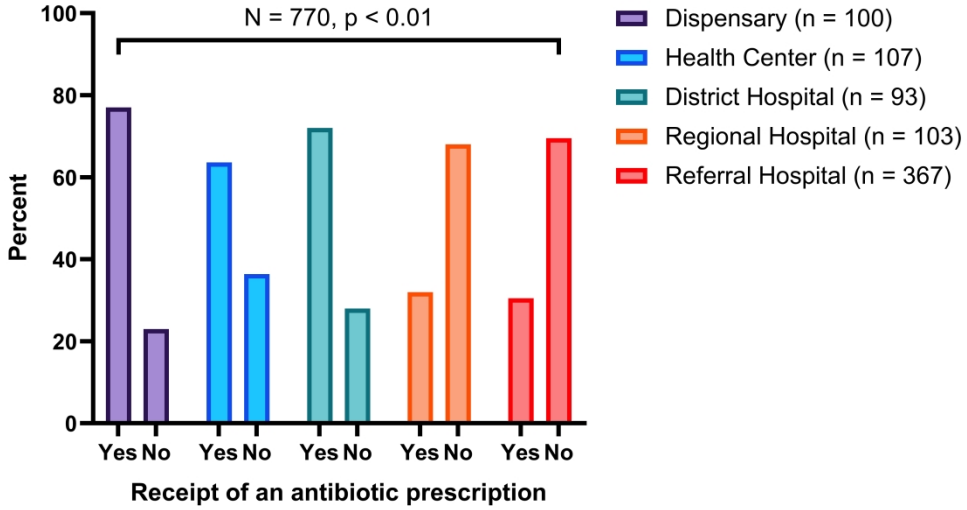

Figure 2. Receipt of an antibiotic prescription by the level of health facility

173x96mm (600 x 600 DPI)

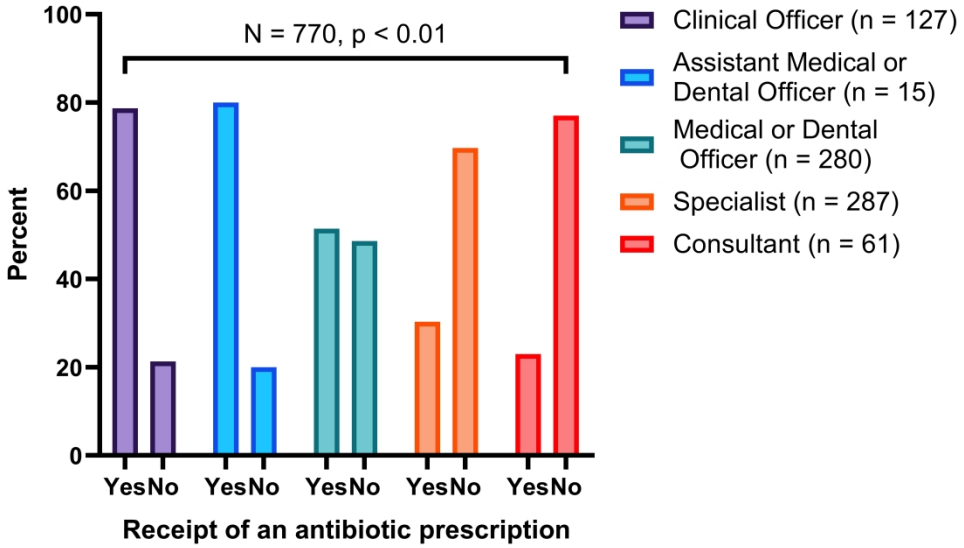

Figure 3. Receipt an antibiotic prescription by prescriber qualification

160x96mm (600 x 600 DPI)

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Supplement 1: Frequency distribution of all study variables

Characteristic	n (%)
Age in years (N = 993)	
Mean (SD) = 36.3 (23.2), Median = 37.0	
Children (< 18 years)	264 (26.6)
Adults (18-59 years)	535 (53.9)
Elderly (≥ 60 years)	194 (19.5)
Sex (N = 993)	
Male	412 (41.5)
Female	581 (58.5)
Level of health facility (N = 993)	
Dispensary	102 (10.3)
Health Centre/Stand-alone clinic by Assistant Dental Officer	119 (12.0)
District Hospital/Clinic Level1 by Medical/Dental Officer	101 (10.2)
Regional Hospital/Clinic Level 2 by specialist)	123 (12.4)
Referral/National/Zonal Hospital/Clinic Level 3 by super specialist	548 (55.2)
Ownership of health facility (N = 993)	
Public	468 (47.1)
Private/Nongovernmental	525 (52.9)
Department visited (N = 993)	
Outpatient	975 (98.2)
Inpatient	18 (1.8)
Diagnosis code (N = 993)	
Other disorders of urinary system	102 (10.3)
Essential (primary) hypertension	81 (8.2)
Acute and URTI of multiple and unspecified sites	65 (6.5)
Type 2 diabetes mellitus	51 (5.1)
Spondylosis	42 (4.2)
Hypertensive Heart Disease	42 (4.2)
Gastritis and duodenitis	39 (3.9)
Disorders of lipoprotein metabolism and other lipidemias	36 (3.6)
Pain, not elsewhere classified	33 (3.3)
Iron deficiency anaemia	31 (3.1)
Dermatophytosis	31 (3.1)
Vasomotor and allergic rhinitis	27 (2.7)
Atopic dermatitis	27 (2.7)
Other sepsis	25 (2.5)

Key; RefH, Referral Hospital, L1C, Level 1 Clinic; L2C, Level 2 Clinic

Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N = 993)	**n (%)**
Iron deficiency anaemia	31 (3.1)
Dermatophytosis	31 (3.1)
Vasomotor and allergic rhinitis	27 (2.7)
Atopic dermatitis	27 (2.7)
Other sepsis	25 (2.5)
Acute nasopharyngitis (common cold)	24 (2.4)
Acute tonsillitis	24 (2.4)
Asthma	23 (2.3)
Malaria, unspecified	23 (2.3)
PUD, site unspecified	22 (2.2)
Chronic kidney disease	18 (1.8)
Complications of analgesics, antipyretics and anti-inflammatory drugs	18 (1.8)
Plasmodium falciparum	16 (1.6)
Conjunctivitis	16 (1.6)
Diseases of pulp and periapical tissues	17 (1.7)
Cough	16 (1.6)
Hookworm disease	14 (1.4)
Candidiasis	14 (1.4)
Other vitamin deficiency	14 (1.4)
Chronic diseases of tonsils and adenoids	14 (1.4)
Other joint disorders, not elsewhere classified	14 (1.4)
Gonarthrosis (arthrosis of knee)	13 (1.3)
Supervision of normal pregnancy	13 (1.3)
Dental caries	13 (1.3)
Bacterial infection of unspecified site	11 (1.1)
Deficiency of other nutrient elements	11 (1.1)
Pneumonia, unspecified organism	11 (1.1)
Other deforming dorsopathies	11 (1.1)
Epilepsy	10 (1.0)
Cystitis	10 (1.0)
Chronic viral hepatitis	10 (1.0)
Acute bronchitis	10 (1.0)
Hyperplasia of prostate	10 (1.0)
Deficiency of other B group vitamins	9 (0.9)

Supplement 1: Frequency distribution of all study variables (Continued)	
Characteristic (N = 993)	**n (%)**
Disorders of refraction and accommodation	9 (0.9)
Other arthritis	8 (0.8)
Headache	9 (0.9)
Ascariasis	8 (0.8)
Other disorders of fluid, electrolyte and acid-base balance	8 (0.8)
Gingivitis and periodontal diseases	8 (0.8)
Gastro-oesophageal reflux disease	8 (0.8)
Gout	8 (0.8)
Other female pelvic inflammatory diseases	8 (0.8)
Other disorders of bladder	7 (0.7)
Amoebiasis	7 (0.7)
Other gastroenteritis and colitis of infectious and unspecified origin	7 (0.7)
Other anemias	7 (0.7)
Other hypothyroidism	7 (0.7)
Cardiomyopathy	7 (0.7)
Other functional intestinal disorders	7 (0.7)
Allergic contact dermatitis	7 (0.7)
Dorsalgia	6 (0.6)
Nerve root and plexus compressions in diseases classified elsewhere	6 (0.6)
Malaise and fatigue	6 (0.6)
Other helminthiasis	6 (0.6)
Other superficial mycoses	6 (0.6)
Type 1 diabetes mellitus	6 (0.6)
Other polyneuropathies	6 (0.6)
Heart failure	6 (0.6)
Acute pharyngitis	6 (0.6)
Bacterial pneumonia, not elsewhere classified	6 (0.6)
Unspecified acute lower respiratory infection	6 (0.6)
Other diseases of upper respiratory tract	6 (0.6)
Cellulitis	6 (0.6)
Other disorders of external ear	6 (0.6)
Unspecified intestinal parasitism	5 (0.5)
Malignant neoplasm of the breast	5 (0.5)
Leiomyoma of the uterus	5 (0.5)
Inflammatory polyneuropathy	5 (0.5)

Supplement 1: Frequency distribution of all study variables (continued)

Characteristic (N = 993)	n (%)
Glaucoma	5 (0.5)
Secondary hypertension	5 (0.5)
Other diseases of hard tissues of teeth	5 (0.5)
Irritable bowel syndrome	5 (0.5)
Arthrosis of first carpometacarpal joint	5 (0.5)
Other disorders of muscle	5 (0.5)
Excessive vomiting in pregnancy	5 (0.5)
Nausea and vomiting	5 (0.5)
Infections of genitourinary tract in pregnancy	4 (0.4)
Varicella (chickenpox)	4 (0.4)
Malignant neoplasm of the prostate	4 (0.4)
Sickle cell disorders	4 (0.4)
Coagulation defect, unspecified	4 (0.4)
Cervical disc disorders	4 (0.4)
Other retinal disorders	4 (0.4)
Otitis externa	4 (0.4)
Disorders of vestibular function	4 (0.4)
Chronic ischemic heart disease	4 (0.4)
Chronic rhinitis, nasopharyngitis and pharyngitis	4 (0.4)
Dental facial anomalies (including malocclusion)	4 (0.4)
Cutaneous abscess, furuncle and carbuncle	4 (0.4)
Other soft tissues disorders, not elsewhere classified	4 (0.4)
Single delivery by caesarean section	4 (0.4)
Congenital malformation of cardiac septa	4 (0.4)
Abdominal and pelvic pain	4 (0.4)
Open wound of the forearm	4 (0.4)
Fever of other and unknown origin	4 (0.4)
Fracture of lower leg, including ankle	4 (0.4)
Dislocation, sprain and strain of joints and ligaments of knee	4 (0.4)
Other intervertebral disc disorders	3 (0.3)
Coxarthrosis (arthrosis of hip)	3 (0.3)
Polyarthrosis	3 (0.3)
Acne	3 (0.3)
Urticaria	3 (0.3)
Other parasitologically confirmed malaria	3 (0.3)

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Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N = 993)	**n (%)**
Trichomoniasis	3 (0.3)
Other bacterial Intestinal Infections	3 (0.3)
Herpes Simplex Infection	3 (0.3)
HIV disease resulting in infectious and parasitic diseases	3 (0.3)
Maligant neoplasm of colon	3 (0.3)
Malignant neoplasm of cervix uteri	3 (0.3)
Haemangioma and lymphangioma, any site	3 (0.3)
Thyrotoxicosis	3 (0.3)
Vitamin D deficiency	3 (0.3)
Disorders of mineral metabolism	3 (0.3)
Hereditary and idiopathic neuropathy	3 (0.3)
Senile cataract	3 (0.3)
Duodenal ulcer	3 (0.3)
Impetigo	3 (0.3)
Other dermatitis	3 (0.3)
Internal derangement of knee	3 (0.3)
Osteomyelitis	3 (0.3)
Acute renal failure	3 (0.3)
Other general symptoms and signs	3 (0.3)
Other abnormal findings of blood chemistry	3 (0.3)
Presence of prosthetic heart valve	3 (0.3)
Fracture of femur	2 (0.2)
Other dorsopathies, not elsewhere classified	2 (0.2)
Other spondylopathies	2 (0.2)
Psoriasis	2 (0.2)
Seborrheic dermatitis	2 (0.2)
Diphyllobothriasis and sparganosis	2 (0.2)
Scabies	2 (0.2)
Streptococcal sepsis	2 (0.2)
Miliary tuberculosis	2 (0.2)
Typhoid and paratyphoid fevers	2 (0.2)
Unspecified HIV disease	2 (0.2)
Viral infection of unspecified site	2 (0.2)
Myasis	2 (0.2)

Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N = 993)	**n (%)**
Streptococcus and staphylococcus as the cause of diseases classified elsewhere	2 (0.2)
Other specified infectious agents as the cause of diseases classified elsewhere	2 (0.2)
Malignant neoplasm of esophagus	2 (0.2)
Malignant neoplasm of penis	2 (0.2)
Malignant neoplasm of thyroid gland	2 (0.2)
Benign lipomatous neoplasm	2 (0.2)
Benign neoplasm of thyroid gland	2 (0.2)
Vitamin B12 deficiency anemia	2 (0.2)
Other nutritional anemias	2 (0.2)
Purpura and other haemorrhagic conditions	2 (0.2)
Other disorders of white blood cells	2 (0.2)
Other specified diabetes mellitus	2 (0.2)
Unspecified diabetes mellitus	2 (0.2)
Hyperprolactinemia	2 (0.2)
Disorders of purine and pyrimidine metabolism	2 (0.2)
Schizophrenia	2 (0.2)
Migraine	2 (0.2)
Other headache syndromes	2 (0.2)
Disorders of autonomic nervous system	2 (0.2)
Other inflammation of the eyelid	2 (0.2)
Other disorders of conjunctiva	2 (0.2)
Nonsuppurative otitis media	2 (0.2)
Suppurative and unspecified otitis media	2 (0.2)
Other rheumatic heart disease	2 (0.2)
Pulmonary embolism	2 (0.2)
Acute and subacute infective endocarditis	2 (0.2)
Cerebral infarction	2 (0.2)
Stroke, not specified as hemorrhage or infarction	2 (0.2)
Other venous embolism and thrombosis	2 (0.2)
Hemorrhoids	2 (0.2)
Hypotension	2 (0.2)
Acute sinusitis	2 (0.2)
Pneumonia due to *H. influenza*	2 (0.2)
Acute bronchiolitis	2 (0.2)

Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N = 993)	**n (%)**
Chronic sinusitis	2 (0.2)
Nasal polyp	2 (0.2)
Respiratory disorders in diseases classified elsewhere	2 (0.2)
Gastric ulcer	2 (0.2)
Inguinal hernia	2 (0.2)
Umbilical hernia	2 (0.2)
Other diseases of the liver	2 (0.2)
Pruritus	2 (0.2)
Nephrotic syndrome	2 (0.2)
Calculus of kidney and ureter	2 (0.2)
Other disorders of kidney and ureter in diseases classified elsewhere	2 (0.2)
Urethral stricture	2 (0.2)
Excessive, frequent and irregular menstruation	2 (0.2)
Abnormal uterine and vaginal bleeding, unspecified	2 (0.2)
Female infertility	2 (0.2)
Threatened abortion	2 (0.2)
Perineal laceration during delivery	2 (0.2)
Single spontaneous delivery	2 (0.2)
Anaemia complicating pregnancy, childbirth and the purperium	2 (0.2)
Congenital malformation of the great arteries	2 (0.2)
Abnormalities of heart beat	2 (0.2)
Other symptoms and signs involving the digestive system and abdomen	2 (0.2)
Abnormal involuntary movements	2 (0.2)
Dislocation, sprain and strain of joints and ligaments of lumbar spine and pelvis	2 (0.2)
Fracture of shoulder and upper arm	2 (0.2)
Fracture of lower end of radius	2 (0.2)
Dislocation of wrist	2 (0.2)
Open wound of lower leg	2 (0.2)
Poisoning by local antifungal, anti-infective and anti-inflammatory drugs, not elsewhere classified	2 (0.2)
Allergy, unspecified	2 (0.2)
Supervision of high-risk pregnancy, unspecified	2 (0.2)
Health supervision and care of other healthy infant and child	2 (0.2)
Spastic quadriplegic cerebral palsy	1 (0.1)
Dengue fever (classical dengue)	1 (0.1)

Supplement 1: Frequency distribution of all study variables (continued)

Characteristic (N = 993)	n (%)
Open wound of abdomen, lower back and pelvis	1 (0.1)
Sensorineural hearing loss, bilateral	1 (0.1)
Antenatal screening	1 (0.1)
Pregnancy confirmed	1 (0.1)
Contact with and exposure to communicable diseases	1 (0.1)
Routine general health check-up of defined subpopulation	1 (0.1)
Other medical procedures as the cause of abnormal reaction of the patient, or of later complication, without mention of misadventure at the time of the procedure	1 (0.1)
Hanging, strangulation and suffocation, undetermined intent	1 (0.1)
Intentional self-harm by jumping from a high place	1 (0.1)
Exposure to discharge of firework	1 (0.1)
Poisoning by antihyperlipidaemic and antiarteriosclerotic drugs	1 (0.1)
Poisoning by hormones and their synthetic substitutes and antagonists, not elsewhere classified	1 (0.1)
Poisoning by antiviral drug	1 (0.1)
Poisoning by antifungals and antibiotics, systemically used	1 (0.1)
Corrosions classified according to extent of body surface involved	1 (0.1)
Burns classified according to extent of body surface involved	1 (0.1)
Burn of first degree of wrist and hand	1 (0.1)
Injury of unspecified muscle and tendon of lower limb, level unspecified	1 (0.1)
Fracture of other toe	1 (0.1)
Open wound of other parts of foot	1 (0.1)
Superficial injury of hip and thigh, unspecified	1 (0.1)
Other and unspecified injuries of wrist and hand	1 (0.1)
Sprain and strain of wrist	1 (0.1)
Superficial injury of wrist and hand	1 (0.1)
Injury of muscle(s) and tendon(s) of the rotator cuff	1 (0.1)
Superficial injury of shoulder and upper arm	1 (0.1)
Fracture of lumbar spine and pelvis	1 (0.1)
Intracranial injury	1 (0.1)
Fracture of skull and facial bones	1 (0.1)
Open wound of the head	1 (0.1)
Intracranial space-occupying lesion	1 (0.1)
Symptoms and signs concerning fluid intake	1 (0.1)
Dizziness and giddiness	1 (0.1)

Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N = 993)	**n (%)**
Unspecified urinary incontinence	1 (0.1)
Painful micturition, unspecified	1 (0.1)
Abnormalities of gait and mobility	1 (0.1)
Rash and other nonspecific skin eruption	1 (0.1)
Other specified symptoms and signs involving the circulatory and respiratory systems	1 (0.1)
Hemorrhage from respiratory passages	1 (0.1)
Gangrene, not elsewhere classified	1 (0.1)
Congenital posterior urethral valves	1 (0.1)
Polycystic kidney, unspecified	1 (0.1)
Congenital pulmonary valve stenosis	1 (0.1)
Congenital hydrocephalus	1 (0.1)
Hypoxic ischemic encephalopathy of newborn	1 (0.1)
Maternal care for breach presentation	1 (0.1)
Other specified pregnancy-related conditions	1 (0.1)
Pre-eclampsia	1 (0.1)
Pre-existing hypertension, complicating pregnancy, childbirth and the puerperium	1 (0.1)
Blighted ovum and nonhydatiform mole	1 (0.1)
Habitual aborter	1 (0.1)
Complete or unspecified abortion without complication	1 (0.1)
Secondary dysmenorrhea	1 (0.1)
Other inflammatory disorders of vagina	1 (0.1)
Endometriosis	1 (0.1)
Female pelvic inflammatory disorders in diseases classified elsewhere	1 (0.1)
Inflammatory disorders of the breast	1 (0.1)
Impotence of organic origin	1 (0.1)
Redundant prepuce, phimosis and paraphimosis	1 (0.1)
Orchitis and epididymitis	1 (0.1)
Hydrocele and spermatocele	1 (0.1)
Inflammatory diseases of the prostate	1 (0.1)
Urethral disorders in diseases classified elsewhere	1 (0.1)
Urethral caruncle	1 (0.1)
Urethritis and urethral syndrome	1 (0.1)
Unspecified renal colic	1 (0.1)
Unspecified kidney failure	1 (0.1)

Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N =993)	**n (%)**
Obstructive and reflux uropathy	1 (0.1)
Hydronephrosis with ureteral stricture, not elsewhere classified	1 (0.1)
Chronic nephritic syndrome	1 (0.1)
Periprosthetic fracture around internal prosthetic joint	1 (0.1)
Other disorders of bone density and structure	1 (0.1)
Short Achilles tendon (acquired)	1 (0.1)
Spontaneous rupture of synovium and tendon	1 (0.1)
Discitis, unspecified	1 (0.1)
Other acquired deformities of limbs	1 (0.1)
Acquired deformities of fingers and toes	1 (0.1)
Arthrosis, unspecified	1 (0.1)
Other specific arthropathies	1 (0.1)
Seropositive rheumatoid arthritis	1 (0.1)
Ulcer of lower limb, not elsewhere classified	1 (0.1)
Lichen planus	1 (0.1)
Unspecified contact dermatitis due to other chemical products	1 (0.1)
Other local infection of skin and subcutaneous tissue	1 (0.1)
Pilonidal cyst without abscess	1 (0.1)
Cholelithiasis	1 (0.1)
Alcoholic hepatic failure	1 (0.1)
Malignant neoplasm of rectum	1 (0.1)
Malignant neoplasm of stomach	1 (0.1)
Malignant neoplasm of liver and intrahepatic bile ducts	1 (0.1)
Malignant neoplasm of other and ill-defined sites in the respiratory system and intrathoracic organs	1 (0.1)
HIV disease resulting in other specified diseases	1 (0.1)
Foodborne staphylococcal intoxication	1 (0.1)
Rotaviral enteritis	1 (0.1)
Other and unspecified syphilis	1 (0.1)
Chlamydial infection of lower genitourinary tract	1 (0.1)
Anogenital herpesviral infection, unspecified	1 (0.1)
Anogenital (venereal) warts	1 (0.1)
Unspecified sexually transmitted disease	1 (0.1)
Enteroviral exanthematous fever	1 (0.1)
Other mosquito-borne viral fevers	1 (0.1)

Supplement 1: Frequency distribution of all study variables (continued)

Characteristic (N = 993)	n (%)
Measles without complications	1 (0.1)
Other viral infections characterized by skin and mucous membrane lesions, not elsewhere classified	1 (0.1)
Unspecified viral hepatitis without hepatic coma	1 (0.1)
Subcutabeous phaeomycotic abscess and cyst	1 (0.1)
Other cestode infections	1 (0.1)
Onchocerciasis	1 (0.1)
Strongyloidiasis	1 (0.1)
Trichiuriasis	1 (0.1)
Enterobiasis	1 (0.1)
Sequelae of tuberculosis	1 (0.1)
Malignant neoplasm of the palate	1 (0.1)
Malignant neoplasm of the tonsil, unspecified	1 (0.1)
Malignant neoplasm of piriform sinus	1 (0.1)
Maignant neoplasm of hypopharynx, unspecified	1 (0.1)
Malignant neoplasm of the bone and articular cartilage, unspecified	1 (0.1)
Kaposi sarcoma	1 (0.1)
Malignant neoplasm of peripheral nerves of lower limb, including hip	1 (0.1)
Malignant neoplasm of ovary	1 (0.1)
Malignant neoplasm of the testis	1 (0.1)
Malignant neoplasm of the kidney, except renal pelvis	1 (0.1)
Malignant (primary) neoplasm, unspecified	1 (0.1)
Hodgkin lymphoma	1 (0.1)
Non-follicular lymphoma	1 (0.1)
Mediastinal (thymic) large B-cell lymphoma	1 (0.1)
Other specified types T/NK-cell lymphoma	1 (0.1)
Chronic lymphocytic leukemia of B-cell type	1 (0.1)
Benign neoplasm of mouth and pharynx	1 (0.1)
Benign neoplasm of parotid gland	1 (0.1)
Other benign neoplasms of connective and other soft tissue	1 (0.1)
Benign neoplasm of the breast	1 (0.1)
Benign neoplasm of the prostate	1 (0.1)
Benign neoplasm of the brain and other parts of the central nervous system	1 (0.1)
Benign neoplasm of other and unspecified endocrine glands	1 (0.1)
Folate deficiency anemia	1 (0.1)

Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N = 993)	**n (%)**
Iodine-deficiency-related (endemic) goiter, unspecified	1 (0.1)
Polycystic ovarian syndrome	1 (0.1)
Vitamin A deficiency, unspecified	1 (0.1)
Niacin deficiency (pellagra)	1 (0.1)
Ascorbic acid deficiency	1 (0.1)
Dietary calcium deficiency	1 (0.1)
Lipid storage disorder, unspecified	1 (0.1)
Mental and behavioral disorders due to use of alcohol	1 (0.1)
Schizotypal disorder	1 (0.1)
Mild depressive episode	1 (0.1)
Recurrent depressive disorder	1 (0.1)
Unspecified mental retardation	1 (0.1)
Secondary parkinsonism, unspecified	1 (0.1)
Essential tremor	1 (0.1)
Other demyelinating diseases of central nervous system	1 (0.1)
Nerve root and plexus disorder, unspecified	1 (0.1)
Diabetic polyneuropathy	1 (0.1)
Other specified disorders of brain in diseases classified elsewhere	1 (0.1)
Other disorders of nervous system in diseases classified elsewhere	1 (0.1)
Disorders of lacrimal system	1 (0.1)
Disorders of orbit	1 (0.1)
Chorioretinal inflammation	1 (0.1)
Diabetic retinopathy	1 (0.1)
Disorders of globe	1 (0.1)
Optic atrophy	1 (0.1)
Otitis externa in mycoses	1 (0.1)
Hearing loss, unspecified	1 (0.1)
Hypertensive heart and renal disease	1 (0.1)
Angina pectoris	1 (0.1)
Other nonrheumatic mitral valve disorders	1 (0.1)
Endocarditis, valve unspecified	1 (0.1)
Other conduction disorders	1 (0.1)
Other cardiac arrhythmias	1 (0.1)
Other cerebrovascular diseases	1 (0.1)
Abdominal aortic aneurysm, ruptured	1 (0.1)

Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N = 993)	**n (%)**
Phlebitis and thrombophlebitis of femoral vein	1 (0.1)
Post procedural disorders of circulatory system, not elsewhere classified	1 (0.1)
Influenza due to identified seasonal influenza virus	1 (0.1)
Influenza, virus not identified	1 (0.1)
Pneumonia due to other specified infectious organisms	1 (0.1)
Peritonsillar abscess	1 (0.1)
Unspecified chronic bronchitis	1 (0.1)
Status asthmaticus	1 (0.1)
Hypersensitivity pneumonitis due to organic dust	1 (0.1)
Pneumonitis due to solids and liquids	1 (0.1)
Adult respiratory distress syndrome	1 (0.1)
Other disorders of tooth development	1 (0.1)
Impacted teeth	1 (0.1)
Disorders of teeth and supporting structures, unspecified	1 (0.1)
Other cysts of jaw	1 (0.1)
Other diseases of jaws	1 (0.1)
Other diseases of lip and oral mucosa	1 (0.1)
Esophagitis	1 (0.1)
Functional dyspepsia	1 (0.1)
Acute appendicitis	1 (0.1)
Incisional hernia without obstruction or gangrene	1 (0.1)
Other abdominal hernia	1 (0.1)
Ulcerative (chronic) pancolitis	1 (0.1)
Other specified noninfective gastroenteritis and colitis	1 (0.1)
Anal fissure, unspecified	1 (0.1)
Anorectal fistula	1 (0.1)
Chronic hepatitis, not elsewhere classified	1 (0.1)
Any Procedure/Surgery done (N = 993)	
No	940 (94.7)
Yes	53 (5.3)
Type of Procedure/Surgery (N = 53)	
Minor	25 (47.2)
Major	7 (13.2)
Specialized	21 (39.6)

Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic	**n (%)**
Length of stay in days (n = 17)	
Mean (SD) = 6.1 (5.7), Median = 3	
1	3 (17.6)
2	4 (23.5)
3	2 (11.8)
5	1 (5.9)
6	1 (5.9)
7	1 (5.9)
8	1 (5.9)
14	2 (11.8)
15	1 (5.9)
18	1 (5.9)
Prescriber Qualification (N = 993)	
Clinical Officer/Dental Therapist	132 (13.3)
Assistant Medical/Dental Officer	18 (1.8)
Medical/Dental Officer	320 (32.2)
Specialist	437 (44.0)
Super-specialist/Consultant	86 (8.7)
Prescriber Qualification Grouped (N = 993)	
Low level (Clinical Officers or Assistant Medical/Dental Officers)	150 (15.1)
Mid-level (Doctor of Medicine/Doctor of Dental Surgery)	320 (32.2)
High level (Specialists/Consultants)	523 (52.7)
Any Medication Prescribed (N = 993)	
No	223 (22.5)
Yes	770 (77.5)
Number of Medications in the prescription (N = 770)	
Mean (SD) = 3.0 (1.7), Median = 3.0	
1	117 (15.2)
2	209 (27.1)
3	212 (27.5)
4	118 (15.3)
5	55 (7.1)
6	39 (5.1)
7	11 (1.4)
8	6 (0.8)
10	2 (0.3)

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Supplement 1: Frequency distribution of all study variables (continued)	
Characteristic (N = 770)	**n (%)**
13	1 (0.1)
Polypharmacy of > 3 Medications	
No	538 (69.9)
Yes	232 (30.1)
Polypharmacy of ≥ 5 Medications	
No	657 (85.3)
Yes	113 (14.7)
Receipt of an antibiotic prescription (N = 770)	
No	413 (53.6)
Yes	357 (46.4)
Receipt of more than one antibiotic prescription (N = 357)	
No	286 (80.1)
Yes	70 (19.6)
Antibiotics prescribed according to TZ STG2017 recommendation with respect to HFL (N = 357)	
No	28 (7.8)
Yes	329 (92.2)

Supplement 2: Study characteristics by receipt of antibiotic prescription

Characteristic (N = 770)	Antibiotic prescription, n (%) No	Yes	*P* value
Age in years			
Children (< 18 years)	73 (34.6)	138 (65.4)	< 0.01
Adults (18-59 years)	223 (54.8)	184 (45.2)	
Elderly (≥ 60 years)	117 (77.0)	35 (23.0)	
Sex			
Male	165 (52.2)	151 (47.8)	0.51
Female	248 (54.6)	206 (45.4)	
Level of health facility			
Dispensary	23 (23.0)	77 (77.0)	< 0.01
Health Centre/Stand-alone clinic by ADO	39 (36.4)	68 (63.6)	
District Hospital/Clinic L1 by MO/DO	26 (28.0)	67 (72.0)	
Regional Hospital/Clinic L2 by specialist	70 (68.0)	33 (32.0)	
Referral/National/Zonal Hospital/Clinic L3 by SS	255 (69.5)	112 (30.5)	
Ownership of health facility			
Public	195 (62.7)	116 (37.3)	< 0.01
Private/Non-governmental	218 (47.5)	241 (52.5)	
Department visited			
Outpatient	408 (54.2)	345 (45.8)	0.04
Inpatient	5 (29.4)	12 (70.6)	
Select Diagnosis			
Other disorders of urinary system			
No	407 (60.3)	268 (39.7)	< 0.01
Yes	6 (6.3)	89 (93.7)	
Acute and URTI of multiple and unspecified sites			
No	400 (56.7)	306 (43.3)	< 0.01
Yes	13 (20.3)	51 (79.7)	
Other sepsis			
No	409 (54.8)	338 (45.2)	< 0.01*
Yes	4 (17.4)	19 (82.6)	
Acute tonsillitis			
No	412 (55.2)	334 (44.8)	< 0.01*
Yes	1 (4.2)	23 (95.8)	

p-values are from Pearson Chi-Square Test or Fisher's Exact Test (*); SS, Super Specialist

Supplement 2: Study characteristics by receipt of antibiotic prescription (Continued)			
	Antibiotic prescription, n (%)		
Characteristic (N = 770)	**No**	**Yes**	***P* value**
Diseases of pulp and periapical tissues			
No	413 (54.3)	347 (45.7)	< 0.01*
Yes	0 (0.0)	10 (100.0)	
Candidiasis			
No	411 (54.4)	345 (45.6)	0.01
Yes	2 (14.3)	12 (85.7)	
Bacterial infection of unspecified site			
No	411 (54.2)	348 (45.8)	0.03*
Yes	2 (18.2)	9 (81.8)	
Pneumonia, unspecified organism			
No	411 (54.1)	349 (45.9)	0.05*
Yes	2 (20.0)	8 (80.0)	
Cystitis			
No	413 (54.3)	348 (45.7)	< 0.01*
Yes	0 (0.0)	9 (100.0)	
Other female pelvic inflammatory diseases			
No	412 (54.0)	351 (46.0)	0.05*
Yes	1 (14.3)	6 (85.7)	
Other disorders of bladder			
No	413 (54.1)	350 (45.9)	< 0.01*
Yes	0 (0.0)	7 (100.0)	
Amoebiasis			
No	413 (54.1)	350 (45.9)	< 0.01*
Yes	0 (0.0)	7 (100.0)	
Cellulitis			
No	413 (53.9)	353 (46.1)	0.05*
Yes	0 (0.0)	4 (100.0)	
Infections of genitourinary tract in pregnancy			
No	413 (53.9)	353 (46.1)	0.05*
Yes	0 (0.0)	4 (100.0)	
Chronic rhinitis, nasopharyngitis and pharyngitis			
No	413 (53.9)	353 (46.1)	0.05*
Yes	0 (0.0)	4 (100.0)	

p-values are from Pearson Chi-Square Test or Fisher's Exact Test (*)

Supplement 2: Study characteristics by receipt of antibiotic prescription (Continued)			
	Antibiotic prescription, n (%)		
Characteristic (N = 770)	**No**	**Yes**	***P* value**
Cutaneous abscess, furuncle and carbuncle			
No	413 (53.9)	353 (46.1)	0.05*
Yes	0 (0.0)	4 (100.0)	
Other gastroenteritis and colitis of infectious and unspecified origin			
No	412 (54.0)	351 (46.0)	0.05*
Yes	1 (14.3)	6 (85.7)	
Acute nasopharyngitis (common cold)			
No	404 (54.1)	343 (45.9)	0.16
Yes	9 (39.1)	14 (60.9)	
Conjunctivitis			
No	408 (54.0)	347 (46.0)	0.11
Yes	5 (33.3)	10 (66.7)	
Cough			
No	408 (54.1)	346 (45.9)	0.07
Yes	5 (31.3)	11 (68.8)	
Gingivitis and periodontal diseases			
No	412 (53.9)	353 (46.1)	0.19*
Yes	1 (20.0)	4 (80.0)	
Acute pharyngitis			
No	412 (53.9)	352 (46.1)	0.10*
Yes	1 (16.7)	5 (83.3)	
Bacterial pneumonia, not elsewhere classified			
No	412 (53.9)	352 (46.1)	0.10*
Yes	1 (16.7)	5 (83.3)	
Unspecified acute lower respiratory infection			
No	412 (53.9)	353 (46.1)	0.19*
Yes	1 (20.0)	4 (80.0)	
Other diseases of upper respiratory tract			
No	412 (53.9)	352 (46.1)	0.10*
Yes	1 (16.7)	5 (83.3)	

p-values are from Pearson Chi-Square Test or Fisher's Exact Test (*)

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Supplement 2: Study characteristics by receipt of antibiotic prescription (Continued)

Characteristic (N = 770)	Antibiotic prescription, n (%) No	Yes	*P* value
Otitis externa			
No	413 (53.8)	354 (46.2)	0.10*
Yes	0 (0.0)	3 (100.0)	
Single delivery by caesarean section			
No	413 (53.8)	354 (46.2)	0.10*
Yes	0 (0.0)	3 (100.0)	
Abdominal and pelvic pain			
No	413 (53.8)	355 (46.2)	0.22*
Yes	0 (0.0)	2 (100.0)	
Impetigo			
No	413 (53.8)	354 (46.2)	0.10*
Yes	0 (0.0)	3 (100.0)	
Osteomyelitis			
No	413 (53.8)	355 (46.2)	0.22*
Yes	0 (0.0)	2 (100.0)	
Non-suppurative otitis media			
No	413 (53.8)	355 (46.2)	0.22*
Yes	0 (0.0)	2 (100.0)	
Suppurative and unspecified otitis media			
No	413 (53.8)	355 (46.2)	0.22*
Yes	0 (0.0)	2 (100.0)	
Acute sinusitis			
No	413 (53.8)	355 (46.2)	0.22*
Yes	0 (0.0)	2 (100.0)	
Respiratory disorders in diseases classified elsewhere			
No	413 (53.8)	355 (46.2)	0.22*
Yes	0 (0.0)	2 (100.0)	
Dislocation of wrist			
No	413 (53.8)	355 (46.2)	0.22*
Yes	0 (0.0)	2 (100.0)	
Any Procedure/Surgery done			
No	403 (54.4)	338 (45.6)	**0.04**
Yes	10 (34.5)	19 (65.5)	

p-values are from Pearson Chi-Square Test or Fisher's Exact Test (*)

Supplement 2: Study characteristics by receipt of antibiotic prescription (Continued)

Characteristic	Antibiotic prescription, n (%) No	Yes	*P* value
Type of Procedure/Surgery (N = 29)			
Minor	4 (40.0)	6 (60.0)	0.71*
Major	0 (0.0)	7 (100.0)	
Specialized	6 (50.0)	6 (50.0)	
Prescriber Qualification (N = 770)			
Clinical Officer/ Dental Therapist	27 (21.3)	100 (78.7)	**< 0.01***
Assistant Medical Officer/Assistant Dental Officer	3 (20.0)	12 (80.0)	
Medical Officer/Dental Officer	136 (48.6)	144 (51.4)	
Specialist	200 (69.7)	87 (30.3)	
Super-specialist/Consultant	47 (77.0)	14 (23.0)	
Prescriber Qualification Grouped (N = 770)			
Low level (Clinical Officer/DT/AMO/ADO)	30 (21.1)	112 (78.9)	**< 0.01**
Mid-level (Medical/Dental Officer	136 (48.9)	144 (51.4)	
High level (Specialists/Consultants)	247 (71.0)	101 (29.0)	
Polypharmacy of ≥ 5 Medications (N = 770)			
No	346 (52.6)	312 (47.4)	0.16
Yes	67 (59.8)	45 (40.2)	
Availability of all medications prescribed in 2017 TZ NEMLIT (N = 770)			
No	220 (72.6)	83 (27.4)	**< 0.01**
Yes	193 (41.3)	274 (58.7)	
All medications prescribed using their generic names (N = 770)			
No	171 (48.9)	179 (51.1)	**0.02**
Yes	242 (57.6)	178 (42.4)	
Was malaria treatment prescribed (N = 770)			
No	407 (54.2)	344 (45.8)	0.05
Yes	6 (31.6)	13 (68.4)	
Presence of injectable formulation in the prescription (N = 770)			
No	388 (55.0)	317 (45.0)	**0.01**
Yes	25 (38.5)	40 (61.5)	

p-values are from Pearson Chi-Square Test or Fisher's Exact Test (*); DT, Dental Therapist; AMO, Assistant Medical Officer; ADO, Assistant Dental Officer

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Supplement 3: Poisson Regression analysis of factors influencing receipt of an antibiotic prescription

Variable (N = 770)	Univariate Regression cPR* (95% CI)	P value	Multivariate Regression aPR** (95% CI)	P value
Age in years				
Children (< 18 years)	2.8 (2.1-3.9)	< 0.001	1.7 (1.3-2.2)	< 0.001
Adults (18-59 years)	2.0 (1.4-2.7)	< 0.001	1.5 (1.1-1.9)	0.004
Elderly (≥ 60 years)	1 [Ref.]		1 [Ref.]	
Sex				
Male	1.1 (0.9-1.2)	0.51	Excluded	NA
Female	1 [Ref.]			
Level of health facility				
Dispensary	2.5 (2.1-3.0)	< 0.001	1.3 (0.9-1.8)	0.14
Health Centre	2.1 (1.7-2.6)	< 0.001	1.5 (1.1-2.0)	0.009
District Hospital	2.4 (1.9-2.9)	< 0.001	1.5 (1.1-1.9)	0.004
Regional Referral Hospital	1.1 (0.8-1.4)	0.77	1.0 (0.7-1.4)	0.97
National Referral Hospital	1 [Ref.]		1 [Ref.]	
Ownership of health facility				
Public	0.7 (0.6-0.8)	< 0.001	1.2 (1.0-1.4)	0.03
Private	1 [Ref.]		1 [Ref.]	
Department visited				
Inpatient	1.5 (1.1-2.1)	0.007	2.0 (1.2-3.4)	0.01
Outpatient	1 [Ref.]		1 [Ref.]	
Any Procedure/Surgery done				
Yes	1.4 (1.1-1.9)	0.01	1.3 (0.8-2.0)	0.34
No	1 [Ref.]		1 [Ref.]	
Prescriber Qualification				
Clinical Officer/Dental Therapist	3.4 (2.1-5.5)	< 0.001	1.9 (1.2-3.0)	0.005
Assistant Medical/Dental Officer	3.5 (2.1-5.9)	< 0.001	2.0 (1.1-3.4)	0.02
Medical/Dental Officer	2.2 (1.4-3.6)	0.001	1.6 (1.1-2.5)	0.03
Specialist	1.3 (0.8-2.1)	0.27	1.3 (0.8-1.9)	0.25
Consultant	1 [Ref.]		1 [Ref.]	
All medications prescribed using their generic names				
No	1.2 (1.0-1.4)	0.02	1.3 (1.1-1.5)	0.002
Yes	1 [Ref.]		1 [Ref.]	
Was malaria treatment prescribed				
No	0.7 (0.5-0.9)	0.01	1.0 (0.8-1.4)	0.77
Yes	1 [Ref.]		1 [Ref.]	
Presence of injectable formulation in the prescription				
Yes	1.4 (1.1-1.7)	0.003	1.4 (1.1-1.8)	0.004
No	1 [Ref.]		1 [Ref.]	

*cPR, Crude Prevalence Ratio; **aPR, Adjusted Prevalence Ratio; CI, Confidence Interval.

Supplement 3: Poisson Regression analysis of factors influencing receipt of antibiotic prescription (Continued)

Variable (N = 770)	Univariate Regression cPR* (95% CI)	P value	Multivariate Regression aPR** (95% CI)	P value
Select Diagnostic Codes				
Other disorders of urinary system - N39				
Yes	2.4 (2.1-2.6)	< 0.001	2.4 (2.1-2.8)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Acute and URTI of multiple and unspecified sites - J06				
Yes	1.8 (1.6-2.1)	< 0.001	1.6 (1.3 – 1.9)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Other sepsis - A41				
Yes	1.8 (1.5-2.2)	< 0.001	1.7 (1.2-2.2)	0.001
No	1 [Ref.]		1 [Ref.]	
Acute tonsillitis - J03				
Yes	2.1 (1.9 – 2.4)	< 0.001	2.3 (1.8 – 3.0)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Candidiasis - B37				
Yes	1.9 (1.5 – 2.4)	< 0.001	1.6 (1.2 – 2.1)	0.002
No	1 [Ref.]		1 [Ref.]	
Bacterial infection of unspecified site - A49				
Yes	1.8 (1.3 – 2.4)	< 0.001	2.1 (1.5 – 2.8)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Pneumonia, unspecified organism - J18				
Yes	1.7 (1.3 – 2.4)	0.001	1.5 (0.8 – 2.9)	0.18
No	1 [Ref.]		1 [Ref.]	
Other female pelvic inflammatory diseases - N73				
Yes	1.9 (1.4 – 2.5)	< 0.001	1.7 (1.2 – 2.5)	0.004
No	1 [Ref.]		1 [Ref.]	
Other gastroenteritis and colitis of infectious and unspecified origin - A09				
Yes	1.9 (1.4 – 2.5)	< 0.001	1.4 (0.9 – 2.0)	0.14
No	1 [Ref.]		1 [Ref.]	
Gingivitis and periodontal disease - K05				
Yes	1.7 (1.1 – 2.7)	0.02	1.9 (1.2 – 2.9)	0.004
No	1 [Ref.]		1 [Ref.]	
Cough - R05				
Yes	1.5 (1.1 – 2.1)	0.02	1.0 (0.7 – 1.4)	0.90
No	1 [Ref.]		1 [Ref.]	

*cPR, Crude Prevalence Ratio; **aOR, Adjusted Prevalence Ratio; CI, Confidence Interval

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Supplement 3: Poisson Regression analysis of factors influencing receipt of antibiotic prescription (Continued)

Variable (N = 770)	Univariate Regression cPR* (95% CI)	P value	Multivariate Regression aPR** (95% CI)	P value
Conjunctivitis - H10				
Yes	1.5 (1.0 – 2.1)	0.05	1.6 (1.0 – 2.7)	0.05
No	1 [Ref.]		1 [Ref.]	
Amoebiasis - A06				
Yes	2.2 (2.0 – 2.4)	< 0.001	2.1 (1.5 – 2.9)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Otitis Externa – H60				
Ref	2.2 (2.0 – 2.4)	< 0.001	0.8 (0.2 – 2.7)	0.70
No	1 [Ref.]		1 [Ref.]	
Acute nasopharyngitis (common cold) - J00				
Yes	1.3 (0.9 – 1.9)	0.10	0.7 (0.5 – 1.1)	0.10
No	1 [Ref.]		1 [Ref.]	
Acute pharyngitis – J02				
Yes	1.8 (1.3 – 2.6)	0.002	2.7 (1.1 – 6.3)	0.03
No	1 [Ref.]		1 [Ref.]	
Bacterial pneumonia not elsewhere classified - J15				
Yes	1.8 (1.3 – 2.6)	0.002	1.2 (0.8 – 1.6)	0.30
No	1 [Ref.]		1 [Ref.]	
Unspecified acute lower respiratory infection - J22				
Yes	1.7 (1.1 – 2.7)	0.02	1.5 (1.0 – 2.2)	0.05
No	1 [Ref.]		1 [Ref.]	
Chronic rhinitis, nasopharyngitis and pharyngitis - J31				
Yes	2.2 (2.0 – 2.3)	< 0.001	4.0 (2.4 – 6.4)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Other diseases of upper respiratory tract - J39				
Yes	1.8 (1.3 – 2.6)	0.002	1.1 (0.7 – 1.7)	0.80
No	1 [Ref.]		1 [Ref.]	
Disease of the pulp and periapical tissues - K04				
Yes	2.2 (2.0 – 2.4)	< 0.001	3.4 (2.3 – 4.8)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Impetigo - L01				
Yes	2.2 (2.0 – 2.3)	< 0.001	2.4 (1.2 – 4.7)	0.01
No	1 [Ref.]		1 [Ref.]	

*cPR, Crude Prevalence Ratio; **aPR, Adjusted Prevalence Ratio; CI, Confidence Interval

Supplement 3: Poisson Regression analysis of factors influencing receipt of an antibiotic prescription (Continued)

	Univariate Regression		Multivariate Regression	
Variable (N = 770)	**cPR* (95% CI)**	**P value**	**aPR** (95% CI)**	**P value**
Cutaneous abscess, furuncle and carbuncle - L02				
Yes	2.2 (2.0 – 2.3)	< 0.001	3.0 (1.9 – 4.9)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Cellulitis - L03				
Yes	2.2 (2.0 – 2.3)	< 0.001	2.4 (1.8 – 3.2)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Cystitis - N30				
Yes	2.2 (2.0 – 2.4)	< 0.001	2.7 (2.1 – 3.5)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Other disorders of bladder - N32				
Yes	2.2 (2.0 – 2.3)	< 0.001	3.5 (2.5 – 4.8)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Infections of genitourinary tract in pregnancy - O23				
Yes	2.2 (2.0 – 2.3)	< 0.001	2.9 (2.1 – 4.0)	< 0.001
No	1 [Ref.]		1 [Ref.]	
Single delivery by caesarean section - O82				
Yes	2.2 (2.0 – 2.3)	< 0.001	1.7 (0.8 – 3.5)	0.18
No	1 [Ref.]		1 [Ref.]	

*cPR, Crude Prevalence Ratio; **aPR, Adjusted Prevalence Ratio; CI, Confidence Interval

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4, 5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	5
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	5
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9, 10, 11
		(*b*) Report category boundaries when continuous variables were categorized	7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12,13,14,15
Generalisability	21	Discuss the generalisability (external validity) of the study results	15
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	2

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.