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Factors associated with knowledge attitudes practices and training interest and antibiotic dispensing challenges related to antimicrobial resistance among drug sellers in urban Bangladesh

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Abstract

Background and objective

Drug sellers play a critical role in antibiotic dispensing in Bangladesh and can influence antibiotic use and antimicrobial resistance (AMR). This study assessed drug sellers' knowledge, attitudes, practices and training interest regarding AMR, identified associated factors, and explored challenges related to dispensing antibiotics without prescription in an urban setting.

Methods

A mixed-methods cross-sectional study was conducted in Mirpur, Dhaka. We mapped 1,100 pharmacies and randomly selected 400 drug sellers for a structured KAP survey. Composite scores were transformed to 0–100 percentage of maximum possible (POMP) scores. Associations were examined using Spearman correlation and multivariable linear regression with HC3 robust standard errors. Two focus group discussions involving 20 drug sellers were analysed thematically.

Results

Mean POMP scores were 75.2 for knowledge, 72.3 for attitude, 69.6 for practice and 76.6 for training interest. The four scores were positively correlated (all $P < 0.001$), with the strongest correlation between attitude and practice ($\rho = 0.648$). In adjusted analyses, graduate-level education, licensed-pharmacy status and longer experience were associated with higher knowledge; knowledge was positively associated with attitude; and licensed-pharmacy status, knowledge ($\beta = 0.22$) and attitude ($\beta = 0.56$) were positively associated ($p < 0.001$) with practice. Knowledge and attitude were also positively associated with training interest. Qualitative findings identified customer demand and affordability, pharmacy competition, pharmaceutical-company incentives, training and awareness needs, prescriber responsibilities, and regulatory monitoring as influences on antibiotic dispensing.

Conclusion

Drug sellers showed moderate AMR-related knowledge, attitudes and practices, with high training interest. Strengthening training, supportive supervision, consistent regulatory monitoring and community awareness may help promote appropriate antibiotic use in urban Bangladesh.

Background

Antimicrobial resistance (AMR) is a major global public health threat, with an estimated 1.27 million deaths directly attributable to resistant infections in 2019 [1] [2] [3]. The World Health Organization (WHO) projects that AMR could cause up to 10 million deaths annually by 2050 if effective measures are not implemented [4]. In Bangladesh, the burden of AMR is substantial, with high levels of resistance observed among common pathogens. For example, 72% of *Escherichia coli* isolates from hospitalized patients are resistant to at least one antibiotic, and 26% are resistant to three or more antibiotics [5]. Misuse and overuse of antibiotics are key drivers of AMR in the country [6].

Multiple stakeholders, including healthcare providers, drug sellers, consumers, and agricultural actors, influence antibiotic use and AMR containment [7]. In Bangladesh, drug sellers play a particularly important role, as they are often the first point of contact for individuals seeking healthcare [8]. According to the Bangladesh Drug and Cosmetics Act, 2023 and supporting regulatory documents a drug seller or pharmacy is any individual or establishment licensed by regulatory body to sell, stock, display, or distribute drugs or medicines. Drug sellers or pharmacies may include: Retail pharmacies (run by registered pharmacists), Medicine shops (often run by trained but non-pharmacist personnel), Unlicensed or informal sellers [9] [10]. Hence pharmacies may be classified as licensed (formal) or non-licensed (informal), depending on regulatory approval.

According to national regulations, drug sellers are categorized based on pharmacy-related qualifications into Grade A (graduate pharmacists), Grade B (diploma pharmacists), and Grade C (certificate holders), as defined by the Pharmacy Council of Bangladesh (PCB) and relevant legislation [9] [11]. Educational qualification of Grade A drug sellers will be Bachelor of Pharmacy (B.Pharm) or higher, registered with PCB and their typical role is to work as Pharmacist in charge of Model Pharmacies. Educational qualification of Grade B drug sellers will be Diploma in Pharmacy (3-year course), registered with PCB and their typical role is dispensing medicines under supervision. Educational qualification of Grade C drug sellers will be Certificate in Pharmacy (6-month course), registered with PCB, and their typical role is to work as Medicine shop staff with limited dispensing capacity [11] [10]. Despite these regulatory frameworks, a large proportion of drug sellers or pharmacies operate without formal training or licensure, particularly in urban and peri-urban settings [12] [13].

In Bangladesh, there are around 163,447 licensed pharmacies termed as formal drug sellers [14] and a similar number of informal drug sellers are selling drugs all over the country; a large proportion of which are not licensed [13]. There are few organizations nationally working on mapping the DS landscape. The majority of the pharmacies are clustered in the urban area, in every 1.5 km area there are around 50 formal and informal pharmacies in Dhaka city [13]. While it is a legal requirement that DS have at least a grade C pharmacy qualification, the majority do not have any training, and for those who have had training it is not usual practice to undertake any refresher training [15]. The Ministry of Health and Family Welfare's (MOHFW) 'Model Medicine Shop' initiative has also undertaken a study of best-practice in the design of local pharmacies, in order to strengthen the national infrastructure to the storage of drugs and the need for appropriate premises. However, the broader training of DS remains neglected. Training and orientation of DS is a priority of government and development partners [16]. This is crucial if the country is going to be able to deliver its AMR National Action Plan (AMR NAP) and, in particular, to restrict selling antibiotics without prescription [16].

Drug sellers contribute significantly to antibiotic access but may also contribute to inappropriate antibiotic use through dispensing without prescription, inadequate counseling, or non-compliance with regulations [17]. This can lead to people taking antibiotics incorrectly or unnecessarily, which can contribute to the development of AMR. Understanding the position of DS within the Bangladeshi health system is essential for designing effective interventions to address AMR and improve antibiotic stewardship [18] [16].

Study objectives

This study aimed to assess the knowledge, attitude, practice, and training interest of drug sellers regarding antimicrobial resistance in an urban setting in Bangladesh.

Specifically, the study aimed to:

- Map the distribution of licensed and non-licensed pharmacies in the study area;
- Assess the knowledge, attitudes, practices, and training interest of drug sellers regarding AMR;
- Identify factors associated with variations in KAP and training interest;
- Explore challenges faced by drug sellers in complying with antibiotic dispensing regulations and their perspectives on potential solutions.

Methods

This cross-sectional study adopted a mixed-methods approach to generate evidence on antimicrobial resistance (AMR)-related knowledge, attitudes, practices, and training needs among drug sellers.

A literature review was conducted to identify gaps in policies and guidelines related to antibiotic dispensing by drug sellers and to inform the development of data collection tools based on previously validated instruments.

As part of the quantitative component, data were collected through mapping of pharmacies and a knowledge, attitude, and practice (KAP) survey among drug sellers working in pharmacies in study site Mirpur.

For the qualitative component, focus group discussions (FGDs) were conducted with drug sellers to explore their perceptions and experiences regarding antibiotic dispensing, interactions with customers, communication about dosage and treatment adherence, awareness of AMR, challenges faced in routine practice and potential solutions.

Setting

The study was conducted in Mirpur, a large urban area of Dhaka comprising several administrative units within the Dhaka North City Corporation. Mirpur comprises 15 administrative wards across 7 thanas. According to the Population and Housing Census 2022, these thanas have a total population of approximately 2,142,650 within an area of 34.3 km². The population is predominantly male (53.7%), and the majority (96.9%) are Muslim [19] [20].

A large number of pharmacies operate in Mirpur to meet the healthcare needs of this population. According to the Directorate General of Drug Administration (DGDA), approximately 437 licensed (formal) pharmacies were registered in the area [14]. However, the operational status of pharmacies was verified during the study mapping exercise through physical visits by trained research assistants. Pharmacies found to be operating at the time of mapping were geolocated and recorded in the mapping database. The mapping exercise identified both licensed (formal) and non-licensed (informal) pharmacies operating across the study area.

Mapping of pharmacies and geospatial data collection

A structured mapping questionnaire was developed to collect key information on pharmacies, including pharmacy name, address (ward number, mohalla, and nearby landmarks), owner contact details, geographical coordinates (latitude and longitude), and licensing status (licensed by the Directorate General of Drug Administration [DGDA], not licensed, or under review).

An electronic case report form (eCRF) was designed using Kobo Toolbox. A team of 10 research assistants received hands-on training on the use of the Kobo Toolbox mobile application for geospatial mapping. The geographical coordinates of pharmacies were captured using GPS-enabled mobile devices through the Kobo Toolbox application, with coordinates recorded at a positional accuracy of ± 5 meters. Following training, a pilot mapping exercise was conducted outside the study area, and necessary refinements were made to the questionnaire and eCRF before commencement of the main mapping exercise.

Mapping was conducted across 15 wards of Mirpur between 28 March and 4 April 2024. A total of 1,100 pharmacies were identified, of which 551 were licensed and 549 were non-licensed, indicating a nearly equal distribution.

Quality assurance measures were implemented throughout data collection. Field data were reviewed daily by data collectors for completeness and consistency before submission to the server. Supervisors monitored field activities through real-time location tracking and conducted random field visits. Data management personnel regularly downloaded and reviewed the data, documented inconsistencies, and verified and corrected them through consultation with field staff.

Using the geographic coordinates and licensing status of pharmacies, a geospatial map was generated using Google Maps (Fig. 1).

Figure 1 illustrates the spatial distribution of licensed and non-licensed pharmacies in Mirpur, Dhaka, Bangladesh. Licensed pharmacies are indicated by green markers, while non-licensed pharmacies are indicated by blue markers. The map demonstrates both licensed and non-licensed pharmacies were widely distributed across the study area, with the two types of pharmacies frequently co-existing within the same local areas.

Insert Fig. 1 here

Sample size

The required sample size for the KAP survey was estimated assuming that 50% of drug sellers in urban Bangladesh have knowledge about antimicrobial resistance (AMR), due to the absence of prior evidence. Using a 95% confidence level, 5% precision, and a 5% non-response rate, the final sample size was calculated as 400 drug sellers [21].

Data collection tool

A structured questionnaire was developed based on a review of relevant literature and previously used instruments in similar settings [21] [22]. The questionnaire was designed to assess knowledge, attitude, practice, and training interest of drug sellers regarding antibiotic dispensing, antimicrobial resistance, and related issues.

The questionnaire included 7 knowledge, 25 attitude, 13 practice, and 5 training interest items. All items were presented as positively worded statements. Responses were collected using a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5).

Agreement (agree or strongly agree) was considered indicative of desirable responses. Knowledge, practice, and training interest items were directly related to drug sellers' roles, while attitude items captured perceptions regarding the roles being played by drug sellers and other stakeholders (e.g., customers, regulatory authorities, and policymakers) in AMR prevention and what was the expectation.

The questionnaire also included background information on socio-demographic and professional characteristics, including general education, pharmacy-related education, duration of training or experience, type of pharmacy, age, and sex.

The tool was pretested in a setting outside the study area, and necessary modifications were made prior to final data collection.

Eligibility criteria

Eligible participants were drug sellers with at least six months of experience in drug dispensing and who provided informed consent.

Survey procedures

A total of 10 enumerators were trained on the study objectives, questionnaire, and data collection procedures. A pilot exercise was conducted prior to the main survey.

The KAP survey was conducted among 400 drug sellers selected from the pharmacy mapping database. The database was stratified according to pharmacy licensing status at the time of mapping into licensed (formal) and non-licensed (informal) pharmacies. Within each stratum, pharmacies were assigned unique identification numbers and selected by simple random sampling without replacement using computer-generated random numbers in SPSS version 31.0. An initial sample of 200 pharmacies was selected from each stratum. One eligible drug seller was recruited from each selected pharmacy, provided that the individual had at least six months of experience in drug dispensing and provided informed consent. When more than one eligible drug seller was present at a selected pharmacy, one was selected by lottery.

If a selected pharmacy was closed, an eligible drug seller was unavailable, or participation was refused, a replacement pharmacy was randomly selected from the remaining unsampled pharmacies within the corresponding licensed or non-licensed stratum using the same random-selection procedure. Overall, 450 pharmacies were approached to obtain the target sample of 400 drug sellers, corresponding to a response rate of 89%.

During the KAP survey, some pharmacies that had been classified as non-licensed at the time of mapping were found to have subsequently obtained licenses. As pharmacy licensing is an ongoing process, their licensing status was updated according to their status at the time of the KAP survey. Consequently, the final sample comprised 229 licensed and 171 non-licensed pharmacies.

Data collection was conducted between mid-September and mid-October 2024 using paper-based questionnaires. Data collectors reviewed completed questionnaires on-site to ensure completeness and consistency. Besides, supervisors, researchers, data manager checked consistency of the collected data, raised query for any inconsistency identified and did necessary correction if required upon consultation with field team.

Following data collection, open ended responses were coded and all data were entered into a database using SPSS software. Data entry was cross-checked against hard copies, and consistency checks were performed. Any discrepancies were resolved through verification with field staff, entry personnel and original questionnaires to ensure data quality.

Missing data handling

Data were checked for completeness during collection. Any missing or inconsistent data were verified and corrected where possible through field validation. Analyses were conducted using available data, and the extent of missing data was minimal.

Bias

Potential sources of bias, including selection bias and measurement bias, were considered during study design and their implementation. Random sampling from a comprehensive mapping frame was used to minimise selection bias. Data collectors were trained, and standardised procedures were followed to reduce measurement bias.

Patient and Public Involvement statement

Patients and the public were not involved in the design of the study or in developing the research questions and outcome measures. Drug sellers—the study population—were involved during piloting of the questionnaire, and their feedback informed refinement of the data collection tools. They also participated in KAP survey and focus group discussions, providing insights into challenges and practices related to antibiotic dispensing. Participants were recruited from mapped pharmacies and provided informed consent. They were not formally involved in assessing study burden or dissemination of findings.

Figure 2 shows flowchart of recruiting participants for the study.

****Insert Fig. 2 here****

KAP survey items and internal consistency

Table 1 presents the knowledge, attitude, practice, and training interest-related statements regarding antimicrobial resistance (AMR) issues used in the KAP survey. The question items were developed based on relevant literature and contextualized to the study setting.

Insert Table 1 here

Responses to all items were collected using a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5).

Internal consistency of the items within each construct was assessed using Cronbach's alpha [23]. The alpha coefficients were 0.687 for knowledge, 0.879 for attitude, 0.678 for practice, and 0.737 for training interest, indicating acceptable to good internal consistency of the scales.

Dependent variables

Composite outcome variables were created for four domains of the KAP survey: knowledge, attitude, practice, and training interest. These composite scores were derived by summing Likert-scale responses (ranging from 1 to 5) across relevant items, thereby preserving the full response variability and measurement precision.

The resulting continuous variables were termed knowledge score, attitude score, practice score, and training interest score.

All items were positively worded, with agreement (agree or strongly agree) reflecting desirable responses. Therefore, higher scores indicate greater levels of knowledge, more favorable attitudes, better practices, and higher training interest regarding antimicrobial resistance.

Independent variables

The following variables were considered as independent variables to examine their association with the outcome variables. General education was categorized as graduate or above versus higher secondary or below. Pharmacy-related education was categorized as having formal pharmacy qualifications (Grade A, B, or C) versus below Grade C.

Duration of training or experience in drug dispensing or related roles was categorized into ≤ 9 years, 10–18 years, and ≥ 19 years based on tertile cut-offs. Age was categorized into 17–35 years, 36–45 years, and 46–75 years, also based on tertiles. Type of pharmacy was categorized as licensed (formal) versus non-licensed (informal).

Knowledge score was categorized into ≤ 28 and > 28 based on the median cut-off, as the first and second tertiles coincided with the median. Attitude score was categorized into ≤ 94, 95–100, and > 100 based on tertile cut-offs.

For descriptive analyses, these variables were used in their categorical form. For multivariable analysis, duration of experience, age, knowledge score, and attitude score were included as continuous variables [24].

Primary and secondary outcome measures

The primary outcomes were composite knowledge, attitude, practice, and training interest scores on antimicrobial resistance among drug sellers, derived from Likert-scale items. Secondary outcomes included factors associated with these scores based on socio-demographic and professional characteristics, as well as qualitative insights into challenges influencing antibiotic dispensing practices.

Quantitative data analysis

Descriptive analyses were conducted for the pharmacy-mapping and KAP survey data. Categorical variables were summarized using frequencies and percentages, whereas continuous variables were summarized using means and standard deviations (SD), together with medians and interquartile ranges (IQR), as appropriate [25, 26].

Responses to the knowledge, attitude, practice and training-interest items were recorded on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Item responses within each domain were summed to generate composite scores and were subsequently transformed to percentage of maximum possible (POMP) scores ranging from 0 to 100 using the formula: [(observed score - minimum possible score)/(maximum possible score - minimum possible score)] x 100 [27]. Higher POMP scores indicated higher levels of the corresponding domain. This transformation placed the four domains, which contained different numbers of items, on a common 0-100 metric while preserving the relative ordering and linear relationships of the original summed scores.

For each POMP outcome, measures of central tendency and dispersion were calculated overall and across categories of selected sociodemographic and professional characteristics. For characteristics with two categories, differences in mean POMP scores were assessed using Welch's independent-samples t-test, with mean differences and 95% confidence intervals (CI) reported. For characteristics with three categories, overall differences in mean POMP scores were assessed using Welch's one-way analysis of variance (ANOVA), which does not require the assumption of equal group variances [28]. Median and IQR values were also presented to describe the distribution of the scores.

Associations among knowledge, attitude, practice and training-interest POMP scores were examined using Spearman's rank correlation because some score distributions deviated from normality. Spearman's rho (rho) and percentile-bootstrap 95% CIs based on 2,000 resamples were estimated for each pair of POMP scores.

Separate multivariable linear regression models were fitted for each POMP outcome to examine independent associations with selected explanatory variables while adjusting for potential confounders [29, 30]. The knowledge model included general education, pharmacy education, type of pharmacy, duration of training or experience, and age. The attitude model additionally included knowledge POMP score. The practice and training-interest models additionally included both knowledge and attitude POMP scores. Regression coefficients (beta) with 95% CIs were used to quantify the adjusted difference in POMP score between categories of categorical predictors relative to the reference category, or the change in POMP score associated with a one-unit increase in a continuous predictor.

Regression assumptions and model robustness were assessed using diagnostic procedures. Heteroscedasticity was assessed using the Breusch-Pagan test, and HC3 heteroscedasticity-consistent standard errors were applied to all multivariable linear regression models to provide robust 95% CIs and P values [31]. Residual normality was assessed using the Shapiro-Wilk test. Multicollinearity among explanatory variables was assessed using variance inflation factors (VIF), with values greater than 5 considered indicative of potentially problematic multicollinearity. Adjusted R-squared values were reported to describe the proportion of variability in each POMP outcome explained by the corresponding model.

All statistical tests were two-sided, and $P < 0.05$ was considered statistically significant. Quantitative analyses were conducted using SPSS version 31.0 and R version 4.6.0.

Sensitivity analysis

No sensitivity analyses were conducted.

Qualitative data collection and analysis

Focus group discussions (FGDs) were designed as a complementary qualitative component to provide contextual understanding of the findings from the quantitative KAP survey rather than as a stand-alone qualitative investigation. As part of the mixed-methods study, qualitative data were collected through two FGDs, comprising 20 drug sellers in total, with 10 participants in each group. The Participants were randomly selected from KAP survey respondents who had expressed willingness to participate in the qualitative component. Random selection from this pool was used to reduce researcher discretion in participant selection. Each FGD comprised 10 participants, a group size consistent with established methodological guidance for facilitating a range of perspectives while allowing participants sufficient opportunity to contribute to the discussion [32]. Selected participants were contacted by members of the research team, and the FGDs were scheduled at mutually convenient dates and times.

The FGDs were conducted in a closed meeting room to maintain privacy and lasted approximately 45–60 minutes. A semi-structured discussion guide was used to explore drug sellers' current and perceived roles in relation to antibiotic dispensing and antimicrobial resistance (AMR) prevention; challenges associated with dispensing antibiotics without prescription; the perceived roles of other stakeholders in AMR prevention; and drug sellers' training needs and interest in further training. All discussions were audio-recorded and transcribed verbatim, and the transcripts were translated into English for analysis.

The transcripts were read repeatedly to support familiarization with the data, after which initial codes were generated. Related codes were grouped into broader categories and themes, and the developing themes were reviewed jointly by two researchers to assess their coherence and consistency with the underlying data. The final themes were refined and interpreted in relation to the study objectives, and representative quotations were selected to illustrate key findings and participants’ perspectives. Qualitative data management and thematic analysis were conducted using NVivo software [32] [33].

Results

Descriptive Analysis

Sociodemographic and professional characteristics

Among the 400 drug sellers participating in the survey, nearly all were male (98.5%), and the mean age was 40.6 years (SD 12.2), with a median of 40 years.

General educational attainment was almost evenly distributed, with 51.0% having higher secondary education or below and 49.0% being graduates or above. Most participants (83.0%) reported some pharmacy educational background. Overall, 69.3% had Grade A, B or C pharmacy qualifications, while the remainder were below Grade C.

Insert Table 2 here

All participants reported previous training or experience in drug dispensing or other relevant role, with a mean duration of 14.8 years (SD 10.3) and a median of 13.0 years (IQR 14.0). Of the pharmacies represented in the KAP survey, 57.3% were licensed and 42.8% were non-licensed. (Table 2).

Distribution of AMR-related Knowledge, attitude, practice and training interest POMP scores by selected characteristics

Across the four AMR-related domains, the mean POMP scores were 75.2 for knowledge, 72.3 for attitude, 69.6 for practice and 76.6 for training interest (Supplementary Figure SF1). Thus, practice had the lowest average score among the four domains, whereas training interest had the highest.

Knowledge

Knowledge POMP scores differed significantly by general education, pharmacy education and type of pharmacy. Drug sellers who were graduates or above had a higher mean knowledge score than those with higher secondary education or below (76.5 vs 74.0; mean difference 2.46 points, 95% CI 1.17 to 3.74; P < 0.001). Those with Grade A/B/C pharmacy education also had a higher mean knowledge score than those with pharmacy education below Grade C (75.8 vs 73.9; mean difference 1.85 points, 95% CI 0.25 to 3.44; P = 0.024). Similarly, drug sellers working in licensed pharmacies had a higher mean knowledge score than those working in non-licensed pharmacies (76.1 vs 74.0; mean difference 2.15 points, 95% CI 0.89 to 3.40; P < 0.001). Knowledge scores did not differ significantly across categories of duration of training or experience or age.

Attitude

Attitude POMP scores differed significantly by pharmacy education and type of pharmacy. Drug sellers with Grade A/B/C pharmacy education had a lower mean attitude score than those with pharmacy education below Grade C (71.6 vs 73.8; mean difference − 2.19 points, 95% CI − 3.77 to − 0.60; P = 0.007). In contrast, drug sellers working in licensed pharmacies had a higher mean attitude score than those working in non-licensed pharmacies (72.9 vs 71.4; mean difference 1.49 points, 95% CI 0.01 to 2.97; P = 0.049). There was no evidence of significant differences in attitude scores by general education, duration of training or experience, or age.

Insert Table 3 here

Practice

Practice POMP scores differed significantly by type of pharmacy and age group. Drug sellers working in licensed pharmacies had a higher mean practice score than those working in non-licensed pharmacies (70.8 vs 67.9; mean difference 2.89 points, 95% CI 1.52 to 4.25; P < 0.001). Practice scores also differed across age groups (P = 0.005), with mean scores of 70.0 among drug sellers aged 17–35 years, 68.0 among those aged 36–45 years and 70.7 among those aged 46–75 years. There was no evidence of significant differences in practice scores according to general education, pharmacy education, or duration of training or experience.

Training Interest

Training-interest POMP scores differed significantly according to duration of training or experience and type of pharmacy. Mean training-interest scores were 76.7 among participants with ≤ 9 years of training or experience, 75.2 among those with 10–18 years and 78.2 among those with ≥ 19 years (overall P = 0.022). Drug sellers working in licensed pharmacies also had a higher mean training-interest score than those working in non-licensed pharmacies (77.6 vs 75.3; mean difference 2.25 points, 95% CI 0.62 to 3.87; P = 0.007). Training-interest scores did not differ significantly by general education, pharmacy education or age.

Relationships between knowledge, attitude, practice and training interest

Participants with knowledge POMP scores > 75 had higher mean attitude, practice and training-interest scores than those with knowledge scores ≤ 75, with mean differences of 7.72, 6.75 and 8.09 POMP points, respectively (all P < 0.001). Practice and training-interest scores also differed significantly across categories of attitude POMP score (both P < 0.001), with the highest mean scores observed among participants in the highest attitude-score (> 75) category (Table 3).

Correlation between AMR-related knowledge, attitude, practice, and training interest POMP scores

The POMP scores for knowledge, attitude, practice and training interest were all positively correlated with one another (Table 4), with all correlations statistically significant (P < 0.001). The strongest correlation was between attitude and practice (Spearman's ρ = 0.648, 95% CI 0.576 to 0.713). Knowledge showed moderate positive correlations with practice (ρ = 0.427, 95% CI 0.334 to 0.518) and training interest (ρ = 0.460, 95% CI 0.358 to 0.551), and a weaker

positive correlation with attitude (ρ = 0.380, 95% CI 0.269 to 0.473). Training interest was also moderately correlated with practice (ρ = 0.424, 95% CI 0.329 to 0.514) and attitude (ρ = 0.429, 95% CI 0.327 to 0.521) (Table 4).

Insert table 4 here

Multivariable linear regression analysis

Results from multivariable linear regression models fitted separately to assess factors associated with knowledge, attitude, practice, and training interest POMP scores are presented in Figs. 3–6.

Factors associated with knowledge POMP score

In the multivariable analysis, graduate-level general education or above was associated with a 2.55-point higher knowledge POMP score compared with higher secondary education or below (adjusted β = 2.55, 95% CI 1.21 to 3.89; P < 0.001). Working in a licensed pharmacy was independently associated with a 1.52-point higher knowledge score compared with working in a non-licensed pharmacy (adjusted β = 1.52, 95% CI 0.23 to 2.82; P = 0.021). Each additional year of training or experience was associated with a 0.14-point increase in knowledge score (95% CI 0.03 to 0.24; P = 0.009). Pharmacy education and age were not independently associated with knowledge score. The model explained approximately 7.5% of the variation in knowledge scores (adjusted R^2=0.075) (Fig. 3).

This result is important because the unadjusted difference by pharmacy education seen in Table 3 was no longer evident after simultaneous adjustment, whereas the association with general education persisted.

****Insert Fig. 3 here***

Factors associated with attitude POMP score

After adjustment, Grade A/B/C pharmacy education was associated with a 3.05-point lower attitude POMP score compared with education below Grade C (adjusted β=−3.05, 95% CI − 4.60 to − 1.50; P < 0.001). Knowledge was positively associated with attitude: each one-point increase in knowledge POMP score was associated with a 0.47-point increase in attitude score (adjusted β = 0.47, 95% CI 0.33 to 0.62; P < 0.001). General education, pharmacy type, duration of training or experience, and age were not independently associated with attitude. The adjusted R^2 was approximately 0.176 (Fig. 4).

****Insert Fig. 4 here***

Factors associated with practice POMP score

The practice model showed the greatest explanatory capacity among the four multivariable models (adjusted R^2=0.537). Working in a licensed pharmacy was independently associated with a 1.50-point higher practice POMP score compared with working in a non-licensed pharmacy (adjusted β = 1.50, 95% CI 0.52 to 2.49; P = 0.003). Both knowledge and attitude were independently positively associated with practice. Each one-point increase in knowledge score was associated with a 0.22-point increase in practice score (adjusted β = 0.22, 95% CI 0.12 to 0.32; P < 0.001), while each one-point increase in attitude score was associated with a 0.56-point increase in practice score (adjusted β = 0.56, 95% CI 0.48 to 0.64; P < 0.001). Strong independent association between attitude and practice is consistent with the Spearman correlation results. General education, pharmacy education, duration of training or experience, and age were not independently associated with practice (Fig. 5).

****Insert Fig. 5 here***

Factors associated with training interest

Higher knowledge and attitude scores were independently associated with greater training interest. Each one-point increase in knowledge POMP score was associated with approximately a 0.33-point increase in training-interest score, while each one-point increase in attitude score was associated with approximately a 0.43-point increase in training-interest score (both P < 0.001). Longer duration of training or experience was also positively associated with training interest, whereas age showed a negative association. General education, pharmacy education and pharmacy type were not independently associated with training interest. The model explained approximately 32.4% of the variation in training-interest scores (adjusted R^2=0.324) (Fig. 6). Descriptive licensed/non-licensed difference in training interest was significant, but pharmacy type did not remain independently associated after adjustment.

****Insert Fig. 6 here***

Regression diagnostics

Regression diagnostics indicated heteroscedasticity in the knowledge model and departures from residual normality in the knowledge, practice and training-interest models. HC3 robust standard errors were therefore used for all models. No evidence of problematic multicollinearity was observed (all variance inflation factors (VIFs) < 2).

Overall Interpretation

The results indicate that the four AMR-related domains were positively interconnected, but their determinants differed. General education, licensed pharmacy status and greater duration of training or experience were independently associated with higher knowledge, whereas knowledge itself was strongly associated with attitude. Practice was most strongly explained by attitude and knowledge, together with an independent positive association with licensed pharmacy status. Training interest was independently related to both knowledge and attitude, as well as duration of training or experience and age.

Qualitative findings from focus group discussions

Thematic analysis of the focus group discussions identified six interrelated themes: (1) customer demand and affordability influencing antibiotic dispensing; (2) competitive pressures influencing antibiotic dispensing; (3) pharmaceutical company incentives and promotional influence; (4) training of drug sellers and community awareness; (5) perceived responsibilities of prescribers in antibiotic use; and (6) regulatory monitoring, supervision and enforcement. The findings below summarise drug sellers' perspectives and experiences, with illustrative quotations presented under each theme.

Customer demand and affordability influencing antibiotic dispensing

Drug sellers described customer demand and financial constraints as important influences on antibiotic dispensing without a prescription. Participants reported that some customers requested antibiotics based on previous prescriptions or recommendations from people they knew, while others wished to avoid or could not afford the cost of consulting a registered physician. Drug sellers also described situations in which customers purchased only a few doses initially and decided whether to obtain the remainder of the course depending on perceived improvement, despite being advised to complete the prescribed course.

"In some cases the customer states that he/she has not enough money or wants to save the money required to consult with [a] registered physician... first he/she will buy few pieces of an antibiotic and start to use and if the patient feels improvement after using few dose[s]... then he/she will purchase [the] remaining course... or discontinue." — FGD1- P3, Drug seller, Mirpur

Competitive pressures influencing antibiotic dispensing

Competition between nearby pharmacies was repeatedly described as influencing dispensing decisions. Drug sellers explained that refusing to sell an antibiotic without a prescription, or insisting that customers purchase the full prescribed course, could lead customers to seek the medicine from another pharmacy. Participants perceived that this could result in loss of immediate sales as well as future customers, creating pressure to dispense antibiotics even when their preferred practice was to request a prescription or advise completion of the full course.

"If we suggest a client to purchase and use the full course of prescribed antibiotics then the client leave[s] the pharmacy and search[es] in other pharmacy where he/she can purchase few pieces of the prescribed antibiotic... So there is a pressure of nearby competitive pharmacy..." — FGD1- P2, Drug seller, Mirpur

Pharmaceutical company incentives and promotional influence

Drug sellers also described promotional activities by pharmaceutical companies as a commercial influence on antibiotic dispensing. Participants reported that pharmaceutical company representatives offer benefits or gifts when products from their companies, including antibiotics, are sold in greater quantities. Such incentives were perceived to create an additional commercial motivation that could influence antibiotic-selling decisions.

"*Pharmaceutical company representatives visit pharmacy and offer drug sellers different types of benefit package or gifts if they can increase sell of antibiotic drugs of their company… So influence of pharmaceutical company [representatives] is one of the factors that may influence dispensing of antibiotic drugs even of below or sub-standard quality…" — FGD1- P8, Drug seller, Mirpur*

Training of drug sellers and community awareness

Drug sellers emphasised the need for further training, particularly for those with lower levels of pharmacy-related education. Suggested training areas included prescription-based antibiotic dispensing, counselling customers on appropriate antibiotic use, completion of prescribed courses, and the consequences of inappropriate use and antimicrobial resistance. Participants also highlighted the importance of community awareness, noting that customers' knowledge, expectations and purchasing behaviour could influence antibiotic use at pharmacy level.

"Drug sellers... should also be trained on proper dispensing of antibiotic[s], [the] way of counseling customer[s] about [the] importance of using antibiotic[s] only as per prescription... [and the] importance of completing [the] course of antibiotic[s]... Robust effort[s] have to be taken to increase mass awareness among the community people..." — FGD1- P5, Drug seller, Mirpur

Perceived responsibilities of prescribers in antibiotic use

Drug sellers also perceived prescribers as having an important role in promoting appropriate antibiotic use. One participant expressed concern about situations in which an antibiotic was initiated on the basis of presenting symptoms and later changed after diagnostic test results became available. The participant viewed such situations as potentially contributing to unnecessary or inappropriate antibiotic exposure if the earlier treatment course was not adequately considered.

"Sometimes Doctor[s] prescribe antibiotic[s] along with some diagnostic test[s]... and the patient purchase[s] and start[s] [the] antibiotic... when the... report is shared with the Doctor, based on the test result the Doctor prescribe[s] [a] new antibiotic... changing the previously prescribed one..." — FGD2- P1, Drug seller, Mirpur

Regulatory monitoring, supervision and enforcement

Participants recommended more consistent monitoring and supportive supervision of pharmacies by regulatory authorities. They considered enforcement across pharmacies important because individual sellers perceived that compliance with prescription requirements could place them at a competitive disadvantage if neighbouring pharmacies continued to dispense antibiotics without prescriptions. Suggested actions included regular monitoring of compliance, ensuring appropriate pharmacy licensing and taking action against repeated non-compliance.

"One of the main reason[s] of selling antibiotics without prescription... is peer pressure or pressure of nearby drug sellers. I think if the concerned regulatory authority take[s] necessary steps and do[es] regular monitoring and supervision... [and] give[s] punishment [to] those who do not follow the rule... then... drug sellers and customer[s] will be used to sell[ing] and use[ing] antibiotic[s] only with [a] prescription." — FGD2- P7, Drug seller, Mirpur

Across these themes, drug sellers described antibiotic dispensing as shaped by interacting customer, competitive, commercial, professional and regulatory influences. Their accounts highlighted the combined importance of reducing inappropriate promotional and market pressures, strengthening drug seller training and community awareness, and ensuring consistent regulatory monitoring and enforcement to support appropriate antibiotic use and AMR prevention.

Discussion

This mixed-methods study provides evidence on AMR-related knowledge, attitudes, practices and training interest among drug sellers in an urban area of Bangladesh, while also documenting the pharmacy landscape and the contextual pressures that shape antibiotic dispensing. The mapping exercise identified nearly equal numbers of licensed and non-licensed pharmacies operating across the study area, and the survey showed mean POMP scores of 75.2 for knowledge, 72.3 for attitude, 69.6 for practice and 76.6 for training interest. The multivariable findings indicate that knowledge, attitude, pharmacy licensing status and professional experience contribute differently across the four outcomes, while the qualitative findings show that dispensing decisions are also shaped by customer demand, affordability, competition, pharmaceutical promotion and regulatory enforcement. Taken together, the findings suggest that antibiotic-dispensing behaviour in community pharmacies reflects both individual competencies and the wider commercial and regulatory environment in which drug sellers work.

The strong positive relationships observed between knowledge, attitude and practice are consistent with evidence from Bangladesh and other South Asian settings. A recent Bangladesh study among community pharmacy staff found that non-prescribed antibiotic dispensing was substantially more common among respondents with poorer knowledge and less favourable attitudes [34]. In South India, community pharmacists demonstrated important knowledge gaps regarding antibiotic use and resistance, while fear of losing customers was reported as the most common reason for dispensing antibiotics without prescription [35]. Evidence from Eastern Nepal also showed that understanding of appropriate antibiotic dispensing varied according to qualifications and work experience, despite widespread recognition that dispensing antibiotics without a valid prescription is problematic [36]. A study of community pharmacists in Lahore, Pakistan reported generally adequate knowledge and positive attitudes but poorer dispensing practices, indicating that awareness does not always translate into appropriate practice [37]. These findings support the interpretation that knowledge and attitudes are important components of appropriate dispensing, but their effects operate within a broader set of professional and market influences.

The association between licensed pharmacy status and higher knowledge and practice scores is also important. In Bangladesh, licensed outlets operate within a more formal regulatory structure and are more likely to be linked with pharmacy qualification, accreditation and regulatory oversight. Earlier intervention research in Dhaka showed that educational guidance could improve some antibiotic-dispensing behaviours, although commercial and customer pressures continued to limit adherence to recommended practice [38]. A Good Pharmacy Practice intervention among Grade C pharmacists in Bangladesh similarly demonstrated improvements in several dispensing behaviours among trained participants, supporting the value of structured capacity-building [15]. Comparable evidence from Nepal indicates that pharmacy personnel with stronger professional qualifications tend to have better understanding of antibiotic indications and AMR-related consequences [36]. The present findings therefore add to regional evidence that formalisation, training, oversight and also licensing may contribute to better dispensing-related competencies and also to address the full range of pressures influencing practice.

The finding that drug sellers with Grade A, B or C pharmacy-related education had lower overall attitude scores than those with pharmacy education below Grade C deserves particular consideration. Item-level analyses indicated that the difference was concentrated in perceptions of the effectiveness of antibiotic colour-strip initiatives, customer awareness and advice-seeking, and the contribution of drug sellers to AMR, whereas responses concerning personal responsibility, participation in AMR-prevention activities, collaboration with healthcare professionals and continuous learning were broadly similar between groups. One possible explanation is that drug sellers with higher levels of pharmacy-related education may have greater awareness of the expected roles of drug sellers, customers and other stakeholders in promoting appropriate antibiotic use and preventing AMR, and may therefore assess existing practices and interventions more critically. This could have contributed to their comparatively lower overall attitude scores. This interpretation is compatible with findings from Nepal, where dispensers with pharmacy educational backgrounds generally demonstrated stronger knowledge of the causes and consequences of AMR [36], and with studies from Pakistan and India showing that professional knowledge may coexist with critical views of current dispensing systems and persistent gaps in practice [36, 38].

The qualitative findings further demonstrate that customer demand and affordability are central to antibiotic-dispensing decisions. Participants described customers requesting antibiotics on the basis of previous prescriptions, advice from acquaintances or expectations of rapid symptom relief, and some customers purchasing only part of a course because of financial constraints. These observations closely resemble findings from Nepal, where over-the-counter antibiotic use was described as a convenient and less costly alternative to formal healthcare, particularly when consultation involved additional time, travel and expense [39]. In Lahore, Pakistan, unwillingness to visit a physician for non-serious illness was the most frequently reported reason for dispensing antibiotics without prescription [37]. A systematic review of qualitative studies from LMICs likewise identified customer demand, expectations, affordability

and barriers to formal healthcare as recurrent drivers of non-prescribed antibiotic sales [40]. The convergence of these findings across South Asia and other LMICs suggests that interventions directed solely at drug sellers are unlikely to be sufficient without parallel efforts to address community expectations and access to affordable formal care.

Competitive pressure between pharmacies was another prominent theme. Drug sellers described concern that refusing a requested antibiotic or insisting on a full course could lead customers to purchase elsewhere, with potential loss of both immediate sales and future business. Similar tensions between professional responsibility and commercial survival have been reported in Haryana, India, where pharmacy employees described customer retention and business competition as important drivers of inappropriate antibiotic dispensing [41]. In Eastern Nepal, 62.8% of pharmacy personnel believed that refusing to dispense antibiotics without prescription could adversely affect pharmacy sales and profit, and 88.1% believed that customers would seek antibiotics from another pharmacy after refusal [36]. Systematic reviews across LMICs have consistently identified the business orientation of medicine outlets, fear of losing customers and competitive pressure as major determinants of non-prescription antibiotic dispensing [39, 42]. The coexistence of licensed and non-licensed pharmacies within the same local areas in Mirpur may therefore have practical implications for compliance, because individual sellers may perceive adherence to prescription requirements as commercially disadvantageous when neighbouring outlets do not follow the same standards.

Participants also identified pharmaceutical company incentives and promotional activities as influences on antibiotic-selling decisions. This finding is supported by earlier qualitative work in Bangladesh, where drug dispensers reported receiving discounts, gifts and other financial or promotional incentives from pharmaceutical companies and described company representatives as important sources of information about medicines [12]. Comparable evidence from Nepal has shown that pharmaceutical representatives may provide monetary and non-monetary incentives and that dispensers may preferentially sell products promoted through such incentives [39]. These findings highlight the commercial dimension of antibiotic stewardship and suggest that attention to promotional practices and ethical marketing should complement interventions focused on individual knowledge and regulatory compliance.

The expressed demand for further training is consistent with both national and regional evidence. In the present study, training interest was positively associated with knowledge and attitude, while participants in the FGDs called for additional training on prescription-based dispensing, counselling, course completion and AMR. In Bangladesh, Good Pharmacy Practice training has been associated with improvements in dispensing behaviour [15], while more recent evidence also indicates that antimicrobial-stewardship training is associated with more favourable attitudes and better dispensing practices among community pharmacists [43]. Pakistani community pharmacists have similarly expressed support need for counselling, stewardship activities and educational interventions [37], and community pharmacy personnel in India and Nepal have demonstrated both willingness to contribute to AMR prevention and persisting knowledge gaps that could be addressed through continuing professional education [38, 41]. These findings support an approach in which initial pharmacy education is complemented by periodic, practice-oriented refresher training linked to current dispensing guidance and AMR stewardship.

The findings on regulatory monitoring and enforcement also align strongly with evidence beyond Bangladesh. Participants argued that consistent supervision across pharmacies is necessary because selective compliance may place individual sellers at a competitive disadvantage. In Nepal, researchers have documented widespread awareness that antibiotics should not be dispensed without prescription alongside continued over-the-counter access and concerns about weak policy enforcement [37, 41]. In Pakistan, dispensing without prescription remains common despite regulatory provisions, with recent studies calling for stronger implementation of stewardship and dispensing policies [37]. Across LMICs, systematic reviews have identified weak enforcement, limited inspection and inconsistent sanctions as recurrent structural drivers of non-prescription antibiotic dispensing [39, 42]. These observations support the need for regulatory strategies that are consistent across outlets and are combined with feasible mechanisms for education, accreditation and supportive supervision rather than relying on isolated enforcement alone.

The gender composition of the study population also reflects the wider pharmacy workforce reported in Bangladesh. Almost all participants in the present study were male (98.5%). Previous Bangladesh pharmacy studies have similarly reported exclusively or overwhelmingly male drug sellers, including a Dhaka intervention study in which all participating drug sellers were male [38]. This consistency suggests that the marked male predominance observed here is characteristic of the retail pharmacy workforce encountered in similar Bangladesh settings rather than being generated solely by the sampling procedure. The current study nevertheless contributes additional evidence from a randomly selected urban pharmacy sample in which licensed and non-licensed outlets were both represented.

Overall, the quantitative and qualitative findings reinforce each other. Knowledge and attitude were positively related to practice, but the qualitative findings show why knowledge alone may be insufficient: dispensing decisions are made in an environment shaped by customer affordability, expectations, commercial competition, promotional incentives and variable regulatory enforcement. This pattern is consistent with the broader LMIC literature, which conceptualises non-prescription antibiotic dispensing as a multi-level problem involving individual knowledge and attitudes, pharmacy characteristics, market incentives, customer behaviour, healthcare access and the regulatory environment [39, 42]. For urban Bangladesh, the findings therefore support a coordinated approach that combines continuing education and practical stewardship training for drug sellers, community awareness, consistent regulatory monitoring, ensure licensing, attention to commercial incentives and stronger linkage between community pharmacies and the formal health system. Such an approach is closely aligned with Bangladesh's National Strategy and Action Plan for AMR Containment 2023–2028, which emphasises workforce capacity, stewardship, surveillance and regulatory strengthening [44].

Limitations

This study has some limitations. Expansion of the study to additional geographical areas was constrained by available study resources. In addition, some pharmacies included in the original mapping database were no longer operational at the time of the KAP survey, which was conducted few months after the mapping exercise during a period of political unrest. Where this occurred, replacement pharmacies were randomly selected from the remaining unsampled pharmacies within the corresponding licensed or non-licensed stratum using the same sampling procedure.

Conclusion

This mixed-methods study highlights the important role of drug sellers in antibiotic use and AMR prevention in an urban setting in Bangladesh. Drug sellers demonstrated moderate levels of AMR-related knowledge, attitudes and practices, with comparatively high interest in further training. Knowledge, attitudes and practices were positively interrelated, while general education, duration of training or experience and pharmacy licensing status showed differing associations with these outcomes.

The qualitative findings further showed that antibiotic dispensing practices occur within a complex environment shaped by customer demand and affordability, competition between pharmacies, commercial influences, training needs and regulatory oversight. Together, the quantitative and qualitative findings indicate that improving antibiotic dispensing practices requires attention to both drug sellers' knowledge and competencies and the wider environment in which dispensing decisions are made.

These findings support the importance of structured training and supportive supervision of drug sellers, strengthened and consistent regulatory monitoring, and community awareness regarding appropriate antibiotic use. Greater engagement of drug sellers within antimicrobial stewardship and AMR-control initiatives may provide an important opportunity to promote appropriate antibiotic use in urban Bangladesh.

Declarations

Funding declaration

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Clinical trial number

Not applicable.

Ethical Approval and accordance

Ethical approval for the study was obtained from the Bangladesh Medical Research Council (BMRC; Registration Number 577 29 022024) and the School of Medicine Research Ethics Committee (SoMREC), University of Leeds (Application Reference MREC 23-060). The study was conducted in accordance with the guidelines and regulations of the approving ethics committees.

Consent to participate

Informed consent to participate was obtained from all participants before data collection. All study participants were aged 18 years or older; no participants under 18 years of age were involved in the study.

Consent to publish

Not applicable.

Conflict of interest

The authors declare that they have no conflict of interest.

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Author contribution statement

AHC, RH, HE conceptualized topics of the manuscript. AHC, RH, BS contributed in preparing write up of background, objectives, methods part. AHC, BS prepared data collection tool. AHC did the data management, analysis and interpretation of results. AHC, RH, HE, BS contributed in preparing discussion section. HE, RK, NJ critically reviewed the paper. AHC addressed the feedback of reviewers.

Data availability statement

The data-sets used and/or analysed during the current study are available from the corresponding author, Asiful Haidar Chowdhury (asifulhc@gmail.com), on reasonable request.

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Tables

Table 1: Knowledge, attitude, practice, and training interest items on antimicrobial resistance used in the KAP survey (Response collected in 5-point Likert scale (strongly disagree to strongly agree))

Knowledge (n=7)	Attitude (n=25)	Practice (n=13)	Training interest (n=5)
●I possess a comprehensive understanding of Antimicrobial Resistance (AMR)	●I consider addressing AMR crucial for public health	●I consistently follow proper guidelines when dispensing antibiotics	●I am willing to participate in training programs on antibiotic dispensing and AMR
●I can identify the factors contributing to the development of AMR	●I feel personally responsible for preventing the misuse of antibiotics	●I always ask for prescriptions before selling antibiotics to customers	●I believe training programs can improve my knowledge and practices in antibiotic dispensing
●My knowledge of the consequences of AMR is comprehensive	●I believe healthcare providers should actively educate the public about AMR	●I provide detailed information to customers on how to use antibiotics	●I think continuous training is essential for drug sellers to combat AMR effectively
●I am aware of the correct usage of antibiotics to prevent AMR	●I think stricter regulations are needed to control the sale of antibiotics	●The introduction of new colored strips has influenced my antibiotic dispensing practices	●I am open to adopting new practices learned through training to prevent AMR
●I believe antibiotic dispensing without a prescription contributes to AMR	●I consider the new colored strips effective in preventing antibiotic misuse	●I have regular communication with healthcare professionals regarding antibiotic dispensing	●Drug sellers should be educated and trained to be more aware of AMR consequences
●I am aware of the new colored strips introduced for antibiotics	●I believe the new colored strips are helpful in educating customers about antibiotic use	●Consultation with healthcare professionals positively impacts my antibiotic dispensing practices	
●I am well-informed about the existing regulations on antibiotic dispensing	●I believe drug sellers play a significant role in contributing to AMR	●Customer demands influence my antibiotic dispensing practices	
	●I think drug sellers should be actively involved in AMR prevention initiatives	●I believe my antibiotic dispensing practices align with ethical standards	
	●The advice provided by drug sellers can influence the antibiotic usage patterns of customers	●I regularly reflect on my antibiotic dispensing practices to identify areas for improvement	
	●I believe collaboration with healthcare professionals can enhance my understanding of AMR	●I am confident in my ability to identify situations requiring antibiotic dispensing	
	●Healthcare professionals should provide more guidance to drug sellers on AMR prevention	●Continuous improvement in antibiotic dispensing practices is essential for preventing AMR	
	●Customers are generally well-informed about the risks of antibiotic misuse	●I actively seek information to stay updated on best practices in antibiotic dispensing	
	●I have observed an increase in awareness among customers regarding AMR	●The COVID-19 pandemic has influenced antibiotic dispensing practices	
	●Customers actively seek advice on antibiotic usage and AMR prevention		
	●Current regulations effectively control antibiotic dispensing practices		
	●Stricter regulations are necessary to curb antibiotic misuse		
	●Compliance with regulations is a shared responsibility of both drug sellers and regulatory authorities		
	●I actively support campaigns aimed at preventing antibiotic resistance		
	●Public awareness campaigns effectively communicate the risks of antibiotic misuse		
	●I believe that public awareness campaigns positively influence customer behavior		
	●Drug sellers should actively participate in antibiotic resistance prevention campaigns		
	●I feel a personal responsibility to contribute to the prevention of Antimicrobial Resistance		
	●Implementing proper antibiotic dispensing practices is a personal responsibility		

Table 1: Knowledge, attitude, practice, and training interest items on antimicrobial resistance used in the KAP survey (Response collected in 5-point Likert scale (strongly disagree to strongly agree))			
Knowledge (n=7)	**Attitude (n=25)**	**Practice (n=13)**	**Training interest (n=5)**
	●I am committed to continuous learning to improve my role in preventing AMR ●I believe there was a need for specific guidelines to address antibiotic dispensing during pandemics		

Table 2: Sociodemographic and professional characteristics of participating drug sellers		
Issues	**Value (%, Mean ± SD, or Median [IQR])**	**n**
Sex		
Male	98.5	394
Female	1.5	6
Age (in completed years)	40.6 ± 12.2	400
	40.0 [17.7]	
General educational qualification		
Higher secondary or below	51.0	204
Graduate or above	49.0	196
Educational background in Pharmacy		
Yes		
No	83.0	332
	17.0	68
Specific pharmacy qualifications (multiple responses)		
Graduate pharmacist and above (Grade A)		
Diploma pharmacist (Grade B)	4.3	17
Pharmacy Technician (Grade C)		
Pharmacy Technician & above	15.3	61
(Grade A or B or C)	53.5	214
Below pharmacy technician	69.3	277
	13.8	55
Have training or prior experience in drug dispensing and other role	100.0	400
Duration of training or prior experience in drug dispensing and other role (Years)		
Mean ± SD		
Median (IQR)		
	14.8 ± 10.3	400
	13.0 [14.0]	
Type of Pharmacy (KAP Survey)		
Licensed (Formal)	57.3	229
Non-licensed (Informal)	42.8	171
Note: SD = standard deviation; IQR = interquartile range		

Table 3. Distribution of AMR-related POMP scores among drug sellers by selected characteristics

Independent variables	Knowledge POMP score	Attitude POMP score	Practice POMP score	Training-interest POMP score
	Mean ± SD (n) [95% CI] Median (IQR)	Mean ± SD (n) [95% CI] Median (IQR)	Mean ± SD (n) [95% CI] Median (IQR)	Mean ± SD (n) [95% CI] Median (IQR)
General education level				
Higher secondary or below	74.0 ± 6.9 (204) [73.0 to 75.0] 75.0 (75.0–75.0)	72.1 ± 7.4 (204) [71.1 to 73.2] 73.0 (67.0–76.0)	68.9 ± 7.3 (204) [67.9 to 69.9] 69.2 (63.5–73.1)	76.0 ± 8.0 (204) [74.9 to 77.1] 75.0 (75.0–80.0)
Graduate or above	76.5 ± 6.1 (196) [75.6 to 77.3] 75.0 (75.0–78.6)	72.5 ± 7.8 (196) [71.3 to 73.5] 73.0 (67.0–77.0)	70.2 ± 6.9 (196) [69.3 to 71.2] 71.2 (65.4–73.1)	77.3 ± 8.9 (196) [76.0 to 78.5] 75.0 (75.0–80.0)
Comparison / overall P value	Mean diff. 2.46 [1.17 to 3.74] P <0.001***	Mean diff. 0.31 [-1.19 to 1.81] P 0.683	Mean diff. 1.34 [-0.05 to 2.73] P 0.059	Mean diff. 1.24 [-0.43 to 2.91] P 0.145
Pharmacy-related education				
Below Grade C	73.9 ± 8.1 (123) [72.5 to 75.4] 75.0 (75.0–78.6)	73.8 ± 7.3 (123) [72.5 to 75.1] 75.0 (68.5–78.0)	70.3 ± 7.8 (123) [68.9 to 71.7] 71.2 (65.4–75.0)	77.2 ± 7.9 (123) [75.8 to 78.6] 75.0 (75.0–80.0)
Grade A/B/C	75.8 ± 5.8 (277) [75.1 to 76.5] 75.0 (75.0–75.0)	71.6 ± 7.7 (277) [70.7 to 72.5] 72.0 (67.0–76.0)	69.2 ± 6.8 (277) [68.4 to 70.0] 69.2 (65.4–73.1)	76.4 ± 8.8 (277) [75.3 to 77.4] 75.0 (75.0–80.0)
Comparison / overall P value	Mean diff. 1.85 [0.25 to 3.44] P 0.024*	Mean diff. -2.19 [-3.77 to -0.60] P 0.007**	Mean diff. -1.12 [-2.73 to 0.49] P 0.172	Mean diff. -0.81 [-2.54 to 0.93] P 0.363
Duration of training or experience in drug dispensing and other roles				
<=9 years	74.6 ± 7.3 (143) [73.4 to 75.8] 75.0 (75.0–75.0)	72.7 ± 7.3 (143) [71.5 to 73.9] 74.0 (68.0–77.0)	69.2 ± 6.6 (143) [68.1 to 70.3] 69.2 (65.4–73.1)	76.7 ± 8.4 (143) [75.3 to 78.1] 75.0 (75.0–80.0)
10-18 years	74.8 ± 5.3 (135) [73.9 to 75.7] 75.0 (75.0–75.0)	71.3 ± 7.2 (135) [70.1 to 72.6] 72.0 (67.0–75.0)	68.9 ± 7.3 (135) [67.7 to 70.2] 69.2 (63.5–73.1)	75.2 ± 8.5 (135) [73.8 to 76.7] 75.0 (75.0–80.0)
>=19 years	76.4 ± 7.1 (122) [75.1 to 77.7] 75.0 (75.0–78.6)	72.8 ± 8.3 (122) [71.3 to 74.3] 73.5 (67.0–78.0)	70.7 ± 7.4 (122) [69.4 to 72.0] 71.2 (67.3–75.0)	78.2 ± 8.4 (122) [76.7 to 79.7] 75.0 (75.0–80.0)
Comparison / overall P value	P 0.071	P 0.192	P 0.121	P 0.022*
Type of pharmacy				
Non-licensed (Informal)	74.0 ± 5.5 (171) [73.2 to 74.8] 75.0 (75.0–75.0)	71.4 ± 7.0 (171) [70.4 to 72.5] 71.0 (67.0–75.0)	67.9 ± 6.6 (171) [66.9 to 68.9] 69.2 (63.5–71.2)	75.3 ± 7.4 (171) [74.2 to 76.5] 75.0 (75.0–75.0)
Licensed (Formal)	76.1 ± 7.3 (229) [75.2 to 77.1] 75.0 (75.0–78.6)	72.9 ± 8.0 (229) [71.9 to 74.0] 74.0 (67.0–77.0)	70.8 ± 7.3 (229) [69.8 to 71.8] 71.2 (65.4–75.0)	77.6 ± 9.1 (229) [76.4 to 78.8] 75.0 (75.0–80.0)
Comparison / overall P value	Mean diff. 2.15 [0.89 to 3.40] P <0.001***	Mean diff. 1.49 [0.01 to 2.97] P 0.049*	Mean diff. 2.89 [1.52 to 4.25] P <0.001***	Mean diff. 2.25 [0.62 to 3.87] P 0.007**
Age group				
17-35 years	75.3 ± 6.9 (145) [74.2 to 76.4] 75.0 (75.0–78.6)	72.6 ± 7.6 (145) [71.3 to 73.8] 74.0 (67.0–76.0)	70.0 ± 6.9 (145) [68.8 to 71.1] 71.2 (65.4–73.1)	77.5 ± 8.0 (145) [76.2 to 78.8] 75.0 (75.0–80.0)
36-45 years	74.3 ± 5.3 (131) [73.3 to 75.2] 75.0 (75.0–75.0)	71.2 ± 7.2 (131) [70.0 to 72.4] 71.0 (67.0–75.0)	68.0 ± 6.0 (131) [67.0 to 69.1] 67.3 (63.5–71.2)	75.3 ± 8.5 (131) [73.9 to 76.8] 75.0 (75.0–75.0)
46-75 years	76.1 ± 7.5 (124) [74.8 to 77.4] 75.0 (75.0–78.6)	73.1 ± 8.0 (124) [71.7 to 74.5] 74.0 (67.0–77.2)	70.7 ± 8.1 (124) [69.3 to 72.2] 71.2 (65.4–75.0)	77.0 ± 9.0 (124) [75.4 to 78.6] 75.0 (75.0–80.0)
Comparison / overall P value	P 0.068	P 0.113	P 0.005**	P 0.086
Knowledge POMP score group				
<=75	—	70.4 ± 6.5 (301) [69.6 to 71.1] 71.0 (66.0–75.0)	67.9 ± 6.2 (301) [67.2 to 68.6] 69.2 (63.5–71.2)	74.6 ± 6.8 (301) [73.9 to 75.4] 75.0 (75.0–75.0)

Table 3. Distribution of AMR-related POMP scores among drug sellers by selected characteristics

Independent variables	Knowledge POMP score	Attitude POMP score	Practice POMP score	Training-interest POMP score
	Mean ± SD (n) [95% CI] Median (IQR)	Mean ± SD (n) [95% CI] Median (IQR)	Mean ± SD (n) [95% CI] Median (IQR)	Mean ± SD (n) [95% CI] Median (IQR)
>75	—	78.1 ± 7.9 (99) [76.5 to 79.7] 78.0 (74.0–83.0)	74.7 ± 7.3 (99) [73.2 to 76.1] 75.0 (69.2–80.8)	82.7 ± 10.0 (99) [80.7 to 84.7] 80.0 (75.0–90.0)
Comparison / overall P value	—	Mean diff. 7.72 [5.99 to 9.46] P <0.001***	Mean diff. 6.75 [5.15 to 8.36] P <0.001***	Mean diff. 8.09 [5.96 to 10.23] P <0.001***
Attitude POMP score group				
<=69	—	—	64.9 ± 5.7 (152) [64.0 to 65.8] 65.4 (61.5–69.2)	73.9 ± 7.3 (152) [72.7 to 75.1] 75.0 (75.0–75.0)
70-75	—	—	70.2 ± 4.8 (127) [69.4 to 71.1] 71.2 (67.3–73.1)	74.5 ± 6.5 (127) [73.3 to 75.6] 75.0 (75.0–75.0)
>75	—	—	74.7 ± 7.0 (121) [73.5 to 76.0] 75.0 (71.2–80.8)	82.3 ± 9.0 (121) [80.7 to 83.9] 80.0 (75.0–90.0)
Comparison / overall P value	—	—	P <0.001***	P <0.001***

Notes: POMP = percentage of maximum possible score (0–100); SD = standard deviation; CI = confidence interval; IQR = interquartile range. For two-category independent variables, P values and mean differences are from Welch's independent-samples t-test; for variables with three categories, P values are from Welch's one-way ANOVA. The reported mean difference is the second listed category minus the first listed category. *P<0.05; **P<0.01; ***P<0.001.

Table 4. Associations between AMR-related POMP scores among drug sellers

Pairs of variables	Spearman's ρ	Strength	P value	95% CI Lower	95% CI Upper
Knowledge – practice	0.427	Moderate	<0.001	0.334	0.518
Knowledge – Attitude	0.380	Weak	<0.001	0.269	0.473
Knowledge – Training interest	0.460	Moderate	<0.001	0.358	0.551
Practice – Attitude	0.648	Strong	<0.001	0.576	0.713
Practice – Training interest	0.424	Moderate	<0.001	0.329	0.514
Attitude – Training interest	0.429	Moderate	<0.001	0.327	0.521

Notes: POMP = percentage of maximum possible score. Spearman rank correlations are reported with percentile bootstrap 95% confidence intervals based on 2,000 resamples. Because POMP is a monotonic linear transformation of each raw composite score, the Spearman correlation coefficients are unchanged from analyses using the corresponding raw summed scores.

Figures

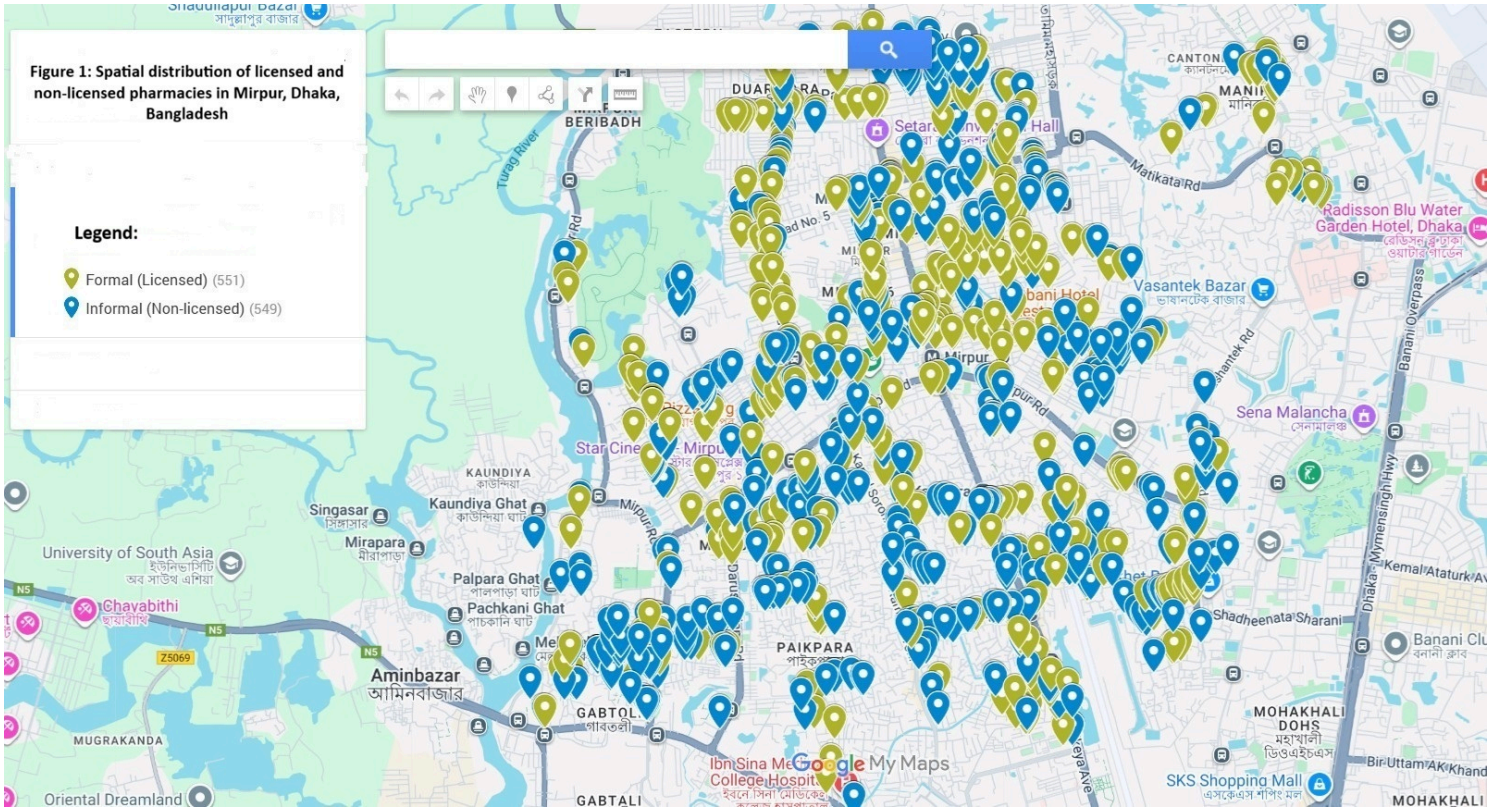


Figure 1

Spatial distribution of licensed and non-licensed pharmacies in study site

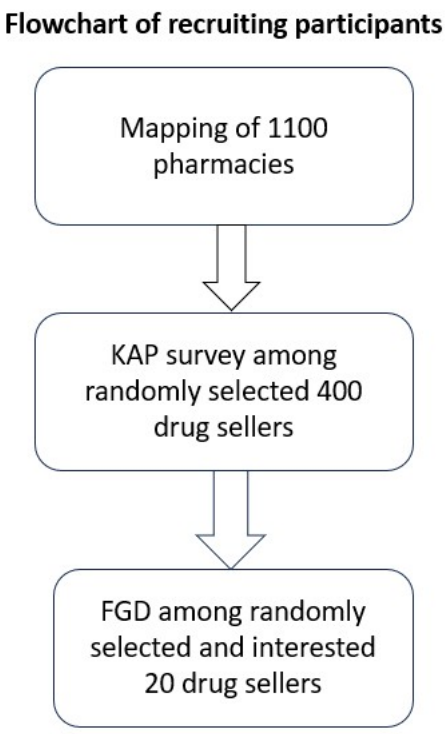


Figure 2

Flowchart of recruiting participants

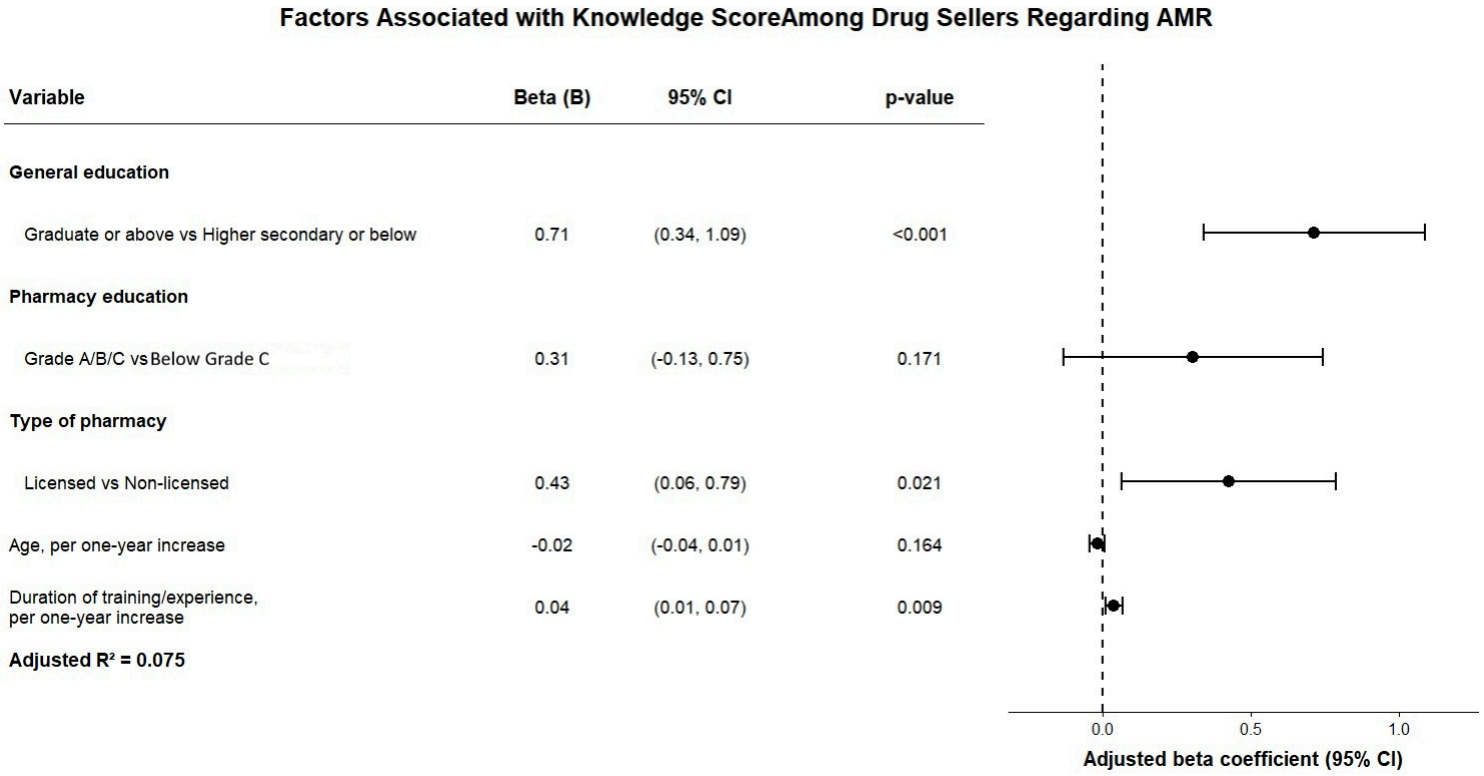


Figure 3

Factors associated with knowledge POMP score among drug sellers

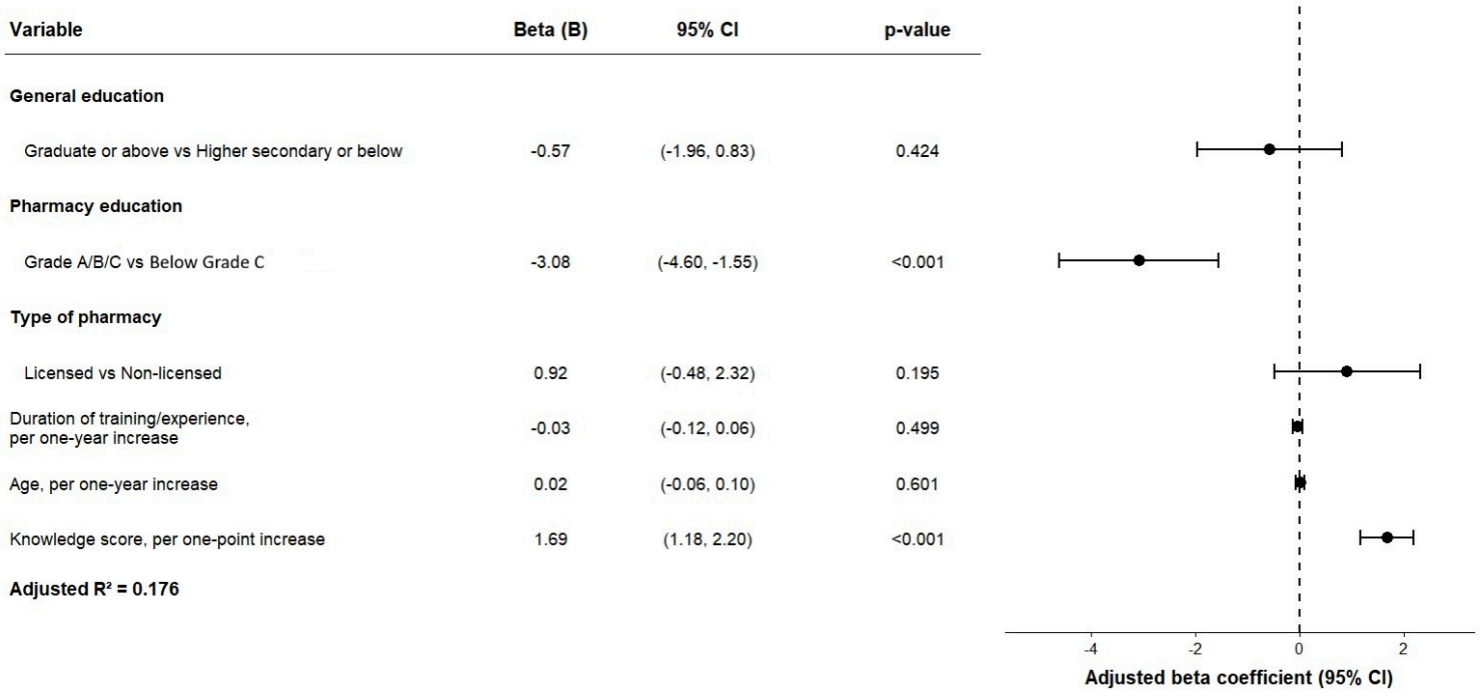


Figure 4

Factors associated with attitude POMP score among drug sellers

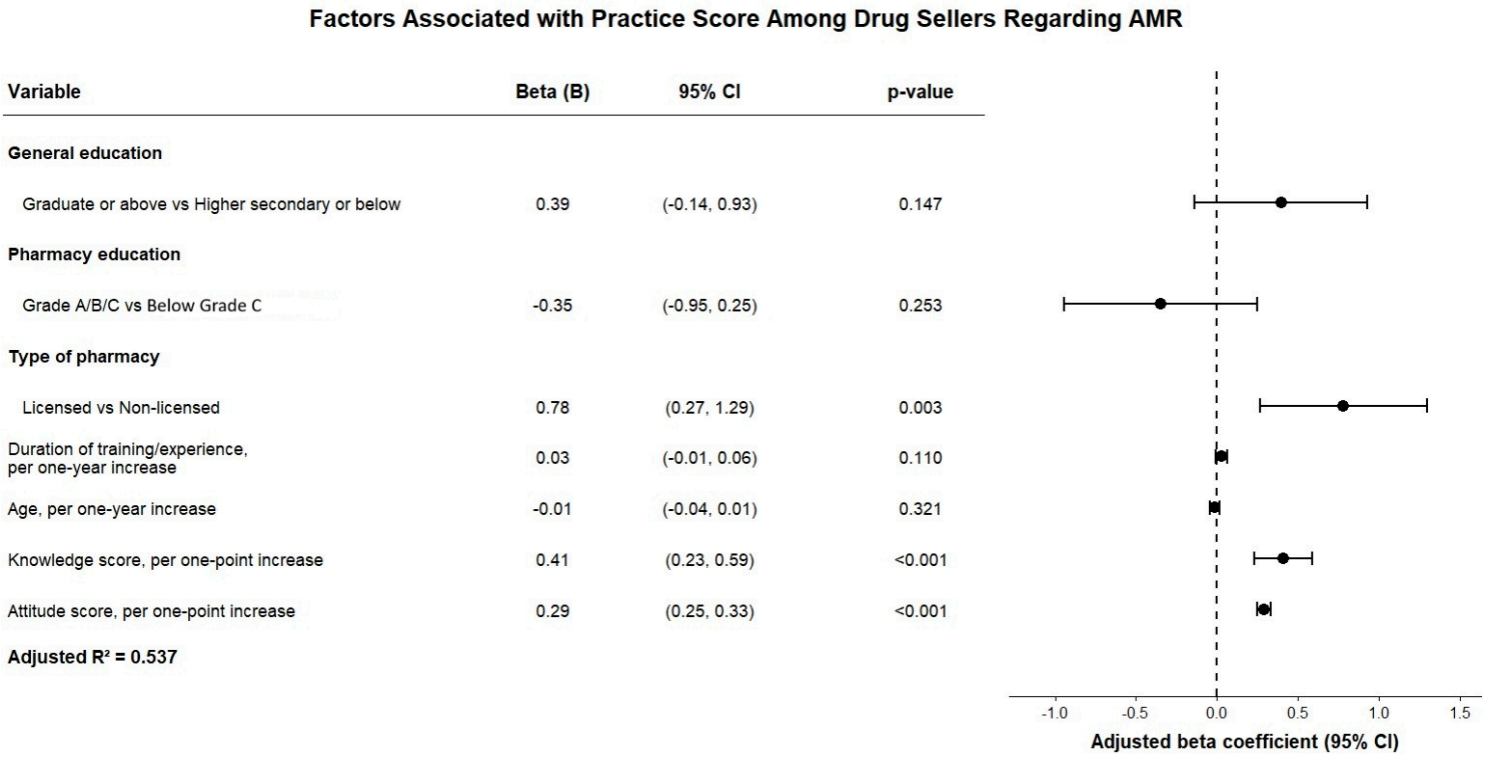


Figure 5

Factors associated with practice POMP score among drug sellers

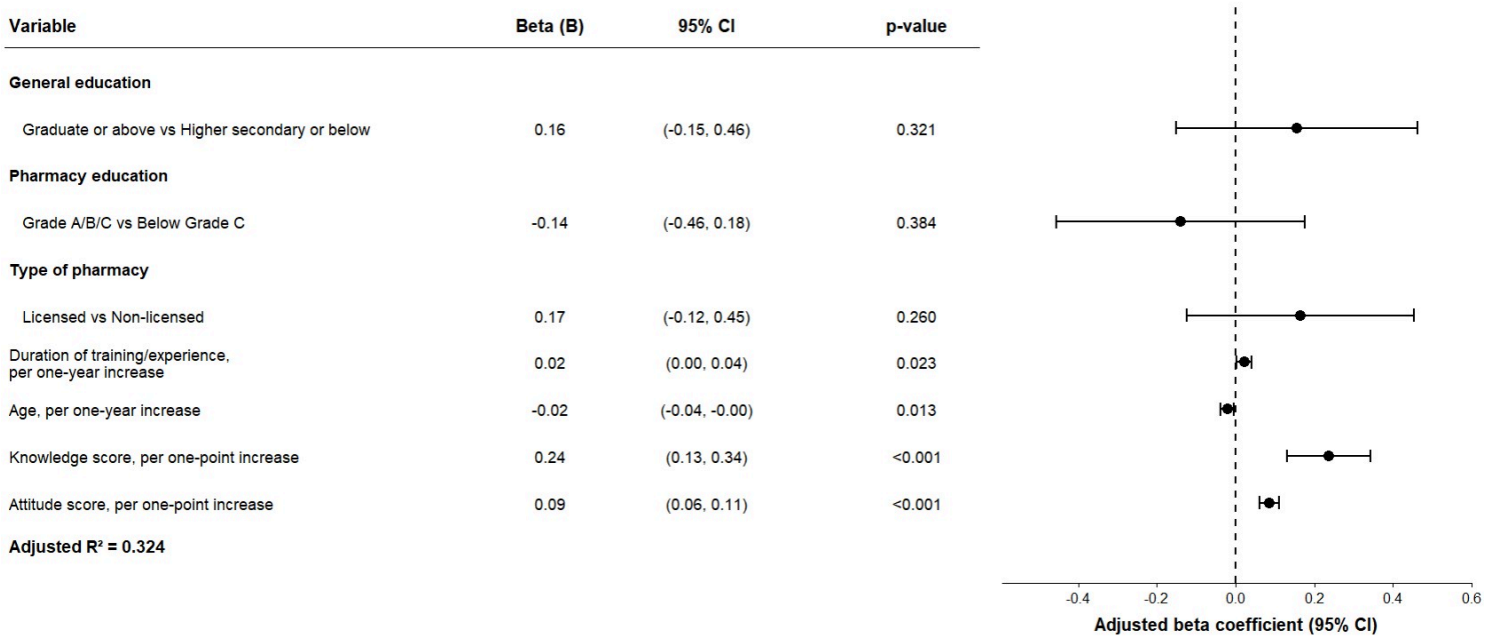


Figure 6

Factors associated with training-interest POMP score among drug sellers

Supplementary Files

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- DSAMR22092026Supplementalfile.docx