The role of multidimensional poverty in antibiotic misuse: a mixed-methods study of self-medication and non-adherence in Kenya, Tanzania, and Uganda

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Summary

Background Poverty is a proposed driver of antimicrobial resistance, influencing inappropriate antibiotic use in low-income and middle-income countries (LMICs). However, at subnational levels, studies investigating multidimensional poverty and antibiotic misuse are sparse, and the results are inconsistent. We aimed to investigate the relationship between multidimensional poverty and antibiotic use in patient populations in Kenya, Tanzania, and Uganda.

Methods In this mixed-methods study, the Holistic Approach to Unravelling Antimicrobial Resistance (HATUA) Consortium collected data from 6827 outpatients (aged 18 years and older, or aged 14–18 years and pregnant) with urinary tract infection (UTI) symptoms in health-care facilities in Kenya, Tanzania, and Uganda. We used Bayesian hierarchical modelling to investigate the association between multidimensional poverty and self-reported antibiotic self-medication and non-adherence (ie, skipping a dose and not completing the course). We analysed linked qualitative in-depth patient interviews and unlinked focus-group discussions with community members.

Findings Between Feb 10, 2019, and Sept 10, 2020, we collected data on 6827 outpatients, of whom 6345 patients had complete data; most individuals were female (5034 [79·2%]), younger than 35 years (3840 [60·5%]), worked in informal employment (2621 [41·3%]), and had primary-level education (2488 [39·2%]). Antibiotic misuse was more common among those least deprived, and lowest among those living in severe multidimensional poverty. Regardless of poverty status, difficulties in affording health care, and more familiarity with antibiotics, were related to more antibiotic misuse. Qualitative data from linked qualitative in-depth patient interviews (n=82) and unlinked focus-group discussions with community members (n=44 groups) suggested that self-medication and treatment non-adherence were driven by perceived inconvenience of the health-care system, financial barriers, and ease of unregulated antibiotic access.

Interpretation We should not assume that higher deprivation drives antibiotic misuse. Structural barriers such as inefficiencies in public health care, combined with time and financial constraints, fuel alternative antibiotic access points and treatment non-adherence across all levels of deprivation. In designing interventions to reduce antibiotic misuse and address antimicrobial resistance, greater attention is required to these structural barriers that discourage optimal antibiotic use at all levels of the socioeconomic hierarchy in LMICs.

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Introduction

Antimicrobial resistance is a complex biosocial phenomenon that threatens global public health and is accelerated by overuse and misuse of antibiotics.[1] Globally, human consumption of antibiotics increased by over 60% between 2001 and 2015, and use in low-income and middle-income countries (LMICs) is rapidly converging with richer nations.[2] Antibiotic misuse, a widely acknowledged driver of antimicrobial resistance,[1] includes behaviours like self-medication, accessing antibiotics without prescription, and incomplete treatment adherence (ie, skipping doses or not fully completing a course).[3] Although many factors can facilitate these behaviours, organisations such as WHO identify better individual optimal antibiotic use among patients as a key policy target to reduce antimicrobial resistance.[4,5]

Poverty, in its multiple dimensions, probably has an important role in the antimicrobial resistance nexus.[6] For example, underfunded public health care and poorly regulated antibiotic dispensing might promote antibiotic misuse, such as self-medication.[3,7–10] However, macroeconomic growth and related urbanisation are associated with the development of antimicrobial resistance hotspots.[11] Deprived sanitation, which is more

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Research in context

Evidence before this study

We searched Google Scholar, PubMed, and Web of Science with the terms "antibacterial", "antimicrobial", "AMR", "antibiotic", "poverty", and "socio* risk factors" for English articles published between Jan 1, 2011, and June 1, 2022. We found several systematic reviews covering subjects relating to poverty, antimicrobial resistance, and factors influencing antibiotic misuse in low-income and middle-income countries (LMICs). Among these studies was a review (published 2018) that identified 19 research articles (seven in LMICs, none in Africa) on the impact of poverty on antimicrobial resistance. The review reported that various dimensions of poverty, such as low education and poor sanitation, have been linked to increased burden of antimicrobial resistance. As well as sparse evidence from LMICs, the review highlighted that poverty was measured inconsistently. We found five systematic reviews (published 2018–22) that focused on antibiotic misuse, mainly in the form of self-medication, in LMICs. Reviews of self-medication identified 103 studies from LMICs (22 from Africa) and found that various socioeconomic factors were associated with self-medication, but relationships were mixed. For example, one study found a positive association between self-medication and employment, whereas others found positive associations with unemployment. Many of the reviewed studies, including those from Africa, found that low socioeconomic status was associated with higher self-medication. One systematic review published in 2022 on education and antibiotic misuse (covering use without prescription and non-adherence) identified 20 studies from Africa and concluded that there was no evidence for a relationship on a global scale, but that there was a positive association between education and antibiotic misuse in the European region. One systematic review published in 2019 on patterns of antibiotic use among patients, including 87 studies from 33 countries (13 studies covering LMICs), suggested lower treatment adherence among the younger population and those with low education and income, and that self-medication is more common in patients who were young and more highly educated, and those with less antibiotic knowledge. Overall, the available evidence suggested that the relationship between elements of poverty and antibiotic misuse was mixed and varied by indicator and context. Multidimensional poverty was rarely the focus of these studies and Africa, particularly east Africa, was under-represented.

Added value of this study

Rather than consider individual socioeconomic indicators, we measured poverty using an adapted version of the internationally recognised acute multidimensional poverty index, which accounts for multiple dimensions of wellbeing: education, health, and living standards. We used harmonised data from individuals in three east African countries, with linked quantitative and qualitative evidence. Our findings showed that the least deprived individuals were the most likely to misuse antibiotics, and this finding was explained by a range of structural and contextual factors. We also showed that knowledge and familiarity with antibiotics does not correlate with better antibiotic use behaviour.

Implications of all the available evidence

Although poverty has an important role in the antimicrobial resistance crisis, we should not assume that poorer subgroups drive antibiotic misuse, or that knowledge and education will promote better antibiotic use. Exploring the various dimensions of poverty remains crucial in understanding the contextual and situational rationale for antibiotic misuse. Notwithstanding the role of individual decision making, greater attention is required on the structural barriers that discourage optimal antibiotic use at all levels of the socioeconomic hierarchy in LMICs.

common in rural and urban informal settlements, increases the risk of bacterial infections and transmission of drug-resistant pathogens.[4,12] At an individual level, evidence on the relationship between dimensions of poverty and antibiotic use and misuse behaviours is limited and often contradictory, and few studies were done in Africa.[3,7,12–17] Some LMIC studies suggest that people with low education and who are living in poverty are more likely to self-medicate[14] and have worse antibiotic treatment adherence.[7,15] Others suggest people with more purchasing power could have more opportunity to self-medicate.[3] Developing a better understanding of social inequalities of antibiotic misuse and antimicrobial resistance in LMICs has been identified as a research priority,[16] but so far this is limited by the scarcity of large-scale comparable data, use of diverse poverty indicators, and a failure to take account of multiple intersecting domains of deprivation.

To address these gaps, we conducted this mixed-methods study to investigate the association between multidimensional poverty and reported antibiotic misuse among patient populations in east Africa (specifically, Kenya, Tanzania, and Uganda), and how other individual and contextual factors influence this association. To guide our study, we developed an evidence-based conceptual framework (figure 1), which describes the complex interplay of social, cultural, and economic factors in the association between poverty and antibiotic misuse. In this study, multidimensional poverty refers to deprivation in basic human capabilities, covering both monetary and non-monetary dimensions. Monetary factors might lead directly to greater treatment non-adherence through inability to afford full doses, or might promote self-medication due to financial unaffordability of formal health care.[6,18] Poor sanitation and chronic health conditions are likely to increase vulnerability to infectious disease and, thus, a need for antibiotics. The association between poverty and antibiotic misuse might be mediated by a number of contextual, attitudinal, and structural factors: for example, the level of education might influence antibiotic knowledge,[7,14,15,19–21] potentially fostering misuse. Other factors, including employment and decision-making processes, could influence both deprivation and antibiotic misuse directly and indirectly. Finally, the association between poverty and antibiotic misuse might be influenced by sociodemographic, cultural, and facilitating contextual factors, such as the disease and pathogen landscape, pluralistic health-care systems, and regulatory infrastructures.[16]

Methods

Study design and participants

In this mixed-methods, interdisciplinary study on three countries, data were generated by the HATUA (Holistic Approach To Unravelling Antimicrobial Resistance) Consortium, and full study details are described elsewhere.[22] This HATUA study used urinary tract infection (UTI), a commonly occurring bacterial infection, as a means through which to investigate the drivers of antimicrobial resistance. Between Feb 10, 2019, and Sept 10, 2020, 6827 outpatients (aged 18 years and older, and pregnant adolescents aged 14 years and older) were recruited from health-care facilities in Kenya, Tanzania, and Uganda, drawn from three sites in each country (Kenya: Makueni, Nairobi, and Nanyuki; Tanzania: Kilimanjaro, Mbeya, and Mwanza; and Uganda: Mbarara, Nakapiripirit, and Nakasongola). A full list of inclusion and exclusion criteria are listed elsewhere.[22] Facilities were predominantly government-funded and included both primary and secondary levels of care (appendix p 2). Doctors or clinical officers identified patients with symptomatic and probable UTI for inclusion to the study during face-to-face consultations. Patients provided a urine sample and answered a questionnaire on treatment seeking for UTI symptoms (eg, dysuria, cloudy urine, needing to urinate more often than normal), antibiotic use practices, knowledge of and attitudes towards antibiotics, illness, and antimicrobial resistance, and sociodemographic characteristics. Approximately 1–2 weeks after attending the clinic, in-depth interviews were conducted with a purposively selected subset of patients (n=82; n=23 from Kenya, n=25 from Tanzania, and n=34 from Uganda) who reported complex treatment seeking (eg, self-treated or having been to another clinic) or who were diagnosed with a multidrug-resistant UTI pathogen. In-depth interviews were conducted by trained, local fieldworkers with standardised topic guides (appendix pp 8–11) in the respondent's primary language and translated by fieldworkers. Interviewees discussed their previous treatment seeking, antibiotic use, knowledge, attitudes, and motivations towards illness, medicine, and antimicrobial resistance, and were also given some antibiotic best-practice guidance issued by National Health Service and Centre for Disease Control (appendix p 11) and asked about challenges to following such advice. Patient qualitative and quantitative data were linked by patient ID.

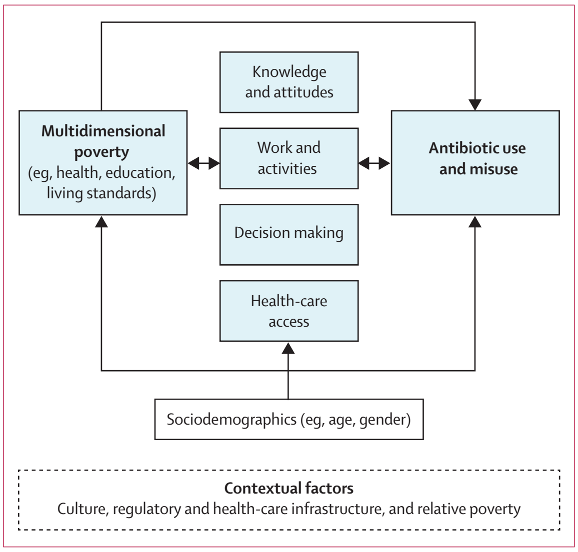

Figure 1: **Evidence-based conceptual framework that guided the mixed-method study design**

Independently of the patient sample, we conducted 44 sex-stratified focus-group discussions with community members in study sites in Tanzania (n=8 in Kilimanjaro, n=7 in Mbeya, and n=8 in Mwanza) and Uganda (n=8 in Mbarara, n=5 in Nakapiripirit, and n=8 in Nakasongola), using standardised topic guides (appendix pp 12–16). Focus-group discussions were conducted to capture details of health-care seeking among a wider group and for a more generalised set of conditions (eg, upper respiratory infections and sexually transmitted infections) than those of individuals who recently attended health-care facilities with UTI-like symptoms. Participants gave written informed consent, and ethical approval for this project was obtained from all institutions involved. Ethics approval for this project was obtained from the University of St Andrews (St Andrews, UK), the National Institute for Medical Research (Dar Es Salaam, Tanzania), the CUHAS/BMC research ethics and review committee (Mwanza, Tanzania), the Mbeya Medical Research and Ethics Committee (Mbeya, Tanzania), Kilimanjaro Christian Medical College (Moshi, Tanzania), Uganda National Council for Science and Technology, Makerere University (Kampala, Uganda), and Kenya Medical Research Institute (Nairobi, Kenya). For Uganda, administrative letters of support were obtained from the district health officers to allow the research to be conducted in the respective hospitals and health centres. Further details are provided in the protocol.[22]

See Online for appendix

Measurement of antibiotic misuse

To explore the associations between multidimensional poverty and antibiotic misuse, we had three binary outcomes of antibiotic misuse: skipping a dose, not completing the course, and self-medication. Antibiotic self-medication details were derived from reported history of recent treatment (ie, since the UTI symptoms started, or within the previous 2 weeks if this information was unknown) for UTI-like symptoms and took the value 1 (*vs* 0 for otherwise) for all patients who, before their recruitment at health clinics, took antibiotics that had not been prescribed by an attending physician (ie, from drug sellers or friends). To measure the skipping of a dose, patients were asked "do you ever skip your dose of antibiotics?", and for not completing the course, "do you usually complete the course of treatment?", to which patients answered yes or no. Interviewees discussed antibiotic use practices during in-depth discussions of treatment-seeking pathways. For the focus-group discussions, participants discussed self-medication without prescription, antibiotic adherence, and taking partial courses.

	Total (N=6345)	Kenya (n=1675)	Tanzania (n=2970)	Uganda (n=1700)
Antibiotic misuse outcomes				
Self-medicated with antibiotics	406 (6·4%)	115 (6·9%)	219 (7·4%)	72 (4·2%)
Skipped a dose	1513 (23·8%)	440 (26·3%)	771 (26·0%)	302 (17·8%)
Incomplete course	803 (12·7%)	220 (13·1%)	359 (12·1%)	224 (13·2%)
Poverty status				
Not deprived	2701 (42·6%)	1391 (83·0%)	918 (30·9%)	392 (23·1%)
Vulnerable	603 (9·5%)	88 (5·3%)	426 (14·3%)	89 (5·2%)
Deprived	1052 (16·6%)	121 (7·2%)	679 (22·9%)	252 (14·8%)
Severe poverty	1989 (31·3%)	75 (4·5%)	947 (31·9%)	967 (56·9%)
Age, years				
>25 years	1706 (26·9%)	461 (27·5%)	678 (22·8%)	567 (33·4%)
25–34 years	2134 (33·6%)	793 (47·3%)	794 (26·7%)	547 (32·2%)
35–44 years	1010 (15·9%)	265 (15·8%)	455 (15·3%)	290 (17·1%)
45–64 years	977 (15·4%)	114 (6·8%)	629 (21·2%)	234 (13·8%)
≥65 years	518 (8·2%)	42 (2·5%)	414 (13·9%)	62 (3·7%)
Sex				
Male	1321 (20·8%)	271 (16·2%)	784 (26·4%)	266 (15·6%)
Female	5024 (79·2%)	1404 (83·8%)	2186 (73·6%)	1434 (84·4%)
Working status				
Formal employment	1368 (21·6%)	414 (24·7%)	721 (24·3%)	233 (13·7%)
Informal employment	2621 (41·3%)	570 (34·0%)	1101 (37·1%)	950 (55·9%)
Homemaker	1586 (25·0%)	455 (27·2%)	740 (24·9%)	391 (23·0%)
Not working	770 (12·1%)	236 (14·1%)	408 (13·7%)	126 (7·4%)
Difficulty in meeting health-care costs				
Easy	2334 (36·8%)	630 (37·6%)	1443 (48·6%)	261 (15·4%)
Some difficulty	2726 (43·0%)	855 (51·0%)	1008 (33·9%)	863 (50·8%)
Very difficult	1285 (20·3%)	190 (11·3%)	519 (17·5%)	576 (33·9%)
Source of health-care advice				
Doctors only	2219 (35·0%)	381 (22·7%)	1146 (38·6%)	692 (40·7%)
Others (eg, friends or drug sellers)	4126 (65·0%)	1294 (77·3%)	1824 (61·4%)	1008 (59·3%)
Knowledge of term antibiotic				
Do not know	3128 (49·3%)	359 (21·4%)	2093 (70·5%)	676 (39·8%)
Another name for medicine	1083 (17·1%)	305 (18·2%)	309 (10·4%)	469 (27·6%)
Medicine for infections or germs	2134 (33·6%)	1011 (60·4%)	568 (19·1%)	555 (32·7%)
Familiarity with antibiotics by name or packaging				
Know 0–3	3114 (49·1%)	897 (53·6%)	1637 (55·1%)	580 (34·1%)
Know ≥4	3231 (50·9%)	778 (46·4%)	1333 (44·9%)	1120 (65·9%)

Data are n (%).

Table 1: **Quantitative sample characteristics (complete case data)**

Multidimensional poverty index (MPI)

To assess multidimensional poverty and ensure contextual comparability, we used an adapted version of the internationally validated acute multidimensional poverty index for developing countries (global MPI), which captures simultaneous deprivations in dimensions of living standards, health, and education.[23] The development of the HATUA MPI is detailed in the appendix (pp 18–21). Our adapted adult version contains seven binary indicators distributed under three equally weighted domains (appendix p 19). These domains comprised one indicator for education (no education and primary education *vs* secondary and tertiary education), two for health (reported any chronic conditions of asthma, heart disease or stroke, cancer, and hypertension, or reported having a disability), and four indicators for living standards (no mains electricity, shared unimproved sanitation, unprotected public access to drinking water, and not owning more than one of the following assets: television, radio, computer, fishing boat, telephone, refrigerator, or bed). Individual-level MPI scores were calculated for each patient on the basis of the counting methodology, for which higher scores suggested someone who has acute deprivations on multiple domains. On the basis of their calculated domain-weighted score (appendix p 19), we categorised patients into four groups (as reported by Fransman and Yu[24]): less than 20%, not deprived; 20% to less than 34%, vulnerable to poverty; 34–49%, deprived; and more than 50%, living in severe poverty.

Other sociodemographic, attitudinal, and knowledge variables

Previous studies from a scoping review[14] suggest that age and sex are probably associated with various poverty indicators and antibiotic misuse,[14] and thus are potential confounders. We grouped participants into five age categories (<25 years, 25–34 years, 35–44 years, 45–64 years, and ≥65 years). We also included socio-economic factors not included in the MPI, such as activity status (formal employment, informal employment, homemaker, or not working), and we reported on the ability of meeting health-care costs (not difficult, some difficulties, or very difficult). Familiarity with antibiotics was measured by the number of antibiotics known or recognised, collected using a drug bag or drug card method, which consisted of interviewers showing pictures and packaging of locally available antibiotics to patients.[25] Patients were also asked whether they knew the term antibiotic (with the following potential answers: do not know, another name for medicine, or medicine to treat infection or germs). Health-care attitudes were measured by responses to the question: "what source(s) of information about medicines/drugs do you use when you are sick?" We dichotomised this response to reflect those who only sought advice from doctors or formal health-care workers versus help from other sources, such as drug sellers or traditional healers. We also tested associations with other variables: awareness of the term antimicrobial resistance or AMR, believing that antibiotics could be used to treat colds and coughs, having health insurance, and decision-making power (needing to seek permission from others before seeking health care). However, as these associations were not important predictors in any of the models, the results were omitted in this study.

Statistical analysis

We estimated the association between MPI and three binary outcomes of antibiotic misuse (skipping a dose, not completing the course, and self-medication) separately. We used Bayesian hierarchical logistic regression models reflecting the hierarchy of the data structure: patients nested in 25 clinics, clinics nested in nine sites, and sites nested in three countries (the full model specification is detailed in the appendix [p 22]). Approximately 9% of our sample had missing values (distributions are shown in the appendix [p 22]), which we accounted for with a Bayesian modelling framework. Model 1 estimated the association between MPI and antibiotic misuse adjusted for age and sex. In model 2, we added related factors: employment and ability to meet health-care costs. In model 3, we added antibiotic knowledge and attitude variables which could mediate the association between MPI and antibiotic misuse. We report odds ratios (ORs) and their credible intervals (95% highest posterior density intervals) as arising from the Bayesian logistic regression models.

Qualitative analysis

In-depth interviews and focus-group discussions were analysed using iterative thematic content analysis in NVivo 12,[26] with the interview and focus-group discussion guides framing initial coding and analysis. Subsequent rounds of in-depth coding proceeded iteratively, constantly shifting between the data, the literature, and interpretative discussions among consortium members and stakeholders (regional and central government health officials, and policy leads for antimicrobial resistance, drug and patient safety, and pharmacist regulation) in Kenya, Tanzania, and Uganda. This approach helped to identify challenges to treatment seeking that lay behind reported behaviour among patients in the linked sample and among the community members in the unlinked sample. The breadth of the qualitative data, which covered both patient and community groups, also gave us confidence that reported experiences were common outside of clinic attendees and were not merely anecdotal.

Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report

Results

Across Kenya, Tanzania, and Uganda, 6830 patients were recruited, of whom 3 (<1%) declined to participate. Of the 6345 patients who participated and had complete data, most were female (5034 [79·2%]), younger than 35 years (3840 [60·5%]), and worked in informal employment (2621 [41·3%]; table 1). Using the HATUA MPI categories, 2701 (42·6%) patients were not deprived, 603 (9·5%) patients were vulnerable to poverty, 1052 (16·6%) patients were deprived, and 1989 (31·4%) patients lived in severe poverty (table 1). Uganda had the highest number of patients living in severe poverty, whereas Kenya had the highest number of patients who were not deprived. A similar poverty distribution was shown in the linked qualitative sample (table 2). Across the three countries, the largest contributor to the HATUA MPI was education (63·1%), followed by sanitation deprivation (14·3%), with drinking water deprivation contributing the least (3·3%; appendix p 19). Recent antibiotic self-medication was more common in Tanzania (219 [7·4%] of 2970 patients) and Kenya (115 [6·9%] of 1675 patients), compared with Uganda (72 [4·2%] of 1700 patients; table 1). More patients from Kenya (440 [26·3%] of 1675 patients) and Tanzania (771 [26·0%] of 2970)

	Total (N=82)	Kenya (n=23)	Tanzania (n=25)	Uganda (n=34)
Sex				
Male	21 (26%)	8 (35%)	8 (32%)	5 (15%)
Female	61 (74%)	15 (65%)	17 (68%)	29 (85%)
Poverty status				
Not deprived	34 (41%)	15 (65%)	10 (40%)	9 (26%)
Vulnerable	4 (5%)	1 (4%)	1 (4%)	2 (6%)
Deprived	14 (17%)	2 (9%)	5 (20%)	7 (21%)
Severe poverty	30 (37%)	5 (22%)	9 (36%)	16 (47%)
Age, years				
<25 years	16 (20%)	7 (30%)	2 (8%)	7 (21%)
25–34 years	26 (32%)	5 (22%)	6 (24%)	15 (44%)
35–44 years	13 (16%)	3 (13%)	6 (24%)	4 (12%)
45–64 years	20 (24%)	4 (17%)	8 (32%)	8 (24%)
≥65 years	7 (9%)	4 (17%)	3 (12%)	0 (0%)
Working status				
Formal employment	9 (11%)	3 (13%)	5 (20%)	1 (3%)
Informal employment	43 (52%)	9 (39%)	9 (36%)	25 (74%)
Homemaker	19 (23%)	5 (22%)	7 (28%)	7 (21%)
Not working	11 (13%)	6 (26%)	4 (16%)	1 (3%)

Data are n (%).

Table 2: **Sample characteristics of patients with linked qualitative and quantitative data**

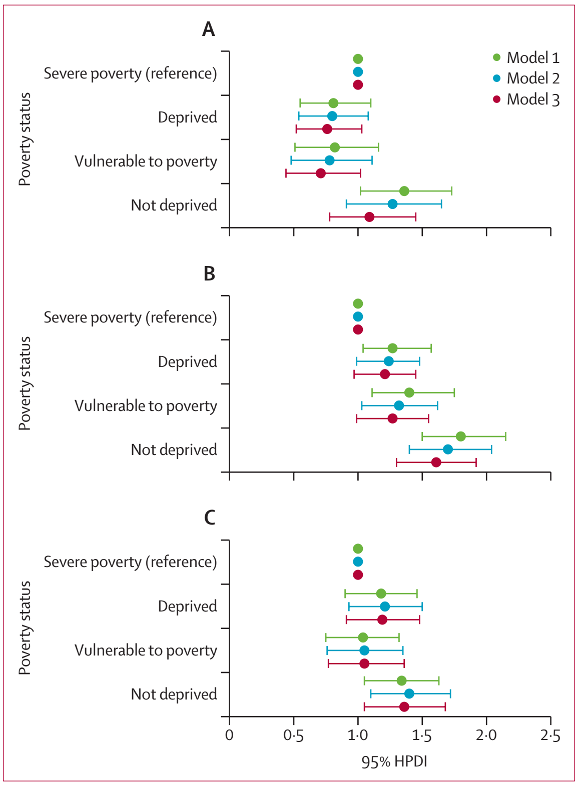

Figure 2: **Adjusted ORs and 95% HPDIs for the three binary outcomes of antibiotic misuse**
(A) Self-medication with antibiotics. (B) Skipping a dose of antibiotics. (C) Not completing the course of antibiotics. HPDI=highest posterior density interval. OR=odds ratio.

reported skipping a dose than from Uganda (302 [17·8%] of 1700 patients). Of the 6345 patients across the three countries, 803 (12·7%) reported not completing the course of antibiotics (table 1).

Associations between the HATUA MPI and the antibiotic misuse outcomes are shown in figure 2A–C. In model 1 (controlling for age and sex), the odds of all outcomes were highest among those who were not deprived, and lower among all other deprivation groups. The association between lower deprivation and higher self-medication was reduced when variables related to health, work, and antibiotic familiarity were accounted for in model 2 and model 3 (figure 2, table 2). The odds of skipping a dose were inversely related to deprivation—ie, the least deprived were most likely to skip doses—and this finding was consistent in model 2 and model 3 (figure 2B). Not completing the course was most common among those who were not deprived, when adjusted for a range of socioeconomic, attitudinal, and knowledge variables (figure 2C).

Full covariate results are shown in table 3. Younger adults (aged <25 years) were more likely than those aged over 25 years to skip a dose and not complete the course of antibiotics. Being formally employed was associated with higher odds of all three antibiotic misuse outcomes, relative to being a homemaker. Treatment non-adherence was more common among patients who said it was very difficult to meet health-care costs, compared with those who said it was easy. Seeking health-care advice from people other than doctors was also associated with higher odds of all three antibiotic misuse outcomes. Greater familiarity with antibiotics (recognising four or more antibiotics from the drug card) was associated with higher odds of self-medication and skipping a dose. We observed country-level, site-level, and clinic-level variation in the three outcomes, as shown by the variation in the random-effects estimates. To address concerns that education is driving the associations between MPI and antibiotic misuse (given that education is the main contributor to the HATUA MPI), we repeated the analysis and removed education from the index (appendix p 33), and this approach returned the same patterns. The results of the fixed-effects parts of the model using a frequentist multilevel approach (appendix pp 36–38) are consistent with the data shown in table 3. Site-level meta-analyses (appendix pp 39–42) detected some differences in the associations by site, but returned the same overall conclusions as regression modelling.

The depth and breadth of the qualitative data from in-depth patient interviews and community focus-group discussions contextualised patterns from the quantitative modelling, allowing us to see antibiotic use behaviours as situationally rational rather than irrational.[27] Respondents across the socioeconomic spectrum identified constraints to optimal antibiotic use, stemming from a complex combination of individual and structural factors (figure 3).

Time constraints helped to explain antibiotic misuse among the least deprived groups. Perceived inconvenience of the health service was frequently cited as a rationale for accessing antibiotics without prescription, especially among those with work responsibilities. Respondents who were employed and less deprived were particularly vocal about long travel and waiting times at government health-care facilities:

> "Mostly when I go there, I have to sacrifice almost a whole day because of the long queues and many waiting hours."
>
> *Kenya: interview with male patient (not deprived)*

Frequent shortages of antibiotics at government health-care centres further strengthened motivations for going straight to private suppliers, which were deemed more efficient. Community members from focus-group discussions also highlighted poor service provision and patient care that compounded the desire to avoid health facilities:

> "You can reach a health facility, and somebody talks to you rudely. If a person talks to you well, even if he does not have treatment for you, you can feel better. Instead, a health worker [says] that 'we don't have drugs, so you can do what you want.'"
>
> *Uganda: focus-group discussion with women (community member, farmer, primary education; focus-group discussion 1)*

Being busy at work was also cited as a reason for skipping doses, either forgetting the medication at home or not adhering to the recommended regimen:

> "when one is at work during the day…they are so engaged to a point of forgetting to the medicine they were supposed to take."
>
> *Kenya: interview with female patient (not deprived)*

Qualitative data corroborates findings that perceived difficulty meeting health-care costs is a key obstacle to optimal antibiotic use, regardless of poverty status. Alongside the perceived inconveniences described above, the financial and out-of-pocket costs of visiting health facilities (eg, a lost day's income, travel, and possible consultation costs) encourage antibiotic self-medication among all deprivation subgroups. Respondents, including those not deprived, commonly reported that cash flow issues drove them to bypass government health-care centres in favour of self-medication:

> "It is not easy [to get antibiotics] because most of the time[s] I don't have money, and that is why I go to my friend for herbal medicine."
>
> *Kenya: interview with male patient (not deprived)*

A commonly cited issue was the inability to cover the cost of transport or drugs:

> "Sometimes you are sick, and you don't have money to take you to the hospital and thus decide to just buy [antibiotics] thinking that you will be healed."
>
> *Tanzania: interview with male patient (severe poverty)*

Financial constraints also contributed to decisions to take partial courses of antibiotics:

> "When the money becomes too much, you end up buying fewer tablets…you take less…When you get enough money, you buy more tablets."
>
> *Uganda: interview with male patient (deprived)*

As we report elsewhere (for Tanzania),[28] the preparedness of sellers to dispense antibiotics without prescription and sell less than the recommended minimum course is almost universal, further rationalising decisions to bypass health professionals. Unsurprisingly, insufficient funds and ill health can become a vicious circle:

> "Something that is needed is money for treatment services and, since you are sick and you cannot work, you will not be having money."
>
> *Tanzania: focus-group discussion with women (community member, trader, some secondary education; focus-group discussion 15).*

The qualitative data underlines the complex relationship between antibiotic knowledge and behaviour, and challenges in measuring an individual's knowledge on antibiotics. Even respondents who recognised the term antibiotic had only a very general awareness of disease, rather than any understanding that antibiotics treat bacterial diseases specifically:

> "[Antibiotic] is the other word for medicine used to treat disease… I think there is no difference [between antibiotics and other drugs]."
>
> *Kenya: interview with male patient (not deprived)*

	Posterior OR (95% HPDI) for self-medication with antibiotics	Posterior OR (95% HPDI) for skipping a dose	Posterior OR (95% HPDI) for not completing the course
Poverty status			
Severe poverty	1·00 (ref)	1·00 (ref)	1·00 (ref)
Deprived	0·76 (0·52–1·03)	1·21 (0·97–1·48)	1·19 (0·91–1·48)
Vulnerable to poverty	0·71 (0·44–1·02)	1·27 (0·99–1·55)	1·05 (0·77–1·36)
Not deprived	1·09 (0·78–1·45)	1·61 (1·30–1·92)	1·36 (1·05–1·68)
Age, years			
<25 years	1·00 (ref)	1·00 (ref)	1·00 (ref)
25–34 years	1·23 (0·89–1·59)	0·94 (0·79–1·10)	0·80 (0·65–0·96)
35–44 years	1·06 (0·71–1·44)	0·89 (0·71–1·07)	0·89 (0·68–1·09)
45–64 years	0·95 (0·61–1·32)	0·81 (0·64–0·98)	0·64 (0·48–0·81)
≥65 years	0·84 (0·47–1·27)	0·85 (0·62–1·09)	0·84 (0·57–1·13)
Sex			
Male	1·00 (ref)	1·00 (ref)	1·00 (ref)
Female	0·88 (0·66–1·11)	1·07 (0·90–1·24)	0·92 (0·75–1·10)
Working status			
Formal employment	1·00 (ref)	1·00 (ref)	1·00 (ref)
Informal employment	0·87 (0·64–1·11)	0·77 (0·64–0·89)	0·84 (0·67–1·02)
Homemakers	0·53 (0·36–0·71)	0·67 (0·53–0·80)	0·79 (0·60–0·98)
Not working	0·84 (0·52–1·17)	0·61 (0·47–0·75)	0·68 (0·49–0·88)
Able to meet health-care costs			
Easy	1·00 (ref)	1·00 (ref)	1·00 (ref)
Some difficulty	1·37 (1·05–1·70)	0·89 (0·76–1·02)	1·13 (0·93–1·34)
Very difficult	1·17 (0·81–1·57)	1·47 (1·20–1·72)	1·38 (1·09–1·70)
Source of advice			
Other (not a doctor)	1·00 (ref)	1·00 (ref)	1·00 (ref)
Doctor's or health-care workers' advice only	0·61 (0·47–0·76)	0·65 (0·56–0·74)	0·67 (0·56–0·79)
Knowledge of term antibiotic			
Do not know	1·00 (ref)	1·00 (ref)	1·00 (ref)
Another name for medicine	1·06 (0·72–1·43)	1·03 (0·84–1·22)	1·14 (0·88–1·40)
Medicine for infections or germs	1·31 (0·93–1·69)	1·05 (0·87–1·22)	1·19 (0·95–1·44)
Familiarity with antibiotics			
Know 0–3	1·00 (ref)	1·00 (ref)	1·00 (ref)
Know ≥4	1·59 (1·25–1·98)	1·31 (1·14–1·49)	0·89 (0·75–1·04)
Random effects			
Country-level variance	2·71 (1·28–4·47)	1·25 (0·01–2·47)	1·71 (0·52–3·38)
Clinic-level variance	0·41 (0·20–0·65)	0·74 (0·04–1·47)	0·67 (0·01–1·04)
Site-level variance	0·16 (0·01–0·40)	0·81 (0·53–1·15)	0·67 (0·01–1·38)

Data are based on 6827 patients with urinary tract infection symptoms in health-care facilities from Kenya, Tanzania, and Uganda. HPDI=highest posterior density interval. OR=odds ratio.

***Table 3:* Hierarchical regression results for associations between multidimensional poverty and outcomes of antibiotic misuse (model 3)**

Financial constraint and care commitments	Work commitments	Inconvenience and health facility under-resourcing
"Yes, the advice is good, but it is not voluntary that we share medicine, but our [financial] resources determine [this choice]. For instance, we can be sick and even our children are sick, and you know that the same medicine you are swallowing can also help treat the child, so you end up sharing the medicine. Financial situation[s] [might prevent people from following the doctor's advice]." Uganda: interview with female patient (deprived)	*"I think when one is asked to set time each day, [it] is so unachievable, especially for the people that are working during the day. For most medicine, we are asked to take them three times in a day, and you find that during the day one is occupied by work, and they forget to take the medicines."* Kenya: interview with male patient (severe poverty)	*"Some of them [people who go directly to drug sellers] do not have enough time to go to the hospital because of the number of sick people in the hospital [the long waiting time], they want to go to the doctor direct, but they are forced to wait. And waiting—time is wasted. So, instead they decide to go to the clinic or drug shop...It is the distance and the weather."* Uganda: interview with female patient (not deprived)
Lack of knowledge and financial constraint	**Competing work and care commitments**	**Time constraints and convenience**
"I think that [not following best practices] is caused by little understanding, but there are genuine reasons; for example, someone taking [a] half dose of drugs due to lack of money, it means he doesn't have money to buy [the] full course...He purchases and take[s] half [of the] course, which is way better than staying sick...Without knowing he is causing more serious effects...But the main cause is poverty." Tanzania: interview with male patient (not deprived)	*"Like for us who work, you leave home in the morning at 6:00am, and the child has to take the drug at 7:00am, so you find you have failed to give the child the medicine in time, you end up skipping some days. The dose gets spoilt, and thus fails to cure the child."* Uganda: interview with female patient (vulnerable to poverty)	*"It is a little difficult, but I can try [to buy antibiotics only with a prescription]...What do I do when I am not able to go to the hospital? At times, I just buy due to lack of otherwise [other options]."* Kenya: interview with female patient (not deprived)

Figure 3: **Challenges to implementing antibiotic use best practices reported by patient interviewees: inter-related themes around financial constraints, work commitments, and inconvenience**

This absence of distinction between antibiotics and other forms of medicine might help to explain the finding that knowledge of the term antibiotic was not associated with lower antibiotic misuse. However, recognising four or more different antibiotics was associated with antibiotic misuse, suggesting familiarity might encourage (over) confidence.

Discussion

Poverty has been suggested as an important driver of antibiotic misuse and antimicrobial resistance in LMICs.[6,29] Previous investigations of poverty, antibiotic misuse, and antimicrobial resistance have tended to use designs which obscure social inequalities within contexts.[8] This unique study used standardised, mixed-methods data from three east African countries and measured poverty holistically via a range of indicators. Contrary to some studies,[3,14] we found that antibiotic self-medication and non-adherence were more common among those who were not living in multidimensional poverty, and least common among people living in the most deprived conditions. The seeming contradiction—that antibiotic non-adherence is predicted by both lower deprivation and difficulty to meet health-care costs—might reflect the fact that the HATUA MPI does not take income into account and that financial struggles are common across the MPI spectrum: 54% of those who are not deprived still find it a little difficult or very difficult to meet health-care costs (data not shown). In line with other mixed-methods study findings,[7] our qualitative analysis suggested that financial and time considerations, and the perceived relative inconvenience of accessing public health care, drives antibiotic misuse across the poverty spectrum. Less deprived subgroups, particularly those in employment, might feel these challenges more acutely, resulting in poorer adherence and more antibiotic self-medication. Further, even the least deprived subgroups might still struggle to pay for health care, which could make antibiotic misuse more probable.

Our findings align with those of others,[30] which question the emphasis on knowledge and awareness of antibiotics as a means of improving antibiotic use behaviours. We observed more antibiotic misuse among the least deprived, better-educated groups who were most familiar with antibiotics, and further, that knowledge of the term antibiotic or how antibiotics worked was not related to better antibiotic use. Although enhanced health literacy regarding antibiotics is important, incomplete understanding can promote overconfidence to self-diagnose and treat.[3] The discrepancy between knowledge of the term antibiotic and recognition of multiple antibiotics suggests that we should be careful to not conflate familiarity with drugs with accurate knowledge about their use, and that neither would necessarily support more appropriate use. Although respondents stated that they want and need a better understanding of disease types, the purpose of antibiotics, and the importance of adherence, they also pointed out that situational constraints limit individual agency to act on this knowledge. The antimicrobial resistance crisis might be driven as much by pluralistic health-care systems, opportunity structures, and markets, as by knowledge, beliefs, and attitudes towards antibiotics.

Our study had some limitations. The linked quantitative–qualitative patient sample was representative of those attending mainly public outpatient services with UTI-like symptoms. However, patient populations are an important subgroup for possible interventions, and UTI is both prevalent and commonly treated with antibiotics in this region. Moreover, similar themes emerged from focus-group discussions, which included non-clinic attendees and discussed treatment seeking for other conditions (eg, respiratory and gastrointestinal problems, which are also commonly associated with antibiotic misuse[3,7]). Nevertheless, the study should be replicated in other patient and community populations. Our adapted MPI used fewer indicators than the global MPI, justified by the focus on the adult population and data availability in our adapted MPI. One consequence of our adapted MPI is that education was the largest contributor to the HATUA MPI. However, our sensitivity analysis without education returned the same conclusions. Another limitation to our study is that our outcomes are self-reported, and we cannot rule out reporting bias.

In conclusion, although poverty has an important role in the antimicrobial resistance crisis, we should not assume that poorer subgroups drive antibiotic misuse. The behaviours of less deprived people might contribute more to the development of antimicrobial resistance than previously acknowledged, yet they are the least likely to suffer the consequences.[6] Continued emphasis on the importance of individual behaviours fails to acknowledge the structural barriers that promote antibiotic misuse across the socioeconomic hierarchy,[5] which include poorly resourced and inefficient public health-care provision, and easy access to antibiotics.[7] Policy interventions aimed at reducing antibiotic misuse behaviours should give attention to these upstream structural barriers that face all levels of society, and limit the agency of individuals to use antibiotics appropriately.

Contributors

DLG conceptualised the paper, analysed quantitative data, and wrote the manuscript. KK conceptualised the paper, co-designed the study, supervised data analysis, wrote the manuscript, and had the final responsibility for the decision to submit for publication. KJF analysed qualitative data and edited the manuscript. SIH analysed qualitative data and edited the manuscript. DLG, KK, KJF, and SIH had access to raw data and verified the data. MFM supervised data collection and reviewed the manuscript. CK supervised data collection and reviewed the manuscript. BA co-designed the study, supervised data collection, and reviewed the manuscript. JK co-designed the study, supervised data collection, and reviewed the manuscript. SEM co-designed the study, supervised data collection, and reviewed the manuscript. SN co-designed the study, supervised data collection, and reviewed the manuscript. JRM co-designed the study, supervised data collection, and reviewed the manuscript. MK co-designed the study, supervised qualitative data analysis, and edited the manuscript. AGL co-designed the study, provided statistical advice, supervised quantitative data analysis, and edited the manuscript. JNM supervised data collection and reviewed the manuscript. HW provided statistical advice and edited the manuscript. EO analysed quantitative data and reviewed the manuscript. MAAA assisted with data preparation and reviewed the manuscript. AA supervised data collection and reviewed the manuscript. BTM co-designed the study, supervised data collection, and reviewed the manuscript. JB supervised data collection and reviewed the manuscript. AS coordinated the study and reviewed the manuscript. JS co-designed the study and reviewed the manuscript. SHG co-designed the study and reviewed the manuscript. GK co-designed the study and reviewed the manuscript. WS co-designed the study and reviewed the manuscript. DJS co-designed the study, supervised data analysis, and reviewed the manuscript. MTGH led the HATUA Consortium and reviewed the manuscript. The contributions of members of the HATUA Consortium are listed in the appendix (p 43).

Declaration of interests

We declare no competing interests.

Data sharing

Individual participant data is not available. The study protocol is available to download online. Country and site-stratified analyses are available on request.

For the **study protocol** see https://bmjopen.bmj.com/content/11/3/e041418.abstract

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