Mapping access to drug outlets in Vietnam: distribution of drug outlets and the sociodemographic characteristics of the communities they serve

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Summary

Background Drug outlets are a vital first point of healthcare contact in low- and middle-income countries (LMICs), but they are often poorly regulated and counter staff may be unqualified to provide advice. This introduces the risk of easy access to potentially harmful products, including unnecessary antimicrobials. Over-the-counter antimicrobial sales are a major driver of antimicrobial resistance (AMR) in LMICs. We aimed to investigate the distribution of different types of drug outlets and their association with socio-economic factors.

Methods We mapped the location of drug outlets in 40 randomly selected geographic clusters, covering a population of 1.96 million people. Data including type of drug outlet, context, operating hours, chief pharmacist name and qualification, and business registration identification were collected from mandatory public signage. We describe the density of drug outlets and levels of staff qualifications in relation to population density, urban vs rural areas, and poverty indices.

Findings We characterised 1972 drug outlets. In the study area, there was an average of 102 outlets/per 100,000 population, compared to the global average of 25. Predictably, population density was correlated with the density of drug outlets. We found that drug outlets were less accessible in rural vs urban areas, and for the poor. Furthermore, for these populations, degree-qualified pharmacists were less accessible and public signage frequently lacked mandatory registration information.

Interpretation Drug outlets appear over-supplied in Vietnam compared to other countries. Unregistered outlets and outlets without degree-qualified pharmacists are prevalent, especially in poor and rural areas, posing a risk for inappropriate supply of antimicrobials, which may contribute to AMR, and raises questions of equitable healthcare access.

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Keywords: Pharmacy distribution; Antimicrobial resistance; Pharmacy practice; Healthcare access; Vietnam

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Research in context

Evidence before this study

- Drug outlets provide beneficial access to health advice and products, and the problem of pharmacy deserts has been well-described in high-income settings.
- Although drug outlets are the first point of healthcare contact for large proportions of the population in low- and middle-income countries, they are often poorly regulated and counter staff may lack the professional qualifications required to offer reliable advice.
- This introduces the risk of easy access to potentially harmful medications, such as unnecessary antibiotics.
- Over-the-counter (OTC) antibiotic sales have been identified as a major driver of emerging antimicrobial resistance in LMICs, including Vietnam.

Added value of this study

- Our study, using a kerbside mapping strategy, provides geographically representative estimates of characteristics and distribution of 1972 drug outlets across 40 districts in both northern and southern regions of Vietnam.
- The density of drug outlets in Vietnam per 100,000 population is four times greater than the global average.
- However, degree qualified pharmacists are rarely accessible, and drug outlets may be poorly regulated, particularly in poor or rural settings.
- This raises general concerns for equitable access to healthcare and is identified as a particular risk for oversupply of antibiotics, which may be contributing to the emergence of AMR.

Implications of all the available evidence

- Our results demonstrate the need to improve access to degree-qualified pharmacists across the country, but especially in poor and rural settings.
- The over-supply of poorly-regulated drug outlets creates a competitive environment where there is a lot of pressure to sell inappropriate antibiotics—interventions to moderate this are required. As a first step, implementation of existing policies on registration of drug outlets should be strengthened.

Introduction

Community drug outlets are the first point of healthcare contact for many people in low- and middle-income countries (LMICs), including in Southeast Asian countries such as Vietnam.[1–5] They play a vital role where healthcare systems are fragmented and difficult to access–providing access to healthcare advice and both prescribed and over-the-counter (OTC) medications. Miller et al.'s 2016 systematic review found that communities in Asia often choose community drug outlets for first contact because they are familiar, have long opening hours, do not require appointments, carry medications to treat most common illnesses, and allow the purchase of medicine in small quantities.[1]

There is global support for the expansion of pharmacy services, and access to qualified pharmacists is a marker of quality for national health systems.[6] However, this access is not universal. Global workforce reports from 2017, and current WHO data, show that the number of degree-qualified pharmacists per population is lower in low- or middle-income countries (10.7 and 11.2/100,000 population, respectively), than high income countries (22.3/100,000 population).[6–8] These figures vary by WHO regions, with the highest number of pharmacists/100,000 population in the European Region (62.6), and lowest in the African Region (8.1). Distribution within countries is also variable, with several studies having identified 'pharmacy deserts', where certain geographic or sociodemographic communities lack access to quality pharmacy services.[9,10]

Southeast Asian is unique amongst the WHO regions for having more drug outlets than degree-qualified pharmacists. Despite having only 17.3 pharmacists per 100,000 population, it has a disproportionately large number of drug outlets. With 30.2 drug outlets per 100,000 population, it has only slightly fewer than the European Region (30.6).[7] Although pharmacist density is recognized as beneficial, the role of drug outlet density is less well-defined, and it is plausible that a high density of drug outlets without pharmacist supervision could place communities at risk of excessive or inappropriate access to potentially harmful medications, including antimicrobial agents. Although Vietnam is in the WHO Western Pacific Region, it shares many similarities with its close geographic Southeast Asian neighbours.

Inappropriate dispensing of antimicrobials in community drug outlets is recognised as a major problem, and potential driver of antimicrobial resistance (AMR), in many LMICs, including Vietnam.[11] According to a recent meta-analysis, the pooled proportion of inappropriate antimicrobial sales in community pharmacies without a prescription was 62% (95% CI 53–72%) globally, and 65% (95% CI 54–76%) in Asia.[12] A recent standardised patient ('mystery shopper') survey of drug outlets in Vietnam revealed that patient actors with viral upper respiratory tract infection symptoms were given antimicrobials inappropriately in 92% (95% CI 88–95%) of the encounters.[13] Similarly, drug outlets in Vietnam dispensed antimicrobials inappropriately without a prescription to 90% of patient actors presenting with presumptive tuberculosis symptoms and 70% with presumptive multi-drug-resistant tuberculosis symptoms, with no clear follow-up plan.[14]

Vietnam has 33.9 pharmacists per 100,000 population[6] and a very high number of community drug outlets. In 2015, it was estimated that there were 57,000 registered retail drug outlets in Vietnam, or 66 per 100,000 population.[15] In 2019 Nguyen et al. counted both registered and unregistered drug outlets in a rural province of Vietnam and found there were 183 drug outlets per 100,000 population.[5] This apparent dramatic oversupply was acknowledged by drug outlet staff interviewed as part of that study, and was used in part to explain the high proportion of inappropriate antimicrobial dispensing observed.[5]

The drug outlets people visit in Vietnam range from large urban outlets staffed by degree-qualified pharmacists to small rural outlets staffed by counter-assistants with little or no formal pharmacy training.[16–18] There are three official tiers of drug outlet in Vietnam. Pharmacies, 'Nha Thuoc', are the highest-level drug outlet and are only registered to bachelor degree-qualified pharmacists (BSc or BPharm).[19] Drug-counters, 'Quay thuoc', are registered to college diploma-qualified pharmacy technicians (CDPharm) or Secondary diploma in pharmacy.[19] Both may be private or government run. Finally, there are medical stations which contain limited supplies of emergency medications, and are state administered. All are legally required to display their registration number and qualifications on outside signage, such that members of the community can be properly informed about their status.

Mapping of pharmacies has proven an effective way to investigate access to quality pharmacy services, and allows investigation of economic, racial/ethnic, and urban-rural inequalities.[20–26] For instance, Ikram and colleagues (2015) studied pharmacy distribution in Baton Rouge, Louisiana (USA) and detected significant differences in pharmacy coverage and accessibility between different local communities.[26] Another study in São Mateus City (Brazil) reported significant geographic variation in pharmacy coverage.[25] Yeeun Kim in Seoul (South Korea) reported vulnerable areas with low accessibility to either public or private health services.[27] There are limited mapping data of pharmacies in LMICs generally, and in Vietnam in particular. Most existing publications concerning community drug outlets from LMICs focus on pharmacy practices or sellers/consumers' knowledge and attitudes to medication[28–32] rather than accessibility. Where mapping has been conducted, the geographical area is often insufficient to reflect the overall complexity of pharmacy coverage and accessibility.[33,34]

Given the distinctive per capita figures for pharmacists and drug outlets in Vietnam, and the established problems with oversupply of non-prescription antimicrobial medications, we decided to map their geographic distribution and investigate community access to quality pharmacy services. Our aims were to investigate the distribution of different tiers of drug outlets and their association with socio-economic factors. We hypothesised: (i) urban communities would have better access to drug outlets than rural communities; (ii) communities with higher socio-economic status would be served by a higher density of drug outlets; (iii) access to higher-level drug outlets (e.g served by degree-level pharmacist, registered with local authorities) would be greater in urban areas and for those with higher socio-economic status.

Methods

Study design

We conducted a cross sectional mapping survey of retail drug outlets in four provinces of Vietnam 2019. This study was conducted as part of the VRESIST project–a cluster randomised clinical trial aimed at reducing inappropriate use of antimicrobial drugs in the community (https://vresist.sydney.edu.au/). VRESIST is funded by the Australian government and run jointly by the Vietnam National Institute for Hygiene and Epidemiology (Ha Noi, Vietnam), the Woolcock Institute for Medical Research (Ha Noi, Vietnam), and the University of Sydney (Sydney, Australia). The current project provided baseline data for VRESIST, as well as enabling us to answer our specific hypotheses.

Definitions of drug outlets and staff qualifications

In this paper, the term 'drug outlets' covers pharmacies, drug counters, and medical stations. Unregistered drug outlets were defined as those where the legally required registration details on their public signage was incomplete or absent. We categorized pharmacist qualifications as degree-level with a Bachelor of Pharmacy (BPharm),[19] diploma-level with College Diploma in Pharmacy (CDPharm),[19] or no/unknown qualification, per Table 1.

Identification of study areas

Vietnam is administratively divided into 63 provinces, 618 districts, and about 11,000 communes. We conducted mapping in four provinces, two northern (Ha Noi and Thanh Hoa) and two southern (An Giang and Ca Mau).

Pharmacist qualification per sign	Classification for study purposes
Dược sĩ đại học (DSDH) (BSc Pharmacy/Bachelor of Pharmacy)	Degree-level pharmacist
Dược sĩ cao đẳng dược (DSCDD) (Pharmacist with college degree)	Diploma level pharmacist
Dược sĩ trung học (DSTH) (Diploma pharmacist)	Diploma level pharmacist
Dược tá (Basic diploma in pharmacy)	Assistant pharmacist
Phụ trách chuyên môn (PTCM-Professional personnel)	Pharmacist (unknown qualification)
Dược sĩ hoặc Dược sĩ phụ trách (DS or DSPT)	Pharmacist (unknown qualification)

Table 1: **Qualifications observed on signage of Vietnamese drug outlets and their classification for study purposes.**

Within each study province, we identified clusters of communes in which to perform detailed mapping, according to a stratified sampling approach. Firstly, for the safety and convenience of fieldworkers, we excluded any districts with an urban centre located greater than 2 h by car or 150 km by road from the provincial urban center, according to Google Maps. In Ha Noi province, we excluded the metropolitan districts of Ha Noi city centre, as data from a capital city is unlikely to be generalizable to the rest of the country.

For the remaining districts we defined sub-district clusters to be mapped. We used the four most populous communes in each district as seed communes then selected neighbouring communes in a clockwise direction, until the resulting polygon contained approximately one quarter of the district population. We randomly selected one sub-district cluster from each district for the mapping study using the minimization method (Fig. 1).[35] Randomization was performed by a person not otherwise engaged in the process and blinded to the identity of the districts.

Sources and preparation for land geometry, population, land classification, and socioeconomic data

We imported map polygon data for Vietnam from the Database of Global Administrative Areas (GADM). We obtained the latest available high-quality population data from the VNM Population per Hectare 2015 (UN Adjusted) dataset, provided by WorldPop. We obtained land cover data for 2015 with 300 square-metre spatial resolution from the Land Cover CCI Climate Research Data Package (CRDP), Land Cover Maps v2.0.7, provided by the European Space Agency. Spatially granular socioeconomic data were obtained from a 2009 evaluation of poverty and development in Vietnam.[36]

Using QGIS (version 3.2.3) we calculated the population density of each commune as the average of the population-per-hectare values of the raster dataset within each commune polygon. We simplified the CRDP land cover (LCCS) categories to 'rural' and 'urban', based on LCCS values of 10–180 and 190, respectively. We used QGIS to determine the proportion of area defined as rural or urban for a given cluster. We assigned poverty rates for each cluster based on district level data.

Drug outlet mapping

Fieldworkers walked or drove a motorbike along every road in the selected survey clusters, following routes generated in Google Maps and monitored by the study coordinator using Strava. Fieldworkers used the mobile app Epicollect5[37] to record geographic and publicly displayed information on signage for every drug outlet observed. Key data collected included location (address and latitude/longitude coordinates), type of drug outlet (pharmacy/drug counter/medical station), context (private or public), plus, as available, operating hours, chief pharmacist name and qualification, and business registration identification.

Data analysis

Primary analysis

Mixed-effects models were fitted with provinces included as random intercepts to allow the mean outcomes to vary by province. Two models were fitted to investigate the two outcomes, community drug outlet density and proportion of registered pharmacies, and their associations with the fixed effects, poverty rate and rural/urban land cover. In line with previous studies on the spatial distribution of community drug outlets,[25,34] we present density as the number of drug outlets per 100,000 population. The lme 4 package[38] was used to fit the mixed-effects models in RStudio Version 1.1.463.

Secondary analysis

Our secondary analyses further investigated the differences in access to pharmacy services for rural vs urban communities. Based on data from Land Cover CCI Climate Research Data Package (CRDP) Land Cover Maps v2.0.7 raster dataset, we classified study areas in the highest quartile for urban land cover as 'urban', and those in the lowest quartile as 'rural' (Hypothesis 1).

We then estimated the proportions of the population within 400 m and 1000 m radius of all drug outlets (approximately 5 min walking or 5 min driving by motorbike, respectively), overall and by urban/rural dwelling (Hypothesis 2). For this, we merged maps with 400 m and 1000 m buffer zones around drug outlets with the WorldPop VNM Population per Hectare 2015 (UN Adjusted) raster maps, and calculated the population within each of the buffer zones as a

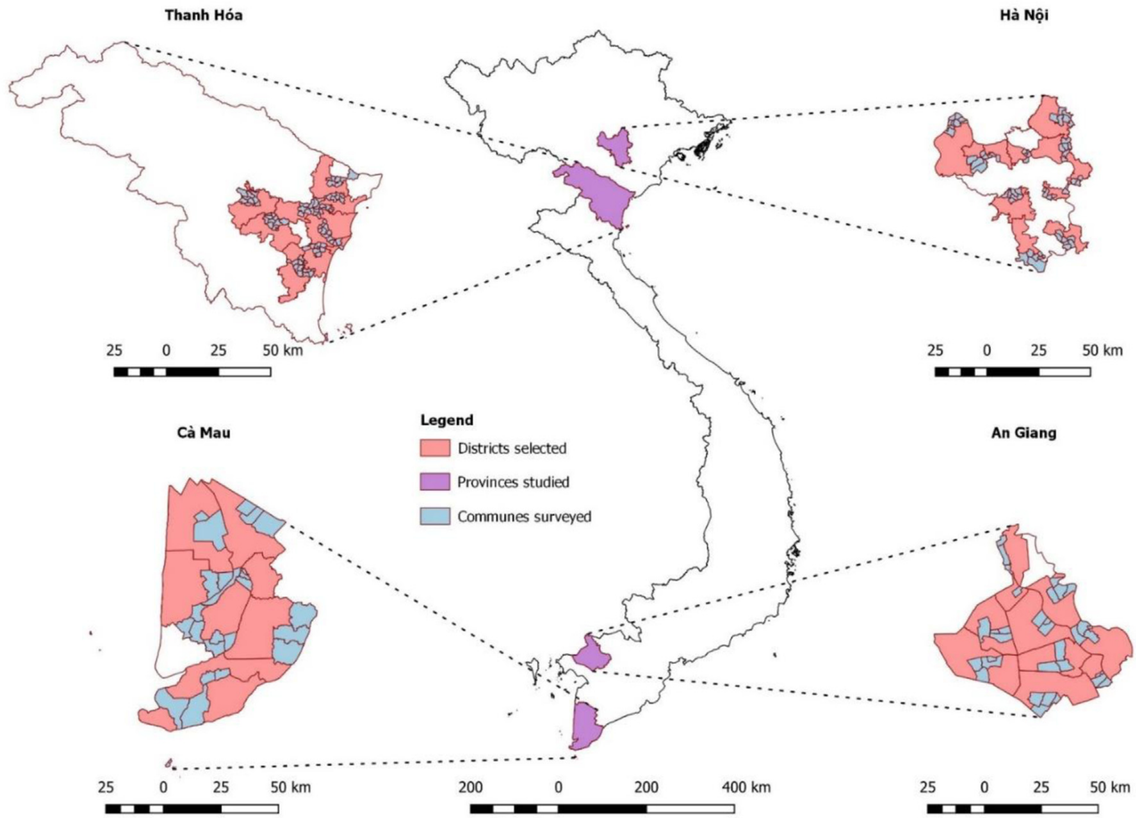

Fig. 1: Map of Vietnam highlighting provinces, districts and communes studied.

proportion of the total commune population. Using the same process, we estimated the proportion of the population within 400 m and 1000 m buffer zones of registered drug outlets and outlets with various pharmacist qualifications as listed previously (see example, Fig. 2) (Hypothesis 3). We compared these markers of access between rural/urban communes. For each drug outlet type, we used the t-distribution to calculate the 95% confidence intervals for the 'urban' and 'rural' categories, and Wilcoxon Rank Sum Tests to assess the significance of variation of access to drug outlets between the 'urban' and 'rural' areas.

Ethical considerations
Ethical approval was provided by the National Institute of Hygiene and Epidemiology Vietnam (HDDD—41/2018), and the University of Sydney Human Research Ethics Committee (2018/912). Approval from the Ministry of Health Vietnam was also obtained.

Role of the funding source
No funding bodies had any role in the study design, data collection, analysis or decision to publish.

Results
Description of pharmacies and study areas
Between 01/01/2019 and 31/05/2019 we mapped the location and features of 1972 drug outlets, in 40 study clusters (containing 202 communes) across 4 provinces of Vietnam. The total population living within our study areas was 1.96 million people, and the mean density of drug outlets was 101.6 per 100,000 population. Of the 1972 drug outlets mapped: 1039 (53%) publicly displayed their registration status on their store signboards in line with legal requirements; 103 (5.2%) identified the presence of a degree-qualified pharmacist; 180 (9%) were classified as pharmacies, 1574 (80%) as drug counters, and 218 (11%) as medical stations (Table 2).

Primary analysis
Our multivariate model identified inverse relationships between density of drug outlets and both the proportion of rural land cover and the average poverty index in a cluster (i.e. there was a lower density of drug outlets in more rural areas (p = 0.03) and in areas with a higher poverty index (p = 0.006)). The relationship between rural land cover or the poverty index and the proportion

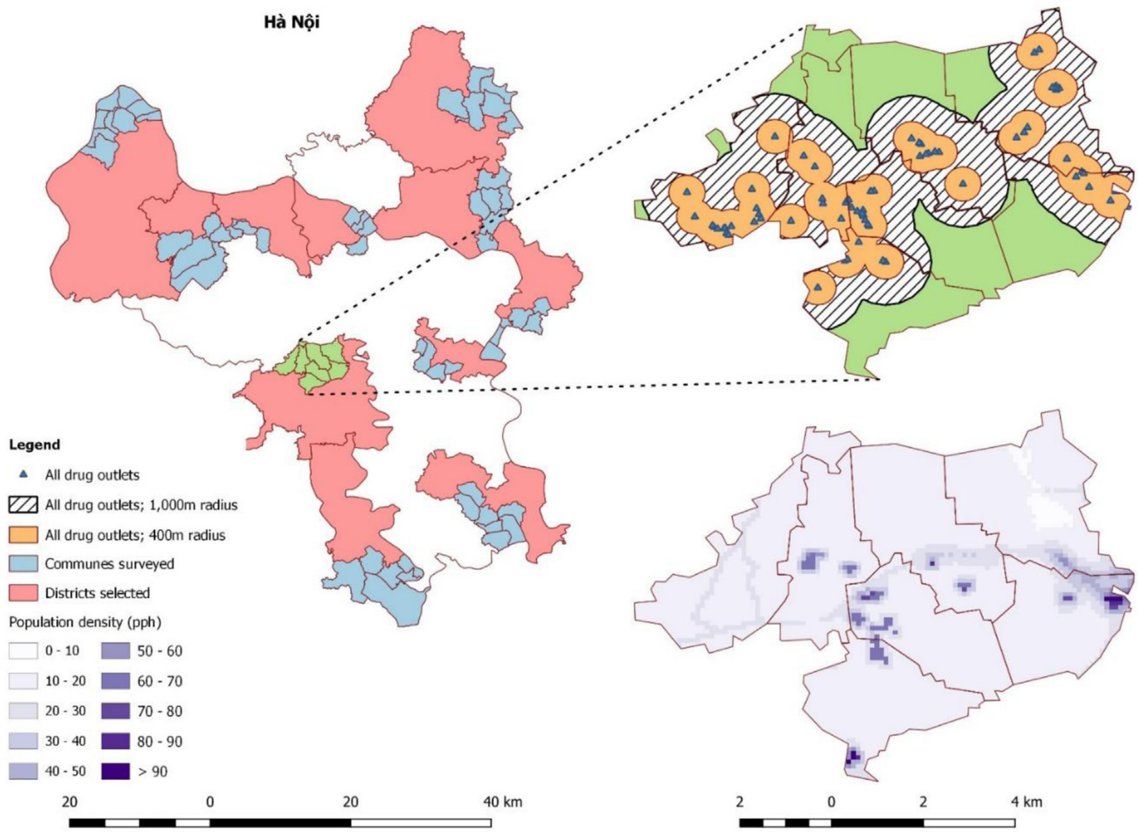

Fig. 2: Example maps: Ha Noi. Showing clusters of communes surveyed (left), with one cluster highlighted in green 'zoomed in' to demonstrate 400 m and 1 km buffer zones (top right) and population density (bottom right).

Demographics	All districts (n = 40)		Hà Nội districts (n = 11)		Thanh Hóa districts (n = 10)		An Giang districts (n = 10)		Cà Mau districts (n = 9)	
	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
Population density (pph)	9.6	(7.7–11.6)	14.7	(10.6–18.8)	10.7	(8–13.4)	8.2	(4.8–11.5)	3.8	(1.7–6)
Poverty index	0.057	(0.046–0.067)	0.023	(0.012–0.035)	0.053	(0.042–0.065)	0.059	(0.039–0.078)	0.099	(0.084–0.114)
Proportion rural land cover	0.879	(0.842–0.916)	0.833	(0.752–0.914)	0.948	(0.904–0.991)	0.889	(0.821–0.958)	0.846	(0.744–0.949)
Proportion urban land cover	0.071	(0.04–0.102)	0.118	(0.049–0.188)	0.029	(0.006–0.053)	0.078	(0.025–0.13)	0.053	(0.0–0.153)
Drug outlets										
Number of drug outlets (total)	1972		810		479		429		254	
	Mean	**95% CI**	**Mean**	**95% CI**	**Mean**	**95% CI**	**Mean**	**95% CI**	**Mean**	**95% CI**
Drug outlet density (outlets per 100,000 people)	101.6	(85.6–117.7)	133.0	(88.9–177.2)	97.7	(86.7–108.7)	88.9	(71.2–106.7)	81.7	(38.6–124.9)
Proportion 'pharmacies'	0.091	(0.02–0.163)	0.019	(0.006–0.033)	0.091	(0.0–0.195)	0.188	(0.0–0.452)	0.072	(0.0–0.204)
Proportion 'drug counters'	0.798	(0.729–0.868)	0.894	(0.861–0.927)	0.744	(0.641–0.848)	0.718	(0.466–0.97)	0.831	(0.714–0.948)
Proportion 'medical stations'	0.110	(0.092–0.128)	0.087	(0.058–0.115)	0.164	(0.128–0.201)	0.094	(0.061–0.127)	0.097	(0.059–0.134)
Registration										
Proportion displaying registration	0.527	(0.449–0.605)	0.323	(0.261–0.385)	0.311	(0.229–0.393)	0.765	(0.699–0.83)	0.752	(0.662–0.842)
Pharmacists										
Proportion with named pharmacist	0.710	(0.669–0.75)	0.646	(0.571–0.721)	0.611	(0.576–0.645)	0.792	(0.717–0.867)	0.806	(0.735–0.877)
BPharm qualification	0.052	(0–0.105)	0.007	(0.001–0.012)	0.031	(0.003–0.059)	0.155	(0.0–0.368)	0.019	(0.0–0.05)
CDPharm qualification	0.427	(0.345–0.509)	0.291	(0.212–0.369)	0.230	(0.149–0.311)	0.566	(0.36–0.771)	0.657	(0.528–0.787)
Unknown qualification	0.224	(0.173–0.275)	0.337	(0.258–0.416)	0.342	(0.283–0.401)	0.071	(0.031–0.112)	0.126	(0.017–0.234)

Table 2: **Study area characteristics (pph = people per hectare; 95% CI = 95% confidence interval).**

of drug outlets with registration displayed in a cluster did not reach significance (Table 3).

Secondary analysis

The highest quartile for proportion of urban land coverage ranged from 0.07–1.0. The 51 communes in this range were classified as 'urban'. The lowest quartile had an urban land coverage proportion of zero—the 96 communes with zero urban land coverage were classified 'rural'.

Urban communes had a mean density of 174.1 pharmacies per 100,000 population compared to 93.2 for rural communes. In urban communes, the mean proportion of drug outlets identifying the presence of a degree-qualified pharmacist was 9.1%, whilst in rural communes it was <0.1%.

The results of 400 m and 1000 m buffer analyses are shown in Table 4. Overall, 51% of the population in urban communities lived within 400 m of a drug outlet, compared to 23% for their rural counterparts ($p < 0.001$). A higher percentage of urban vs rural dwellers lived within 400 m of both registered drug outlets (35% vs 10%; $p < 0.001$) and degree-level pharmacists (44% vs 17%; $p < 0.001$).

The same trends were observed in the 1,000 m scenario. Notably, the 1,000 m radius for all drug outlets covered 74% of urban populations and 36% of rural populations ($p < 0.001$) (Table 4).

Discussion

In this study we studied almost 2000 drug outlets in four provinces of Vietnam. We collected data observable to a passer-by to provide a snapshot of the current landscape of drug dispensing facilities. It is a legal requirement for drug outlets in Vietnam to display information on their registration with local authorities alongside details of the chief pharmacist. We observed a high rate of missing information regarding pharmacist qualification and business registration on drug outlet signage. Our main finding is a very high density of community drug outlets with significant differences between rural and urban accessibility. This incomplete display of registration information disempowers consumers and compromises their ability to choose quality health services. In concert with an undersupply of degree qualified pharmacists and high prevalence of 'drug-counters', it creates opportunities for antimicrobial misuse in the community and the subsequent spread of pathogen resistance.

Understanding that pharmacies are often the first source for healthcare in LMICs, including Vietnam, the 'pharmacy deserts' described elsewhere would be a concern. However, our most striking observation is that the density of drug outlets in Vietnam is extremely high. Previous estimates of the density of drug outlets in Vietnam, based on business analyses, suggested 66/100,000 population.[15] In our study we observed a density of registered drug outlets of 52.8/100,000 population. Both figures are high even by the standard of Southeast Asia, where WHO estimates the density of drug outlets as 30.2/100,000 population.

Even more striking is the density of registered and apparently unregistered drug outlets, combined. Almost half of all drug outlets were apparently unregistered, with a combined density of 101.6/100,000 population (range by province 81.7–133/100,000 population), in which most of them were drug counters. One study cluster had a drug outlet density of 323/100,000 population (of which 36.6% displayed their registration). Our estimates are likely to be robust, as they are based on a large and diverse sample area, and are supported by a previous single-district study from Nguyen et al. 2019[5] where they identified a total density of 186/100,000 population (with more drug outlets unregistered than registered). A high density of drug outlets has been identified as a potential driver for poor dispensing practice in Vietnam, due to the need to compete with other drug-sellers by giving the customer whatever they request.[5] The problem is compounded by the apparent low rate of registration (all types of drug outlets in Vietnam are legally required to display their registration number and chief pharmacist's qualifications on outside signage), which raises red-flags for quality of care and products available to communities. Recent studies in Vietnam have found that drug outlets without registration information on their signage provided poorer quality of care for simulated patients with symptoms of tuberculosis and viral infections including inappropriate provision of antimicrobials, compared to registered pharmacies.[13,14] In concert with an undersupply of degree qualified pharmacists and high prevalence of 'drug-counters', it creates opportunities for antimicrobial

	Drug outlet density (drug outlets per 100,000 people)		Proportion of registered drug outlets	
	β (95% CI)	p-value	β (95% CI)	p-value
Rural land cover proportion	−134.3 (−232.4, −36.2)	0.03	−0.28 (−0.57, 0.011)	0.11
Poverty rate	−601.8 (−936.5, −267.3)	0.006	−0.87 (−2.25, 0.68)	0.33

Table 3: **Results of mixed effect models showing relationships of: drug outlet density with poverty and rural land cover; proportion of drug outlets displaying registration with poverty and rural land cover.**

Population fraction within radius of 400 m	400 m radius from drug outlet				
	Rural (n = 96)		Urban (n = 51)		p-value
	Mean	95% CI	Mean	95% CI	
All drug outlets	0.226	(0.197, 0.256)	0.511	(0.453, 0.568)	<0.001
Unregistered drug outlets	0.184	(0.156, 0.211)	0.417	(0.359, 0.475)	<0.001
Registered drug outlets	0.104	(0.083, 0.125)	0.345	(0.282, 0.408)	<0.001
Pharmacist qualification					
BPharm	0.169	(0.142, 0.197)	0.438	(0.382, 0.495)	<0.001
CDPharm	0.003	(0.000, 0.006)	0.074	(0.041, 0.107)	<0.001
Unknown	0.107	(0.086, 0.127)	0.257	(0.191, 0.322)	<0.001
Population fraction within radius of 1000 m	**1000 m radius from drug outlet**				
	Rural (n = 96)		Urban (n = 51)		p-value
	Mean	95% CI	Mean	95% CI	
All drug outlets	0.616	(0.561, 0.671)	0.914	(0.848, 0.979)	<0.001
Unregistered drug outlets	0.556	(0.498, 0.614)	0.861	(0.787, 0.935)	<0.001
Registered drug outlets	0.372	(0.319, 0.424)	0.742	(0.659, 0.824)	<0.001
Pharmacist qualification					
BPharm	0.522	(0.464, 0.581)	0.861	(0.801, 0.921)	<0.001
CDPharm	0.016	(0.001, 0.030)	0.239	(0.153, 0.326)	<0.001
Unknown	0.384	(0.328, 0.440)	0.629	(0.526, 0.732)	<0.001

p-values by Wilcoxon Rank Sum Test.

Table 4: **Results of secondary buffer radius analysis.**

misuse in the community and the subsequent spread of pathogen resistance.

We identified some important differences in access to drug outlets in urban vs rural areas. There was a clear relationship between increasing rural land cover and decreasing density of drug-outlets per population, such that for every 10% increase in rural land cover we would expect 13 fewer drug outlets/100,000 population. Fifty-one percent of the urban population sample lived within 5-min walk of a drug outlet, compared to 22.6% of the rural population. The differential distribution of drug outlets between urban and rural settings is not unique to Vietnam. Schommer et al. reported metropolitan designation and population density as determining factors for the density and distribution of community pharmacies in Minnesota, USA.[39] They argued that city roads, transport hubs, and communication lines provided the infrastructure, while higher population density translated into higher demand for services and supply of workforce.[39] Within the Southeast Asia region, in Thailand, 34% of pharmacies are located in Bangkok (density 47.2/100,000 population) with the remaining dispersed throughout regional areas (density 13.3/100,000), as calculated based on the 2010 census.[40]

We also observed a significant relationship between increasing rates of poverty and decreasing density of drug outlets, even correcting for the effect of poverty being concentrated in rural areas of Vietnam.[36] Based on our model, for every 1% increase in people living below the poverty line, we would expect 6 fewer drug outlets/100,000 population.

Although our primary regression analysis failed to show a significant relationship between rural areas and the proportion of pharmacies displaying their registration, our secondary comparative analysis showed an effect. In urban areas a higher proportion of the pharmacies were registered pharmacies as compared to rural areas. It is possible that pharmacies in rural areas are visited less frequently by any regulatory officials due to the distance from main cities and therefore have "escaped" from law enforcement authorities. Similarly poor regulatory compliance among pharmacies in rural areas was previously shown in many Low-and-Middle income countries including Sri Lanka and Indonesia.[41,42]

The percentage of the population within 400 m and 1000 m radius, a BSc degree-level pharmacist (BPharm) in urban areas was higher than in rural areas. Therefore, this shows that the rural population had relatively less access to registered drug outlets with degree-level pharmacists than urban dwellers—further restricting their healthcare options. Accessibility is important, since close proximity to a facility, not lower cost or better service quality, has been described as the deciding factor underlying healthcare choices in Vietnam.[43]

It is plausible that inadequately trained drug outlet staff over-dispense medications like antimicrobials, and act as potential drivers for increased rate of antimicrobial consumption and resistance in Vietnam.[13,14]

According to our results, rural or poor people may have reduced access to registered outlets with degree-qualified staff, and this could be a barrier to receiving adequate health information or appropriate medication. This compounds already described differences in the level of healthcare expertise in rural vs urban setting.[1,13,14,31]

This study has several policy and public health implications. First, it emphasises the importance of improving the implementation of policies on registration of drug outlets. Second, it indicates that access to high-quality pharmacy services in rural areas should be a priority.

Limitations

Due to accessibility issues and resourcing, we restricted rural study areas to areas within 2 h drive of an urban centre. Our rural clusters may not be representative of more isolated rural areas and to the entire nation. In this study we collected data on registration from signs displayed publicly, as legally required. We did not have ethical approval to enter stores, and our ethics approval expressly forbade sharing information with authorities that could potentially implicate business owners in wrongdoing. Therefore, we were unable to corroborate roadside observations with registries held by local authorities. However, the consistency of our findings with other studies, and with data published on the total number of registered pharmacies in Vietnam, suggests that many of these apparently unregistered drug outlets are genuinely unregistered.

Conclusion

Vietnam appears to be over-supplied with drug outlets compared to other countries, both globally and within the region. Apparently unregistered drug outlets, staffed by people unqualified to provide healthcare or pharmaceutical advice, are prevalent, especially in poor and rural areas. This raises general concerns for equitable access to healthcare and is identified as a particular risk for oversupply of antimicrobials, which may be contributing to the emergence of AMR.

Contributors

JB, TTL, TA, PTTV, THH, TTMH, CHT, DDA, and GF were responsible for conception and study design. JB, JMC, TTL, SZ, HL, MW, PTTV, NTCV, THH, and TTMH were responsible for data curation. JB, JMC, TTL, SZ, HL, TA, and GF accessed and verified the data. HL and TTL coordinated study activities across the sites with a supervision of TA and JB. JMC and TTL led the data analysis with a supervision of JB and GF. JB, JMC, and TTL drafted the manuscript with a supervision of GF. All authors contributed to the final version of the manuscript and approved the submission. All authors had full access to all the data in the study, and the corresponding author had final responsibility to submit for publication.

Data sharing statement

Data may be available according to data sharing policy of the local partners and ethics committees upon request to the corresponding author.

Editor note

The Lancet Group takes a neutral position with respect to territorial claims in published maps and institutional affiliations.

Declaration of interests

The authors declare that they have no conflict interests.

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