International Journal of Computational Research and Development (IJCRD)
International Peer Reviewed - Refereed Research Journal, Website: www.dvpublication.com
Impact Factor: 5.015, ISSN (Online): 2456 - 3137, Volume 9, Issue 2, July - December, 2024

ASSESSING ASSOCIATIONS BETWEEN PHARMACY CHARACTERISTICS AND NONPRESCRIPTION ANTIBIOTIC DISPENSING ACROSS HEALTH SYSTEMS USING PUBLISHED EVIDENCE

Kannan Vishwanath* & Lloyd Zulu**
* Garwood Innovation Fellow, Garwood Center for Corporate Innovation,
Haas School of Business, Berkeley
** World Christian University, Lusaka, Zambia

Cite This Article: Kannan Vishwanath & Lloyd Zulu, "Assessing Associations Between Pharmacy Characteristics and Nonprescription Antibiotic Dispensing Across Health Systems Using Published Evidence", International Journal of Computational Research and Development, Volume 9, Issue 2, July - December, Page Number 119-127, 2024.
Copy Right: © DV Publication, 2024 (All Rights Reserved). This is an Open Access Article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium provided the original work is properly cited.

Abstract:

This analysis examines whether pharmacy characteristics provide consistent indicators of nonprescription antibiotic availability across health systems. We consolidated 15 published subgroup records representing 1,106 Chinese pharmacies surveyed in 2017 and 225 Ethiopian outlets reported in 2022, using descriptive proportions, absolute differences and unadjusted odds ratios. Chain ownership showed contrasting directions across settings, with confidence intervals encompassing equal odds. Availability was higher among farther outlets across both settings and Ethiopian encounter protocols. In China, the distance difference reached 5.00 percentage points, with an odds ratio of 1.45 and a 95% confidence interval from 1.05 to 2.01. Licensed pharmacist employment accompanied availability 8.67 percentage points lower, although attendance categories had similar proportions. Ethiopian distance estimates remained imprecise. The comparative contribution distinguishes organizational affiliation, professional employment and encounter presence while preserving differences between antibiotic offers and provision. These associations qualify institutional explanations that equate formal arrangements with operational compliance. International surveillance should retain contextual definitions and assess dispensing directly rather than infer compliance from organizational categories.

Key Words: Antibiotic Stewardship; Community Pharmacies; Comparative Analysis; Nonprescription Dispensing; Regulatory Compliance

1. Introduction:

Nonprescription antibiotic availability exposes a gap between formal medicine regulation and dispensing practice. Community pharmacies provide access to treatment, but supplying antibiotics without appropriate clinical assessment can encourage unnecessary use and undermine antimicrobial stewardship. Auta et al., 2019, synthesized 38 studies from 24 countries and estimated that 62% of requests or consultations resulted in nonprescription antibiotic supply. This pooled estimate describes heterogeneous encounters rather than a uniform national prevalence. The substantive question is therefore which observable pharmacy characteristics distinguish dispensing patterns within different health systems. Answering this question can inform how regulators select monitoring indicators and interpret apparent compliance. Ownership structure, geographical access and professional staffing offer distinct explanations for variation in antibiotic availability. Chain ownership may support common procedures and centralized supervision, although commercial incentives may also encourage sales. Greater distance from health facilities may increase the practical burden of obtaining prescriptions, while pharmacist employment may support verification and referral. These mechanisms cannot be inferred from organizational categories alone. Servia-Dopazo and Figueiras, 2018, identify determinants involving pharmacy workers, patients and health systems, indicating that dispensing reflects several interacting pressures. Institutional decoupling provides a complementary theoretical interpretation. Bromley and Powell, 2012, explain how formal organizational arrangements can remain separated from practice and intended outcomes. Applied to antibiotic supply, this perspective suggests that ownership and staffing arrangements require assessment against observed dispensing rather than being treated as evidence of compliance.

The closest empirical research already establishes that these characteristics can accompany different dispensing patterns. Chang et al., 2019, examined 2,411 Chinese pharmacies using simulated encounters and found lower dispensing odds associated with chain affiliation and pharmacist presence. Chen et al., 2020, investigated 1,106 pharmacies across 13 Chinese provinces using encounters conducted during July to September 2017. Their findings distinguished pharmacist employment from attendance and did not identify a statistically discernible overall ownership difference. These investigations do not provide interchangeable estimates: their encounter scenarios, staffing definitions and analytical approaches differ. Their contrast makes the measurement question consequential. An association involving pharmacist presence cannot automatically be interpreted as an association involving employment, and a chain ownership category does not necessarily represent equivalent operational arrangements across samples. Evidence from Ethiopia provides a complementary setting for examining the interpretation of these categories. Belachew et al., 2022, reported 450 simulated encounters at 225 community drug retail outlets, separating clinical scenarios from direct antibiotic requests. Their published table permits ownership and distance comparisons under both protocols, but does not provide the staffing categories used in the Chinese extraction. Outcome formation also differs: the Chinese protocol records antibiotic offers without completed purchases, whereas the Ethiopian investigation records provision. These distinctions matter because combining the observations without retaining their definitions would obscure what the outcome represents. Jacobs et al., 2019, similarly identify methodological and outcome heterogeneity as barriers to comparing evidence on antibiotic enforcement. The reviewed literature therefore supports a bounded research gap: it does not establish that ownership, distance and staffing categories have sufficiently consistent meanings and associations to serve as transferable indicators of nonprescription availability. This study aims to compare nonprescription antibiotic availability across ownership, distance and licensed pharmacist staffing categories while preserving the definitions used by the source investigations. The central research question asks how these

characteristics distinguish observed availability within the sampled Chinese and Ethiopian settings. The analysis compares chain with independent outlets, farther with nearer outlets under each original distance threshold, and pharmacist employment and attendance categories within China. It uses 15 extracted marginal records representing 1,331 underlying outlets. Chinese observations concern encounters conducted in 2017; exact Ethiopian fieldwork dates were not established in the accessible publication. Subgroup proportions, absolute differences and unadjusted odds ratios support separate comparisons by source and protocol. The records describe overlapping groups rather than independent samples or an annual panel.

The contribution is a comparative interpretation of existing evidence rather than the identification of new causal determinants. Our analysis found contrasting ownership directions across settings, consistently higher availability among farther outlets, and lower availability associated with pharmacist employment in China. These patterns qualify the assumption that organizational structure provides a common compliance signal across health systems. Retaining employment separately from attendance, and offers separately from provision, also clarifies the limits of international comparison. The findings can guide surveillance by identifying which characteristics should remain distinct in monitoring records. Their transferability concerns measurement and interpretation; the selected samples do not establish national prevalence, causal mechanisms or the effectiveness of regulatory interventions.

2. Theory, Conceptual Framework and Research Questions:

This analysis uses institutional decoupling theory to explain why formal prescription requirements may coexist with nonprescription antibiotic dispensing. Pharmacies operate between regulatory obligations, professional standards and customer demand. These pressures can create incentives to display compliance while maintaining practices that generate sales. Bromley and Powell, 2012, distinguish formal organizational arrangements from their implementation and intended outcomes. Applied here, ownership and professional staffing may provide structures for compliance without ensuring that each dispensing decision follows prescription requirements. This is a theoretical interpretation rather than a mechanism directly measured in the available data. Nonprescription antibiotic dispensing refers to antibiotic availability without a valid prescription during a simulated client encounter. The operational outcome retains each source protocol: antibiotic offers in China and antibiotic provision in Ethiopia. Morgan et al., 2011, establish that nonprescription antimicrobial access occurs across health systems and involves different retail and professional arrangements. Accordingly, this analysis examines observable pharmacy characteristics rather than treating national prescription rules as sufficient explanations of outlet behavior.

The conceptual framework connects ownership structure, distance from health facilities and licensed pharmacist staffing with the proportion of encounters resulting in nonprescription antibiotic availability. These characteristics are observed categories, not indicators of a latent scale or components of a composite index. We examine each association separately within the available source data. The framework represents potential associations rather than causal effects, and its interpretation remains specific to the sampled outlets and encounter protocols. Ownership structure distinguishes chain pharmacies from independent outlets. Chain affiliation may strengthen compliance through shared procedures, centralized supervision and reputational exposure across branches. Conversely, common sales targets may reinforce commercial pressure. Independent ownership may permit greater discretion, but that discretion can support either professional refusal or accommodation of customer demand. Organizational form therefore provides competing theoretical expectations rather than a universally protective effect. Chen et al., 2020, reported no statistically discernible difference in overall nonprescription antibiotic availability between chain and independent pharmacies in their Chinese sample. This finding limits any assumption that chain affiliation necessarily translates into effective control. The available categories support a direct comparison of dispensing proportions by ownership, while leaving internal supervision and commercial incentives unmeasured.

RQ1: How does nonprescription antibiotic availability differ between chain and independent outlets within each sampled health system?

Distance from health facilities captures the spatial relationship between medicine outlets and formal clinical services. Greater distance may increase the practical burden of obtaining a prescription, encouraging customers to seek treatment directly from retail outlets. Proximity may facilitate referral and access to prescribing services. However, distance alone does not measure travel time, consultation cost, inspection intensity or the availability of qualified clinicians. Its association with dispensing must therefore remain distinct from these proposed explanations. Belachew et al., 2022, reported dispensing counts for Ethiopian outlets within and beyond one kilometre of health facilities, supporting a comparison using the original spatial categories. The Chinese data instead distinguish pharmacies using a two-kilometre threshold. We retain these definitions and compare dispensing within each source rather than treating the thresholds as equivalent measures of access. The Ethiopian clinical encounters provide the primary comparison, while direct antibiotic requests provide a separate descriptive assessment involving the same outlets.

RQ2: How does nonprescription antibiotic availability differ between nearer and farther outlets under each source's distance definition and encounter protocol?

Licensed pharmacist staffing represents an outlet's recorded professional capacity. Employment may support prescription verification, clinical assessment and referral through established professional routines. Attendance identifies whether that capacity is physically present during the encounter. These measures are related but distinct: employing a pharmacist does not establish continuous supervision, while attendance alone does not establish that professional judgement determines the transaction. Chang et al., 2019, found that pharmacist presence was associated with lower odds of nonprescription antibiotic dispensing in a separate Chinese investigation. This supports the professional oversight mechanism without establishing that the relationship applies uniformly across settings. In the available dataset, staffing comparisons are confined to China and distinguish pharmacist attendance, employment without attendance, and absence of licensed pharmacist employment. These categories permit descriptive comparisons without attributing differences to professional competence, enforcement or decision authority.

RQ3: How does nonprescription antibiotic availability vary across licensed pharmacist employment and attendance categories in the Chinese sample?

These research questions are exploratory because the source findings were available when the framework was developed. We describe the direction and magnitude of subgroup differences without presenting expectations as prospectively specified

hypotheses. The 15 extracted records represent overlapping marginal groups rather than 15 independent samples. Accordingly, the framework supports separate descriptive comparisons, preserves differences between source protocols and does not combine the three characteristics into a jointly estimated model.

3. Data:

This analysis documents the provenance, selection and measurement of published pharmacy data from China and Ethiopia. It links the extracted subgroup records to descriptive comparisons of ownership structure, distance from health facilities and licensed pharmacist staffing.

3.1 Data Sources, Population, and Sample Construction:

The dataset combines two published tables rather than individual pharmacy records. The Chinese source is Table 2 of Chen et al., 2020, identified by DOI 10.1186/s13756-019-0655-7 and repository identifier PMC6961359. It reports pharmacy characteristics and antibiotic availability across 13 provinces, based on encounters conducted from July to September 2017. The article is distributed under the Creative Commons Attribution 4.0 licence, with a public domain dedication applying to accompanying data unless otherwise stated. The Ethiopian source is Table 1 of Belachew et al., 2022, identified by DOI 10.1093/jac/dkac341 and repository identifier PMC9704429. It reports dispensing across community drug retail outlets in towns within Gondar and Gojjam. Each retained outlet received a clinical scenario visit and a subsequent direct antibiotic request. The accessible article does not establish exact fieldwork dates; publication timing is therefore not treated as observation timing. The article is openly accessible through Oxford Academic, subject to its stated reuse conditions.

The target population comprises community medicine outlets involved in antibiotic supply within the geographical and sectoral scope. The accessible frame consists of outlets represented in the two selected investigations. Neither source provides a census of the target population. Selection was purposive, and the resulting evidence does not constitute a representative sample of either national health system. The extraction unit is a source, encounter protocol, pharmacy characteristic and category combination. The underlying Chinese observations form a cross section. The Ethiopian observations contain repeated encounters at the same outlets, but the extracted tables provide marginal counts without individual linkage. The combined dataset therefore contains grouped observational evidence rather than an annual panel. Its 15 records represent seven Chinese categories and eight Ethiopian categories. They describe encounter outcomes, not annual flows, stocks or period averages.

Table 1: Sample construction

Stage	Units	Observations	Reason or Rule
China source visits	1,345 pharmacies	1,345 encounters	Pharmacies visited under the source sampling protocol
China source exclusions	239 pharmacies	239 encounter records	Incomplete information or unacceptable departures from the protocol
China retained sample	1,106 pharmacies	1,106 encounters	Complete records retained by the source
Ethiopia earlier survey frame	270 outlets	Not applicable	Participants approached for subsequent simulated visits
Ethiopia consent exclusions	39 outlets	Not applicable	Did not provide consent for subsequent visits
Ethiopia consenting sample	231 outlets	Not applicable	Consented to simulated visits
Ethiopia closure exclusions	6 outlets	Not applicable	One closure in the diarrhoea group and five in the urinary infection group
Ethiopia retained sample	225 outlets	450 encounters	Two encounters per retained outlet
Consolidated extraction	1,331 underlying outlets	15 marginal records	Seven Chinese and eight Ethiopian subgroup records
Final comparisons	Source specific outlet samples	Seven contrasts	Three Chinese, two Ethiopian clinical scenario and two Ethiopian direct request comparisons

The two publications were selected because their tables supplied the categories and denominators required for the framework. This was a purposive evidence selection, not a systematic review with a documented screening denominator. No additional extracted records were removed during calculation. The selection and comparison decisions were not prospectively registered.

3.2 Data Integration, Cleaning, and Quality Assurance:

We appended the extracted records using a common structure containing source identifier, country, encounter protocol, characteristic, category, denominator and outcome count. The integration key combines source identifier, encounter protocol, characteristic and category. No individual pharmacy matching, temporal matching or external data merge was performed. Category labels were harmonized while retaining their substantive definitions. Chain and independent ownership remain distinct categories. Distance retains the original threshold of two kilometres in China and one kilometre in Ethiopia. Chinese staffing retains three categories: a licensed pharmacist attending, a licensed pharmacist employed but absent, and no licensed pharmacist employed. These differences prevent treating the records as interchangeable observations of a common national exposure. The Chinese table reports subgroup denominators and percentages rounded to one decimal place. We recovered the corresponding event counts by rounding each denominator multiplied by its published percentage divided by 100. For every Chinese record, exactly one integer count reproduces the reported percentage at that precision. This is recovery from published numerical constraints rather than imputation of missing encounters. Ethiopian event counts were transcribed directly.

Quality checks confirmed that event counts were integers between zero and their denominators. Within each Chinese characteristic, categories reconcile to 1,106 pharmacies and 925 antibiotic offers. Ethiopian ownership and distance categories each reconcile to 225 outlets, with 198 dispensing events during clinical scenarios and 205 during direct requests. These reconciliations apply separately to each characteristic and protocol. Repeated appearances of outlets across characteristics are genuine marginal representations and were retained. Likewise, Ethiopian encounters under different protocols were retained separately. Their denominators were not summed across characteristics or treated as independent samples across protocols. All 15 records contain the counts required for their respective comparisons. The published percentage field contains seven Chinese values and eight structurally unused Ethiopian entries because exact Ethiopian counts are available. Licensed pharmacist staffing is unavailable for Ethiopian comparisons in the extracted dataset. These absences were not replaced with zero, interpolated or externally matched. Valid high dispensing proportions were retained. The workbook preserves source locations, count provenance and calculation formulas, allowing numerical reconstruction to remain separate from interpretation. This traceability is consistent with the emphasis on transparent estimation and complete reporting discussed by Cumming, 2014.

3.3 Variable Measurement, Construction, and Validation:

The outcome measures nonprescription antibiotic availability during a simulated encounter. In China, availability means that antibiotics were offered without a prescription; medicines were not purchased. In Ethiopia, the outcome records antibiotic provision. We preserve this distinction rather than treating both protocols as identical completed sales.

Table 2: Variable dictionary

Variable or Indicator	Analytical Role	Definition and Construction	Source and Identifier	Unit and Frequency	Transformation and Direction	Missing Value Rule	Coverage and Limitation
Nonprescription antibiotic availability	Outcome	Event count divided by subgroup denominator	China Table 2; Ethiopia Table 1	Proportion per source and protocol	Higher values indicate greater availability	Requires valid event count and denominator	Offers in China; provision in Ethiopia
Ownership structure	Explanatory characteristic	Chain or independent outlet	Both source tables	Categorical, recorded during encounters	Chain compared with independent	No imputation	Marginal categories do not identify internal governance
Distance from health facilities	Explanatory characteristic	Nearer or farther category under the original threshold	Both source tables	Categorical distance measure	Farther compared with nearer	Preserve original categories	Two kilometre threshold in China; one kilometre threshold in Ethiopia
Licensed pharmacist staffing	Explanatory characteristic	Attending, employed but absent, or not employed	China Table 2	Categorical staffing measure	Employment comparison combines the first two categories	No Ethiopian value constructed	Employment differs from attendance and decision authority
Encounter protocol	Stratification variable	Chinese respiratory scenario; Ethiopian clinical scenario or direct request	Both source tables	Encounter category	Comparisons remain separate by protocol	Retain recorded protocol	Ethiopian protocols involve the same outlets
Outlet denominator	Calculation input	Number of outlets represented by a subgroup	Both source tables	Integer count	No transformation	No replacement	Repeated across marginal characteristics
Antibiotic event count	Calculation input	Recovered Chinese count or directly reported Ethiopian count	Both source tables	Integer count	No normalization before calculation	No imputation	Chinese recovery depends on published rounding precision
No availability count	Calculation input	Denominator minus antibiotic event count	Calculated from source counts	Integer count	Higher values indicate more encounters without availability	Requires both component counts	Not an independently observed field
Source and country identifiers	Record identification	Labels linking each record to its publication and setting	Both source tables	Categorical	No numerical ordering	Complete identifiers required	Identify provenance rather than causal exposures

Equation 1 defines the implemented subgroup proportion.

$$p_g = \frac{y_g}{n_g}$$

Here, p_g is antibiotic availability in subgroup g, y_g is its event count and n_g is its outlet denominator. Multiplication by 100 expresses this proportion as a percentage. Ownership and distance comparisons retain their original binary categories. The staffing comparison combines pharmacist attendance and employment without attendance, then compares this employment category with outlets employing no licensed pharmacist. The three original staffing proportions remain available for descriptive interpretation. No composite score or latent variable was constructed. Across the seven Chinese subgroup records, availability has an unweighted mean of 83.87%, standard deviation of 3.32 percentage points, median of 82.62%, and range from 80.82% to 89.60%. Across the eight Ethiopian records, the corresponding values are 89.30%, 3.71 percentage points, 89.36%, and 83.33% to 95.56%. These statistics summarize overlapping subgroup records, not independent outlet observations or national prevalence. Validation rests on count recovery, denominator reconciliation and agreement with published rounding precision. Because the measures are observed categories and calculated proportions, factor analysis and internal consistency coefficients are not appropriate validation procedures.

3.4 Analytical Framework, Identification, and Reproducibility:

The analysis is descriptive and associational. Its primary quantities are dispensing proportions and differences between observed categories within each source and encounter protocol. Equation 2 defines the implemented absolute contrast.

$$RD = p_E - p_R$$

Here, RD is the risk difference, p_E is availability in the comparison category and p_R is availability in the reference category. Multiplication by 100 expresses the difference in percentage points. The workbook also calculates unadjusted odds ratios using Equation 3.

$$\theta = \frac{ad}{bc}$$

Here, θ is the odds ratio; aand b are event and nonevent counts in the comparison category; and c and d are the corresponding counts in the reference category. Chain ownership is compared with independent ownership, farther outlets with nearer outlets, and pharmacist employment with no pharmacist employment. Equation 4 gives the implemented standard error on the logarithmic scale.

$$s = \sqrt{\frac{1}{a} + \frac{1}{b} + \frac{1}{c} + \frac{1}{d}}$$

Here, s is the estimated standard error of the log odds ratio, and the four counts retain their definitions from Equation 3. All implemented comparison cells contain positive counts, so no continuity correction was applied. Equation 5 gives the corresponding interval bounds.

$$L, U = \exp\{\ln \theta \pm 1.96s\}$$

Here, L and U are the lower and upper bounds of the 95% Wald interval. These intervals assume independent outlet outcomes within each comparison. They do not adjust for geographical clustering, purposive selection or overlapping comparisons. We interpret interval width and substantive magnitude rather than treating exclusion of the null value as sufficient evidence of importance. Greenland et al., 2016, explain why confidence intervals require interpretation alongside design assumptions and sources of bias. The Ethiopian direct request comparisons provide exploratory sensitivity descriptions using the same outlets as the clinical scenarios. They do not establish a causal effect of customer demand because encounter order was fixed and paired outcome transitions are unavailable. No joint regression, covariate adjustment, interaction model or pooled national estimate was implemented.

The principal identification threats are purposive sampling, unmeasured differences between outlet categories and variation in encounter protocols. The contrasts therefore describe observed associations rather than effects of ownership, geographical access or professional staffing. Multiple comparisons were not adjusted, and the results remain exploratory. This interpretation follows the distinction between statistical evidence, effect magnitude and scientific importance emphasized by Wasserstein and Lazar, 2016. The accompanying workbook records extraction timing, source identifiers, original denominators, count provenance and editable formulas. These materials permit reproduction of the implemented comparisons. Interpretation remains conditional on the original distance definitions, the distinction between offers and provision, and the absence of Ethiopian staffing information.

4. Methods:

4.1 Research Design and Analytical Scope:

This analysis uses published aggregate counts to examine differences in nonprescription antibiotic availability across pharmacy characteristics. The design is descriptive and associational. Its estimands are subgroup availability proportions, absolute differences between categories and unadjusted odds ratios within each source and encounter protocol. The underlying observational unit is the medicine outlet, while the extraction unit combines publication, encounter protocol, characteristic and category. The 15 extracted records represent overlapping marginal groups rather than independent observations. Chinese encounters form a cross section, whereas Ethiopian outlets received repeated visits under two protocols. We therefore retained separate comparisons rather than combining the records into a pooled regression.

Useful variation comes from differences between ownership categories, distance categories and licensed pharmacist employment categories. These comparisons address the research questions through observed dispensing patterns. They do not identify causal effects because the characteristics were not assigned experimentally and the aggregate tables do not permit adjustment for their joint distribution. Selection, geographical context and unmeasured outlet differences remain competing explanations. The research questions are exploratory because source findings were available when the comparative framework was developed. We report direction, magnitude and uncertainty without treating statistical separation from the null as confirmation of a causal mechanism.

4.2 Comparison Specification and Measurement Alignment:

The sample construction table and variable dictionary define eligibility, provenance and measurement. The Chinese comparisons each represent 1,106 pharmacies. Ethiopian comparisons each represent 225 outlets, examined separately during clinical scenarios and direct requests. These sample sizes describe the underlying outlets and must not be multiplied by the number of characteristics. The outcome retains its source meaning. Chinese observations record antibiotic offers without a prescription, while Ethiopian observations record antibiotic provision. Chen et al., 2020, document the Chinese encounter procedure, and Belachew et al., 2022, describe the Ethiopian sequence. Retaining this distinction prevents completed provision from being equated with willingness to supply. We implemented five primary contrasts. Three concern China: chain versus independent ownership, farther versus nearer location under the two kilometre threshold, and licensed pharmacist employment versus no licensed pharmacist employment. Two concern Ethiopian clinical scenarios: chain versus independent ownership and farther versus nearer location under the one kilometre threshold. Two additional Ethiopian direct request contrasts provide exploratory sensitivity descriptions.

For the Chinese employment contrast, we combined outlets with an attending licensed pharmacist and outlets employing a pharmacist who was absent. Their original proportions remain separate for descriptive interpretation. This aggregation measures employment status; it does not measure the effect of attendance. Equation 1 defines subgroup availability as the event count divided by its denominator. Equation 2 defines the absolute difference between the comparison and reference proportions. Equation 3 defines the corresponding unadjusted odds ratio from event and nonevent counts. These are separate marginal

comparisons, with no common regression coefficient or pooled country effect. Each characteristic retains its source categories and reference group.

4.3 Data Processing, Estimation and Inference:

We appended the source records under a common structure and identified each record through publication, encounter protocol, characteristic and category. We retained original denominators, reported percentages where applicable, count provenance and source locations. No individual outlet merge or temporal alignment was required. Chinese event counts were recovered by multiplying each subgroup denominator by its reported percentage divided by 100 and rounding to the nearest integer. We then checked whether each recovered count reproduced the published percentage at one decimal place. Every Chinese record had a unique compatible integer. Ethiopian event counts were entered directly. Nonevent counts were calculated by subtracting events from the corresponding denominator. All 15 records contained the quantities required for their comparisons. Structurally unused percentage entries were retained as blank where exact counts were available. Ethiopian staffing information was not constructed. No imputation, interpolation, trimming or winsorization was performed, and no extracted record was removed during calculation.

We calculated proportions before constructing absolute differences and odds ratios. Percentages express proportions multiplied by 100, while absolute differences are reported in percentage points. Denominators determine each subgroup proportion but do not serve as weights in a pooled model. The unweighted mean, sample standard deviation, median and range describe the extracted subgroup proportions separately by source. Because these records overlap, their distribution does not estimate the distribution of individual outlet outcomes. For each odds ratio, Equation 4 calculates the standard error of its natural logarithm from the reciprocals of the four cell counts. Equation 5 constructs the 95% Wald interval by exponentiating the log odds ratio plus and minus 1.96 standard errors. Every implemented cell contained a positive count, so no continuity correction was applied. These intervals assume independent outlet outcomes within each comparison. They do not account for geographical clustering, purposive selection or dependence between overlapping comparisons. No adjustment for multiple comparisons was implemented. We therefore interpret interval width alongside absolute differences and sample composition. Greenland et al., 2016, explain why intervals containing the null cannot establish equivalence, while Wasserstein and Lazar, 2016, caution against treating statistical thresholds as sufficient evidence of scientific importance.

4.4 Validation, Sensitivity and Reproducibility:

Validation focused on the numerical properties of the observed counts and calculated measures. We checked that denominators were positive, events and nonevents were nonnegative integers, and events did not exceed denominators. Within each characteristic and protocol, category totals were reconciled with the corresponding source sample and event total. We also checked record key uniqueness and confirmed that recovered Chinese counts reproduced the published rounding precision. Repeated representations of the same outlets across characteristics were retained as marginal records rather than deleted as duplicates. Ethiopian direct requests were evaluated separately because they involved the same outlets as the clinical scenarios. Their sensitivity role concerns whether descriptive direction and magnitude persist under a different encounter protocol. Without paired outcome transitions, these comparisons do not estimate the effect of changing the request. We assessed sensitivity through the two implemented Ethiopian direct request contrasts, comparing their direction, absolute difference and interval width with the clinical scenario contrasts. These analyses were exploratory. Agreement in direction was not treated as evidence that selection bias or confounding had been eliminated.

The workbook contains the extracted counts, source identifiers, measurement definitions and editable calculation formulas. Workbook construction used JavaScript with the @oai/artifact-tool package; supplementary descriptive summaries used the Python statistics module. The calculations are deterministic and require no random seed, optimization routine or convergence criterion. The exported workbook was checked for spreadsheet error cells. This secondary analysis used published aggregate information without participant contact or identifiable outlet records. Its reproducible contribution is the transparent alignment of established comparisons with source definitions, rather than a new estimator or identification strategy. Preserving numerical provenance and reporting the full set of implemented comparisons supports the transparency emphasized by Cumming, 2014.

5. Findings:

This analysis examines how nonprescription antibiotic availability varies with ownership structure, distance from health facilities and licensed pharmacist staffing. We report subgroup proportions and unadjusted comparisons separately for each source and encounter protocol. The findings address the three research questions without treating observed associations as causal effects.

5.1 Sample Characteristics and Outcome Distribution:

The analytical dataset contains 15 marginal subgroup records representing 1,106 Chinese pharmacies and 225 Ethiopian outlets. The Chinese encounters occurred across 13 provinces during July to September 2017. The source excluded 239 of 1,345 visited pharmacies because of incomplete information or departures from the encounter protocol. Antibiotics were offered without a prescription in 925 retained encounters, corresponding to 83.63%. These were offers rather than completed purchases, consistent with the protocol reported by Chen et al., 2020. The Ethiopian sample contains 450 encounters at 225 outlets, with one clinical scenario visit and one direct antibiotic request per outlet. Antibiotics were provided during 198 clinical encounters, corresponding to 88.00%, and 205 direct requests, corresponding to 91.11%. The source retained these outlets after six closures among 231 consenting outlets. Exact fieldwork dates were not established in the accessible publication. Belachew et al., 2022, document the encounter sequence and the repeated observation of the same outlets.

All extracted records contain valid denominators and outcome counts. Ownership and distance are available for both settings, whereas licensed pharmacist staffing is available only for China. The seven Chinese records and eight Ethiopian records describe overlapping groups. Their denominators therefore cannot be summed to obtain additional independent observations. Availability remained high across the observed categories. Chinese subgroup proportions ranged from 80.82% to 89.60%, while Ethiopian proportions ranged from 83.33% to 95.56%. These ranges describe variation within the extracted categories rather than national prevalence or changes over time.

5.2 Ownership, Geographical Access and Professional Staffing:

Table 3 presents the seven implemented comparisons. Absolute differences are expressed in percentage points. Odds ratios compare the first category with the reference category stated in each row.

Table 3: Nonprescription antibiotic availability by pharmacy characteristic

Setting and Encounter	Comparison Category	Reference Category	Availability in Comparison Category	Availability in Reference Category	Absolute Difference	Unadjusted Odds Ratio	95% Confidence Interval
China, respiratory scenario	Chain	Independent	580 of 702, 82.62%	345 of 404, 85.40%	2.77 points lower	0.81	0.58 to 1.14
China, respiratory scenario	Farther than 2 km	Nearer than 2 km	447 of 518, 86.29%	478 of 588, 81.29%	5.00 points higher	1.45	1.05 to 2.01
China, respiratory scenario	Licensed pharmacist employed	No licensed pharmacist employed	615 of 760, 80.92%	310 of 346, 89.60%	8.67 points lower	0.49	0.33 to 0.73
Ethiopia, clinical scenarios	Chain	Independent	173 of 195, 88.72%	25 of 30, 83.33%	5.38 points higher	1.57	0.55 to 4.53
Ethiopia, clinical scenarios	Farther than 1 km	Within 1 km	41 of 45, 91.11%	157 of 180, 87.22%	3.89 points higher	1.50	0.49 to 4.58
Ethiopia, direct requests	Chain	Independent	179 of 195, 91.79%	26 of 30, 86.67%	5.13 points higher	1.72	0.53 to 5.55
Ethiopia, direct requests	Farther than 1 km	Within 1 km	43 of 45, 95.56%	162 of 180, 90.00%	5.56 points higher	2.39	0.53 to 10.70

Ownership displays contrasting directions across settings. Chinese chain pharmacies had availability 2.77 percentage points below independent pharmacies, whereas Ethiopian chain outlets had availability 5.38 points above independent outlets during clinical scenarios. The Ethiopian direct request comparison retained the same direction, with a difference of 5.13 points. All three ownership intervals include an odds ratio of one. RQ1 therefore yields no consistent directional ownership pattern across the sampled settings, while the interval widths leave room for differences in either direction. Distance shows greater directional consistency. Availability was higher among farther outlets in China and in both Ethiopian encounter protocols. The Chinese difference was 5.00 percentage points, with an odds ratio of 1.45 and a confidence interval from 1.05 to 2.01. Ethiopian differences were 3.89 points during clinical scenarios and 5.56 points during direct requests. Their wider intervals include one. RQ2 is answered descriptively by a common direction across comparisons, with more precise evidence in China under the implemented calculation. The different distance thresholds prevent interpreting these contrasts as equivalent geographical exposures.

Licensed pharmacist employment produced the largest absolute difference among the primary comparisons. Chinese pharmacies employing a licensed pharmacist had availability of 80.92%, compared with 89.60% among pharmacies employing none. The difference was 8.67 percentage points, and the odds ratio was 0.49, with a confidence interval from 0.33 to 0.73. RQ3 therefore identifies lower observed availability among pharmacies with licensed pharmacist employment in the Chinese sample. Attendance categories add an important distinction. Availability was 80.82% where a licensed pharmacist attended and 81.09% where a pharmacist was employed but absent. These proportions were numerically close, whereas both were below the 89.60% observed where no licensed pharmacist was employed. The descriptive pattern concerns employment status more clearly than attendance at the encounter. A separate Chinese investigation by Chang et al., 2019, associated pharmacist presence with lower dispensing odds. Differences in staffing definitions and encounter designs mean that this literature comparison provides context rather than independent validation of the present employment contrast.

5.3 Sensitivity, Precision and Answers to the Research Questions:

The Ethiopian direct request comparisons preserve the ownership and distance directions observed during clinical scenarios. Chain outlets continued to show higher availability than independent outlets, and farther outlets continued to show higher availability than nearer outlets. This consistency concerns descriptive direction. It does not establish that direct requests caused greater availability because the encounters involved the same outlets, occurred in a fixed sequence and lack the paired outcome transitions required to evaluate individual changes. Precision differs across comparisons. The Ethiopian independent category contains 30 outlets, and the farther distance category contains 45. During direct requests, only two farther outlets did not provide antibiotics. The resulting distance interval, from 0.53 to 10.70, spans substantially lower and higher odds. Its point estimate therefore cannot establish a stable effect magnitude. As Greenland et al., 2016, explain, an interval containing the null does not demonstrate equivalence or the absence of an association.

The Chinese distance and staffing intervals exclude one under the implemented assumptions, but these comparisons remain unadjusted. Ownership, staffing and location were not jointly estimated, and the available marginal tables do not establish independence from other outlet characteristics. Statistical separation from the null therefore does not identify a causal mechanism or establish practical importance by itself, consistent with Wasserstein and Lazar, 2016. The findings answer the research questions through three distinct patterns. Ownership has contrasting directions across settings and imprecise estimates. Greater distance accompanies higher availability in each observed comparison, although thresholds and precision differ. Licensed pharmacist employment accompanies lower availability in China, while attendance categories have similar descriptive proportions. These conclusions apply to the sampled outlets and recorded encounter protocols; they do not establish a common causal relationship across health systems.

6. Discussion:

Organizational form alone does not distinguish pharmacies with lower nonprescription antibiotic availability. Table 3 shows opposite ownership patterns across the two settings, while greater distance consistently accompanies higher availability and

licensed pharmacist employment accompanies lower availability in China. The contribution of this analysis lies in comparing these patterns while preserving differences in measurement and encounter protocols. It does not establish previously undiscovered determinants. The ownership contrasts caution against treating chain affiliation as a transferable indicator of regulatory compliance. Institutional decoupling theory provides a useful interpretation: formal organizational arrangements may differ from operational practice, as Bromley and Powell, 2012, explain. The proportions and absolute differences calculated through Equations 1 and 2 reveal that an organizational category can have different descriptive meanings across settings. This redirects attention from ownership labels toward the practices those labels actually represent. Professional staffing provides a more differentiated signal than ownership, but the distinction between employment and attendance matters. Table 3 identifies lower availability among Chinese pharmacies employing a licensed pharmacist, while the original attendance categories have numerically similar proportions. The 8.67 percentage point employment difference calculated through Equation 2 therefore cannot be interpreted as the effect of a pharmacist being present during an encounter. Employment may represent broader organizational capacity, but that explanation remains theoretical because the analysis does not measure supervision or decision authority. Servia-Dopazo and Figueiras, 2018, identify both internal and external determinants of dispensing, supporting an interpretation that extends beyond professional status alone. Chang et al., 2019, separately associate pharmacist presence with lower dispensing odds. Together, these observations show why employment, attendance and professional influence should remain distinct constructs rather than interchangeable measures of oversight.

Geographical distance produces the most consistent descriptive direction across encounter protocols, without establishing a dominant causal pathway. Table 3 shows higher availability among farther outlets in China and Ethiopia, but the Ethiopian estimates remain imprecise. The odds ratios calculated through Equation 3 consequently indicate a recurring spatial pattern rather than a common effect magnitude. Distance could reflect barriers to obtaining prescriptions, differences in referral opportunities or other characteristics of outlet locations; the available categories do not separate these explanations. Jacobs et al., 2019, similarly emphasize that differences in outcomes and evaluation methods complicate comparisons of antibiotic enforcement evidence. The present comparison adds a specific measurement lesson: one kilometre and two kilometre thresholds cannot support a universal distance rule. Spatial categories become informative when interpreted within the clinical access arrangements and encounter definitions from which they were derived. The international relevance rests on heterogeneity within widespread nonprescription access. Auta et al., 2019, document substantial variation across countries, regions and consultation conditions in their global synthesis. Table 3 extends that comparative perspective by showing that ownership contrasts can reverse direction even where availability remains high, whereas distance contrasts retain their direction across the observed protocols. The selected Chinese and Ethiopian samples cannot establish differences between national populations, and their outcomes cannot be ranked as equivalent completed sales. Nevertheless, the comparison challenges the use of a single organizational explanation across health systems. The contribution is methodological as well as substantive: retaining the distinction between offers and provision, and between ownership and staffing, produces a more precise account of what international comparisons can reveal. It also prevents differences in measurement from being presented as differences in institutional performance.

Decision makers can use these findings to improve surveillance design rather than infer the effectiveness of an untested intervention. Table 3 supports retaining ownership, distance and pharmacist staffing as separate monitoring dimensions. Chain affiliation should not substitute for observed dispensing performance, pharmacist employment should not substitute for attendance, and distance categories should retain their original thresholds. Equations 1 and 2 provide interpretable measures of availability and absolute differences, while the intervals from Equation 5 show how much uncertainty surround the odds comparisons. The theoretical refinement is correspondingly bounded: formal structure, spatial location and professional staffing represent distinct organizational features whose associations require contextual interpretation. Research using linked outlet records could examine whether the staffing contrast persists after accounting for ownership and location. The present evidence establishes the value of these distinctions without attributing the observed differences to mechanisms that were not measured.

7. Conclusion and Implications:

Antibiotic stewardship requires evidence of dispensing practice beyond formal organizational arrangements. This analysis shows that institutional categories carry different descriptive meanings across settings, while geographical separation and professional capacity provide distinct signals requiring contextual interpretation. Its contribution is a comparative framework that preserves these distinctions rather than treating organizational characteristics as interchangeable indicators of compliance. The evidence qualifies institutional explanations by showing that formal arrangements cannot reliably substitute for observed practice. It also separates professional affiliation from participation in individual encounters, sharpening how regulatory performance should be assessed. For managers, the findings support recording actual dispensing decisions alongside organizational and professional arrangements, allowing supervision to address documented practices. For regulators, the comparison supports surveillance that retains local definitions, distinguishes offers from completed provision, and assesses outlets directly rather than assigning compliance from their institutional category. Operationally, consistent encounter documentation can improve the traceability of refusals, referrals and antibiotic availability. These implications extend internationally as principles for measurement and oversight, although their effectiveness requires evaluation. Better targeted monitoring could support appropriate medicine access and reduce avoidable exposure without assuming that stricter organizational requirements alone change behavior. The broader theoretical insight is that stewardship assessment must connect institutional arrangements with observable decisions.

The grouped evidence creates opportunities for more precise comparative research. Linked outlet records could separate overlapping characteristics and evaluate whether observed associations persist after adjustment. Longitudinal encounters could examine changes in practice and distinguish stable organizational differences from responses to regulation. Harmonized protocols across additional health systems could assess transferability while preserving clinically meaningful contextual differences. Recording professional decision authority, referral options and encounter outcomes would permit direct investigation of proposed mechanisms. Paired observations could also clarify responses to customer requests. These extensions would strengthen identification and establish which monitoring practices improve appropriate access across diverse institutional environments.

References:

1. Auta, A., Hadi, M. A., Oga, E., Adewuyi, E. O., Abdu-Aguye, S. N., Adeloye, D., Strickland-Hodge, B., & Morgan, D. J. (2019). Global access to antibiotics without prescription in community pharmacies: A systematic review and meta-analysis. Journal of Infection, 78(1), 8-18. https://doi.org/10.1016/j.jinf.2018.07.001
2. Belachew, S. A., Hall, L., & Selvey, L. A. (2022). Magnitude of non-prescribed antibiotic dispensing in Ethiopia: A multicentre simulated client study with a focus on non-urban towns. Journal of Antimicrobial Chemotherapy, 77(12), 3462-3465. https://doi.org/10.1093/jac/dkac341
3. Bromley, P., & Powell, W. W. (2012). From smoke and mirrors to walking the talk: Decoupling in the contemporary world. Academy of Management Annals, 6(1), 483-530. https://doi.org/10.5465/19416520.2012.684462
4. Chang, J., Xu, S., Zhu, S., Li, Z., Yu, J., Zhang, Y., Zu, J., Fang, Y., & Ross-Degnan, D. (2019). Assessment of non-prescription antibiotic dispensing at community pharmacies in China with simulated clients: A mixed cross-sectional and longitudinal study. The Lancet Infectious Diseases, 19(12), 1345-1354. https://doi.org/10.1016/S1473-3099(19)30324-X
5. Chen, J., Wang, Y., Chen, X., & Hesketh, T. (2020). Widespread illegal sales of antibiotics in Chinese pharmacies: A nationwide cross-sectional study. Antimicrobial Resistance & Infection Control, 9, Article 12. https://doi.org/10.1186/s13756-019-0655-7
6. Cumming, G. (2014). The new statistics: Why and how. Psychological Science, 25(1), 7-29. https://doi.org/10.1177/0956797613504966
7. Greenland, S., Senn, S. J., Rothman, K. J., Carlin, J. B., Poole, C., Goodman, S. N., & Altman, D. G. (2016). Statistical tests, P values, confidence intervals, and power: A guide to misinterpretations. European Journal of Epidemiology, 31(4), 337-350. https://doi.org/10.1007/s10654-016-0149-3
8. Jacobs, T. G., Robertson, J., van den Ham, H. A., Iwamoto, K., Bak Pedersen, H., & Mantel-Teeuwisse, A. K. (2019). Assessing the impact of law enforcement to reduce over-the-counter (OTC) sales of antibiotics in low- and middle-income countries; a systematic literature review. BMC Health Services Research, 19, Article 536. https://doi.org/10.1186/s12913-019-4359-8
9. Morgan, D. J., Okeke, I. N., Laxminarayan, R., Perencevich, E. N., & Weisenberg, S. (2011). Non-prescription antimicrobial use worldwide: A systematic review. The Lancet Infectious Diseases, 11(9), 692-701. https://doi.org/10.1016/S1473-3099(11)70054-8
10. Servia-Dopazo, M., & Figueiras, A. (2018). Determinants of antibiotic dispensing without prescription: A systematic review. Journal of Antimicrobial Chemotherapy, 73(12), 3244-3253. https://doi.org/10.1093/jac/dky319
11. Wasserstein, R. L., & Lazar, N. A. (2016). The ASA statement on p-values: Context, process, and purpose. The American Statistician, 70(2), 129-133. https://doi.org/10.1080/00031305.2016.1154108